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Original Research Article

THE EFFECTS OF DEXMEDETOMIDINE INFUSION ON POST OPERATIVE RECOVERY SCORES AND ANALGESIC REQUIREMENT IN PATIENTS UNDERGOING LAPAROSCOPIC CHOLECYSTECTOMY MAINTAINED ON SEVOFLURANE UNDER GENERAL ANAESTHESIA

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ABSTRACT

Background: Laparoscopic cholecystectomy under general anaesthesia is associated with perioperative stress responses and postoperative pain, which may influence recovery quality. Dexmedetomidine, a selective α2-adrenergic agonist, has been increasingly used as an anesthetic adjuvant due to its sedative, analgesic, and opioid-sparing properties. The aim is to evaluate the effects of dexmedetomidine infusion on postoperative recovery scores and analgesic requirement in patients undergoing laparoscopic cholecystectomy maintained on sevoflurane under general anaesthesia.

Materials and Methods: This hospital-based, prospective, double-blind randomized controlled trial included 80 patients (ASA I–II) undergoing elective laparoscopic cholecystectomy. Patients were randomly allocated into two groups: Group D (dexmedetomidine, n=40) received a loading dose of dexmedetomidine followed by intraoperative infusion, while Group C (control, n=40) received normal saline. Anaesthesia was maintained with sevoflurane. Postoperative recovery was assessed using emergence times, Ramsay Sedation Score, Modified Aldrete Score, pain intensity using Visual Analogue Scale (VAS), time to first analgesic request, and total postoperative rescue analgesic consumption over 24 hours.

Results: Dexmedetomidine significantly prolonged early recovery parameters such as emergence, response to commands, and orientation ($p<0.001$) and resulted in higher early postoperative sedation scores. However, Modified Aldrete Scores and PACU discharge times were comparable between groups. Postoperative pain scores were significantly lower in the dexmedetomidine group at most time intervals, with a markedly prolonged time to first analgesic requirement and a significant reduction in total tramadol consumption over 24 hours ($p<0.001$).

Conclusion: Intraoperative dexmedetomidine infusion provides superior postoperative analgesia and significant opioid-sparing effects with acceptable and transient sedation, without delaying discharge readiness. Dexmedetomidine is an effective anesthetic adjuvant for laparoscopic cholecystectomy under sevoflurane-based general anaesthesia.

Keywords: Dexmedetomidine. Postoperative recovery. Laparoscopic cholecystectomy.

INTRODUCTION

Laparoscopic cholecystectomy is one of the most commonly performed minimally invasive surgical procedures worldwide and is associated with significant perioperative physiological stress despite its minimally invasive nature. The creation of pneumoperitoneum, patient positioning, and airway manipulation during general anaesthesia provoke sympathetic stimulation, leading to tachycardia, hypertension, and increased myocardial oxygen demand. These responses may adversely influence perioperative hemodynamic stability and postoperative recovery, particularly in susceptible patients. Therefore, optimizing anesthetic techniques to attenuate stress responses while ensuring rapid recovery and effective postoperative analgesia remains a major goal of modern anesthetic practice.[1]

Sevoflurane is widely used for maintenance of general anaesthesia in laparoscopic surgeries due to its rapid onset and offset, favorable hemodynamic profile, and smooth emergence characteristics. However, volatile anesthetics alone may not sufficiently blunt the stress responses associated with laryngoscopy, pneumoperitoneum, and surgical stimulation. Additionally, higher concentrations of inhalational agents may delay emergence and prolong recovery, adversely affecting postoperative recovery scores and discharge from the post-anesthesia care unit (PACU).

Dexmedetomidine, a highly selective α2-adrenergic agonist, has emerged as an important anesthetic adjuvant due to its sedative, analgesic, sympatholytic, and anesthetic-sparing properties. Unlike other sedatives, dexmedetomidine produces a unique form of sedation resembling natural sleep, allowing easy arousability without respiratory depression. Its central sympatholytic action leads to attenuation of perioperative stress responses, reduction in heart rate and blood pressure fluctuations, and decreased catecholamine release. These properties make dexmedetomidine particularly advantageous in laparoscopic surgeries where hemodynamic perturbations are common.[2]

Several studies have demonstrated that intraoperative dexmedetomidine infusion reduces the requirement of inhalational anesthetics, opioids, and muscle relaxants while providing superior perioperative hemodynamic stability. Furthermore, its analgesic properties have been shown to reduce postoperative pain scores and opioid consumption, thereby minimizing opioid-related adverse effects such as nausea, vomiting, and respiratory depression. However, concerns persist regarding delayed emergence and prolonged sedation when dexmedetomidine is used in higher doses or continued until the end of surgery.[3]

