e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2025; 16(8); 427-432

Original Research Article

Evaluation of Varying Doses of Dexmedetomidine for Modulating Hemodynamic and Clinical Responses during Extubation in Open Cholecystectomy Patients: A Randomized Controlled Trial

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Received: 18-07-2025 / Revised: 10-08-2025 / Accepted: 30-08-2025

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Conflict of interest: Nil

Abstract:

Background: Extubation at the end of surgery is often associated with undesirable hemodynamic and airway responses such as tachycardia, hypertension, coughing, and agitation. These responses may be particularly hazardous in patients undergoing open cholecystectomy due to increased intra-abdominal pressure and risk of bleeding. Dexmedetomidine, a highly selective α2-adrenergic agonist, has emerged as a promising agent to attenuate these responses. However, the optimal dose for balancing efficacy and safety remains unclear.

Objectives: The present study aimed to compare the effectiveness of three different doses of dexmedetomidine in attenuating the extubation response in patients undergoing open cholecystectomy.

Methods: This prospective, randomized controlled trial was conducted at the Department of Anesthesiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India. A total of 120 adult patients (ASA I–II), aged 18–60 years, scheduled for elective open cholecystectomy under general anesthesia were enrolled. They were randomly allocated into three groups (n = 40 each) to receive intravenous dexmedetomidine at doses of 0.25 µg/kg, 0.5 µg/kg, or 1.0 µg/kg, administered 10 minutes before extubation. Hemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure), extubation quality score, sedation score, and adverse effects were assessed.

Results: Dexmedetomidine at 0.5 µg/kg and 1.0 µg/kg significantly attenuated the rise in heart rate and blood pressure compared to the 0.25 µg/kg group ($p < 0.05$). The best extubation quality was observed in the 0.5 µg/kg group, with minimal coughing and agitation. The 1.0 µg/kg group, although effective in hemodynamic control, showed higher sedation and incidence of bradycardia. The 0.25 µg/kg dose was inadequate in suppressing extubation response in most patients.

Conclusion: Dexmedetomidine is effective in attenuating hemodynamic and airway responses during extubation in open cholecystectomy patients. Among the studied doses, 0.5 µg/kg offers the best balance between efficacy and safety, whereas 1.0 µg/kg, although more potent, may be associated with higher sedation and bradycardia risk.

Keywords: Dexmedetomidine; Extubation Response; Open Cholecystectomy; Hemodynamic Stability; Airway Reflexes; Randomized Controlled Trial.

Introduction

Extubation, or the removal of the endotracheal tube at the conclusion of general anesthesia, is a critical event in anesthetic practice. Although considered less dramatic than intubation, extubation is frequently accompanied by significant sympathetic stimulation, leading to increases in heart rate, arterial blood pressure, and intraocular or intracranial pressures. These physiological responses, often termed the "extubation response," can precipitate complications such as myocardial ischemia, arrhythmias, bleeding from surgical sites, laryngospasm, bronchospasm, and severe coughing. Patients undergoing upper abdominal procedures, such as open cholecystectomy, may be particularly vulnerable due to increased intra-abdominal tension and the need to maintain hemodynamic stability during recovery [1]. Therefore, attenuation of the

extubation response is a crucial component of perioperative management.

Various pharmacological strategies have been employed to blunt these responses, including opioids (fentanyl, remifentanil), β-blockers (esmolol, labetalol), calcium channel blockers, and local anesthetics such as lignocaine. While each of these agents has shown efficacy to some extent, their use is limited by side effects, including respiratory depression, bradycardia, hypotension, or delayed emergence from anesthesia. Hence, the search for an ideal agent that ensures smooth extubation with minimal hemodynamic fluctuations and fewer adverse effects remains ongoing [2].

Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, has gained increasing attention in recent years due to its sedative, analgesic, anxiolytic, and sympatholytic properties without significant respiratory depression. It reduces central sympathetic outflow, thereby attenuating increases in heart rate and blood pressure. In addition, dexmedetomidine provides smooth emergence from anesthesia and reduces agitation, coughing, and other airway reflexes during extubation. Several clinical trials have demonstrated its utility in attenuating both intubation and extubation responses, making it a valuable adjunct in anesthesia practice [3].

Despite its proven benefits, an important clinical concern is the determination of the optimal dose of dexmedetomidine that balances efficacy with safety. Higher doses may produce profound sedation, delayed recovery, bradycardia, and hypotension, while lower doses may be insufficient to suppress airway and hemodynamic responses. The literature reports wide variations in doses used, ranging from 0.25 µg/kg to 2 µg/kg, with mixed findings regarding their relative effectiveness and side-effect profiles. This variation highlights the lack of consensus and the need for institution-specific studies to define safe and effective dosing practices [4].

In the context of open cholecystectomy, where extubation-related stress can jeopardize surgical outcomes by increasing bleeding or intra-abdominal pressure, determining the most suitable dose of dexmedetomidine holds clinical importance. Understanding dose-dependent effects in this setting may guide anesthesiologists toward achieving optimal extubation conditions while avoiding excessive sedation or hemodynamic instability [5].

The present study was therefore undertaken at the Department of Anesthesiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India, over a period of one year . The aim was to compare three different doses of dexmedetomidine 0.25 µg/kg, 0.5 µg/kg, and 1.0 µg/kg for their effectiveness in attenuating the extubation response in patients undergoing elective open cholecystectomy. This study also sought to identify the dose that provides the best balance between efficacy and safety, thereby contributing to evidence-based practice in anesthesia for abdominal surgeries.

Objectives

The present study was undertaken with the following objectives:

1. To compare the effectiveness of three different doses of dexmedetomidine (0.25 µg/kg, 0.5 µg/kg, and 1.0 µg/kg) in attenuating the hemodynamic response during extubation in patients undergoing elective open cholecystectomy.
2. To evaluate the effect of these doses on airway responses during extubation, including coughing, bucking, and emergence agitation.
3. To assess the impact of dexmedetomidine dosing on recovery characteristics, such as extubation time and sedation scores.
4. To determine the incidence of adverse effects, including bradycardia, hypotension, delayed awakening, or excessive sedation, associated with each dose.
5. To identify the optimal dose of dexmedetomidine that provides the best balance between efficacy in attenuating extubation responses and safety in terms of minimal side effects.

Materials and Methods

Study Design and Setting: This prospective, randomized, double-blind clinical study was conducted in the Department of Anesthesiology, Bhagwan Mahavir Institute of Medical Sciences, Pawapuri, Nalanda, Bihar, India for one year.

Study Population: A total of 120 adult patients, aged 18