Postoperative recovery quality is increasingly recognized as a crucial outcome parameter, assessed using standardized recovery scores such as the Modified Aldrete Score and Ramsay Sedation Score. Early attainment of discharge criteria from PACU, adequate pain control, and minimal sedation are essential for enhanced recovery protocols. While dexmedetomidine has been extensively studied in various surgical populations, its impact on postoperative recovery profiles and analgesic requirements specifically in patients undergoing laparoscopic cholecystectomy under sevoflurane-based general anaesthesia remains an area of clinical interest.[4]

Aim: To evaluate the effects of dexmedetomidine infusion on postoperative recovery scores and analgesic requirement in patients undergoing laparoscopic cholecystectomy maintained on sevoflurane under general anaesthesia.

Objectives

1. To compare postoperative recovery profiles using Modified Aldrete and Ramsay Sedation Scores between dexmedetomidine and control groups.
2. To assess postoperative pain scores and time to first analgesic requirement in both groups.
3. To compare total postoperative rescue analgesic consumption within 24 hours between the two groups.

MATERIALS AND METHODS

Source of Data: Data were collected from patients undergoing elective laparoscopic cholecystectomy at the Department of Anaesthesiology, Jawaharlal Nehru Hospital and Research Centre, Bhilai, Chhattisgarh.

Study Design: This study was a hospital-based, prospective, double-blind randomized controlled trial.

Study Location: The study was conducted in the Department of Anaesthesiology, JLN Hospital and Research Centre, Bhilai, Chhattisgarh.

Study Duration: The study was carried out over a period of nine months from January 2018 to September 2018.

Sample Size: A total of 80 patients were enrolled and randomly allocated into two groups:

- **Group C (Control group):** 40 patients receiving normal saline
- **Group D (Dexmedetomidine group):** 40 patients receiving dexmedetomidine infusion

Sample size calculation was based on recovery profile parameters as described in previous literature.

Inclusion Criteria

- Patients aged 18–65 years
- ASA physical status I and II
- BMI < 30 kg/m²
- Patients undergoing elective laparoscopic cholecystectomy

Exclusion Criteria

- Refusal to participate
- Pregnancy or lactation
- Baseline heart rate <55/min or heart block
- Significant cardiovascular, hepatic, renal, or endocrine disease

- Known allergy to dexmedetomidine
- Patients on sedatives, opioids, or psychiatric medications
- Conversion to open cholecystectomy

Procedure and Methodology: After obtaining institutional ethical clearance and written informed consent, patients were randomized using computer-generated randomization. Standard monitoring was applied, and baseline vitals were recorded. Group D received dexmedetomidine 0.5 µg/kg diluted in 20 ml normal saline over 10 minutes before induction followed by an infusion of 0.5 µg/kg/hr intraoperatively, while Group C received an equivalent volume of normal saline. Anaesthesia was induced with propofol, fentanyl, and vecuronium and maintained with sevoflurane, oxygen, and nitrous oxide. Study drug infusion was discontinued after gall bladder dissection. Recovery endpoints, pain scores, sedation scores, and analgesic requirements were recorded as per protocol study proforma

Sample Processing: All observations were recorded in a predesigned and pretested study proforma and compiled for analysis.

Data Collection: Intraoperative hemodynamic parameters, recovery endpoints, Ramsay Sedation Scores, Modified Aldrete Scores, VAS pain scores, time to first analgesic request, and total rescue analgesic consumption were documented.

Statistical Methods: Data were entered in Microsoft Excel and analyzed using SPSS version 20. Quantitative variables were expressed as mean ± SD and compared using unpaired t-test. Qualitative variables were expressed as percentages and analyzed using Chi-square or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULTS

[Table 1] states that the two study groups were comparable with respect to baseline demographic and clinical characteristics. The mean age of patients in Group D (39.98 ± 9.68 years) was similar to that of Group C (38.43 ± 10.43 years), with no statistically significant difference (p = 0.49). The gender distribution was also comparable, with males constituting 42.5% in Group D and 55.0% in Group C (p = 0.26). Mean body weight did not differ significantly between Group D (68.50 ± 11.21 kg) and Group C (71.20 ± 11.06 kg) (p = 0.28). The proportion of ASA physical status I patients was similar in both groups (67.5% in Group D vs 60.0% in Group C; p = 0.48). Additionally, the duration of surgery was comparable between the two groups (64.08 ± 5.02 min in Group D vs 62.28 ± 3.09 min in Group C; p = 0.87).

Table 1: Baseline comparability of study groups (n=80)

Variable	Group D (n=40)	Group C (n=40)	Test of significance	Difference D-C (95% CI)	p value
Age (years)	39.98 ± 9.68	38.43 ± 10.43	t = 0.69	1.55 (-2.93 to 6.03)	0.49
Male sex, n (%)	17 (42.5)	22 (55.0)	χ^2 = 1.25	-12.5% (-34.2 to 9.2)	0.26
Body weight (kg)	68.50 ± 11.21	71.20 ± 11.06	t = -1.08	-2.70 (-7.65 to 2.25)	0.28
ASA I, n (%)	27 (67.5)	24 (60.0)	χ^2 = 0.49	7.5% (-13.5 to 28.5)	0.48
Duration of surgery (min)	64.08 ± 5.02	62.28 ± 3.09	t = 1.93	1.80 (-0.05 to 3.65)	0.87

Table 2: Postoperative recovery profiles (PACU) and recovery endpoints

Variable	Group D (n=40)	Group C (n=40)	Test of significance	Difference D-C (95% CI)	p value
Emergence (eye opening), min	5.90 ± 0.74	4.35 ± 0.53	t = 10.77	1.55 (1.26 to 1.84)	<0.001
Response to commands, min	6.60 ± 0.59	4.90 ± 0.67	t = 12.04	1.70 (1.42 to 1.98)	<0.001
Orientation, min	8.15 ± 0.80	6.03 ± 0.58	t = 13.57	2.12 (1.81 to 2.43)	<0.001
Ramsay Sedation Score (0 min)	1.88 ± 0.33	1.00 ± 0.00	t = 16.87	0.88 (0.78 to 0.98)	<0.001
Ramsay Sedation Score (15 min)	1.98 ± 0.36	1.03 ± 0.16	t = 15.25	0.95 (0.83 to 1.07)	<0.001
Ramsay Sedation Score (30 min)	2.00 ± 0.00	1.75 ± 0.44	t = 3.59	0.25 (0.11 to 0.39)	0.022
Ramsay Sedation Score (45 min)	2.00 ± 0.00	2.00 ± 0.00		0.00 (0.00 to 0.00)	0.535
Modified Aldrete (0 min)	7.88 ± 0.33	7.58 ± 0.50	t = 3.21	0.30 (0.11 to 0.49)	0.62
Modified Aldrete (15 min)	7.98 ± 0.16	8.00 ± 0.00	t = -0.79	-0.02 (-0.07 to 0.03)	0.264
Modified Aldrete (30 min)	8.43 ± 0.50	8.60 ± 0.50	t = -1.52	-0.17 (-0.39 to 0.05)	0.10
Modified Aldrete (45 min)	9.00 ± 0.00	9.00 ± 0.00		0.00 (0.00 to 0.00)	0.527
Recovery discharge time (min)	36.00 ± 7.44	33.75 ± 6.58	t = 1.43	2.25 (-0.89 to 5.39)	0.289

[Table 2] shows that postoperative recovery endpoints differed significantly between the two groups, particularly in early recovery parameters. Patients in Group D exhibited longer emergence time (5.90 ± 0.74 min) compared to Group C (4.35 ± 0.53 min), and this difference was statistically significant (p < 0.001). Similarly, time to response to commands and orientation were significantly prolonged in Group D compared to Group C (p < 0.001 for both). Ramsay Sedation Scores at 0, 15, and 30 minutes were significantly higher in Group D, indicating deeper early postoperative sedation (p < 0.05), while scores were comparable at 45 minutes. Modified Aldrete scores at various PACU intervals did not show clinically meaningful or statistically significant differences between the groups, and both groups

achieved an Aldrete score of 9 by 45 minutes. Recovery discharge time from PACU was slightly longer in Group D, but this difference was not statistically significant (p = 0.289).

Table 3: Postoperative pain (VAS) and time to first analgesic

Variable	Group D (n=40)	Group C (n=40)	Test of significance	Difference D-C (95% CI)	p value
VAS 0.5 h	0.58 ± 0.59	3.75 ± 1.19	t = -15.09	-3.17 (-3.59 to -2.75)	<0.001
VAS 1 h	1.63 ± 0.54	3.23 ± 1.90	t = -5.12	-1.60 (-2.22 to -0.98)	<0.001
VAS 1.5 h	2.50 ± 0.64	1.83 ± 0.81	t = 4.10	0.67 (0.35 to 0.99)	<0.001
VAS 2 h	3.43 ± 0.90	2.50 ± 0.85	t = 4.75	0.93 (0.54 to 1.32)	<0.001
VAS 2.5 h	1.73 ± 1.11	3.35 ± 1.29	t = -6.02	-1.62 (-2.16 to -1.08)	<0.001
VAS 3 h	1.40 ± 0.67	3.38 ± 1.58	t = -7.19	-1.98 (-2.53 to -1.43)	<0.001
VAS 3.5 h	1.75 ± 0.54	2.75 ± 1.55	t = -3.90	-1.00 (-1.51 to -0.49)	<0.001
VAS 4 h	2.05 ± 0.45	2.98 ± 1.39	t = -4.11	-0.93 (-1.38 to -0.48)	<0.001
VAS 6 h	2.45 ± 0.88	3.05 ± 1.41	t = -2.29	-0.60 (-1.12 to -0.08)	0.023
VAS 8 h	2.70 ± 0.99	3.23 ± 1.46	t = -1.89	-0.53 (-1.09 to 0.03)	0.024
VAS 10 h	1.88 ± 0.82	2.80 ± 1.45	t = -3.51	-0.92 (-1.44 to -0.40)	<0.001
VAS 14 h	1.73 ± 0.51	2.88 ± 1.51	t = -4.65	-1.15 (-1.64 to -0.66)	<0.001
VAS 18 h	1.93 ± 0.47	2.93 ± 1.40	t = -4.28	-1.00 (-1.47 to -0.53)	<0.001
VAS 22 h	2.13 ± 0.33	2.88 ± 1.16	t = -4.00	-0.75 (-1.12 to -0.38)	<0.001
VAS 24 h	1.98 ± 0.16	3.15 ± 1.53	t = -4.81	-1.17 (-1.65 to -0.69)	<0.001
Time to first analgesic (min)	122.55 ± 12.46	42.63 ± 8.20	t = 33.89	79.92 (75.23 to 84.61)	<0.001

[Table 3] describes that postoperative pain scores assessed using the Visual Analogue Scale (VAS) were consistently lower in Group D compared to Group C at most postoperative time points. At early intervals (0.5 and 1 hour), Group D demonstrated significantly lower pain scores than Group C (p < 0.001). Although transiently higher VAS scores were observed in Group D at 1.5 and 2 hours, subsequent assessments from 2.5 hours up to 24 hours showed significantly lower pain scores in Group D (p < 0.001 for most intervals). Importantly, the time to first analgesic requirement was markedly prolonged in Group D (122.55 ± 12.46 min) compared to Group C (42.63 ± 8.20 min), and this difference was highly statistically significant (p < 0.001).

Table 4: Postoperative rescue analgesic consumption (first 24 hours)

Variable	Group D (n=40)	Group C (n=40)	Test of significance	Difference D-C (95% CI)	p value
Total number of tramadol doses (24 h)	0.30 ± 0.46	2.95 ± 0.71	t = -19.81	-2.65 (-2.92 to -2.38)	<0.001
Total tramadol dose (mg) (24 h)	15.38 ± 23.38	147.50 ± 35.72	t = -19.57	-132.12 (-145.55 to -118.69)	<0.001

[Table 4] shows that postoperative rescue analgesic consumption within the first 24 hours was significantly lower in the dexmedetomidine group. The mean number of tramadol doses required in Group D was 0.30 ± 0.46 compared to 2.95 ± 0.71 in Group C, demonstrating a highly significant reduction (p < 0.001). Similarly, the total tramadol dose consumed over 24 hours was substantially lower in Group D (15.38 ± 23.38 mg) compared to Group C (147.50 ± 35.72 mg), with a statistically significant difference (p < 0.001).

DISCUSSION

Baseline Characteristics [Table 1]: The present study demonstrated good baseline comparability between the dexmedetomidine group (Group D) and the control group (Group C) with respect to age, gender distribution, body weight, ASA physical status, and duration of surgery, with no statistically significant differences observed. This baseline homogeneity strengthens the internal validity of the study and ensures that differences in postoperative recovery and analgesic outcomes can be primarily attributed to the pharmacological effects of dexmedetomidine rather than confounding demographic or procedural factors. Similar baseline comparability has been reported in randomized controlled trials by Fu Y et al. (2025),[5] where no significant differences in age, ASA status, or surgical duration were observed between dexmedetomidine and placebo groups undergoing laparoscopic cholecystectomy or other laparoscopic procedures. This consistency across studies supports the methodological robustness of the present trial.

Postoperative Recovery Profiles [Table 2]: In the present study, dexmedetomidine was associated with a statistically significant prolongation of early recovery endpoints, including emergence, response to verbal commands, and orientation time. This finding is consistent with the known sedative properties of dexmedetomidine mediated through α2-adrenergic receptor activation in the locus coeruleus. Similar observations have been reported by Yang A et al. (2021),[6] who noted delayed early emergence in patients receiving dexmedetomidine as an anesthetic adjuvant.

Ramsay Sedation Scores were significantly higher in Group D during the early PACU period (0–30 minutes), indicating deeper but controlled sedation.

However, by 45 minutes, sedation scores were comparable between groups, suggesting that dexmedetomidine-induced sedation was transient and clinically acceptable. Importantly, Modified Aldrete Scores did not differ significantly between groups at any PACU interval, and both groups achieved a score of ≥9 by 45 minutes, indicating readiness for discharge. These findings align with studies by Silva GN et al. (2023),[7] which reported that dexmedetomidine did not adversely affect discharge readiness despite mild prolongation of early recovery times.

Postoperative Pain Scores and Time to First Analgesic [Table 3]: Postoperative pain assessment revealed significantly lower VAS scores in Group D at most postoperative time points, particularly during the early postoperative period and extending up to 24 hours. The analgesic effect of dexmedetomidine is attributed to its spinal and supraspinal α2-mediated inhibition of nociceptive transmission. Comparable reductions in postoperative pain scores have been demonstrated by Prashantha KH et al. (2021),[8] in patients undergoing laparoscopic cholecystectomy.

A markedly prolonged time to first analgesic request was observed in Group D, reinforcing the prolonged analgesic benefit of intraoperative dexmedetomidine infusion. This finding is in agreement with Zheng L et al. (2024),[9] who reported a significant increase in pain-free duration following dexmedetomidine use in laparoscopic surgeries.

Postoperative Rescue Analgesic Consumption [Table 4]: The present study demonstrated a profound opioid-sparing effect of dexmedetomidine, as evidenced by significantly fewer tramadol doses and markedly reduced total tramadol consumption within the first 24 postoperative hours. These results are consistent with previous studies by Rabie A et al. (2022),[10] which showed substantial reductions in postoperative opioid requirements with dexmedetomidine infusion. Reduced opioid consumption is clinically advantageous, as it minimizes opioid-related adverse effects and enhances overall postoperative recovery.

CONCLUSION

The present randomized double-blind controlled study demonstrated that intraoperative dexmedetomidine infusion, when used as an adjuvant to sevoflurane-based general anaesthesia for laparoscopic cholecystectomy, significantly influenced postoperative recovery characteristics and analgesic requirements. Dexmedetomidine was associated with a modest but statistically significant prolongation of early recovery parameters such as emergence, response to commands, and orientation time, along with higher early postoperative Ramsay Sedation Scores. However, these effects were transient and did not adversely affect overall recovery quality, as evidenced by comparable Modified Aldrete Scores and similar PACU discharge times between the two groups.

Importantly, dexmedetomidine provided superior postoperative analgesia, reflected by significantly lower postoperative pain scores at most time intervals, a markedly prolonged pain-free period, delayed requirement for first rescue analgesic, and a substantial reduction in total postoperative tramadol consumption within the first 24 hours. The pronounced opioid-sparing effect observed in the dexmedetomidine group underscores its clinical benefit in enhancing postoperative comfort while minimizing opioid-related adverse effects.

Overall, dexmedetomidine proved to be an effective and safe anesthetic adjuvant in laparoscopic cholecystectomy, offering improved postoperative analgesia and controlled sedation without compromising discharge readiness, thereby supporting its incorporation into balanced anesthesia and multimodal analgesia protocols.

Limitations of the Study

1. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other clinical settings.
2. The sample size, although adequately powered for primary outcomes, was relatively small and may not detect rare adverse effects of dexmedetomidine.
3. Only ASA physical status I and II patients were included; therefore, results may not be applicable to patients with significant comorbidities or higher ASA grades.
4. Long-term postoperative outcomes such as patient satisfaction, quality of recovery beyond 24 hours, and return to normal activity were not assessed.
5. The study evaluated a single dosing regimen of dexmedetomidine; dose–response relationships and comparisons with other dosing strategies were not explored.

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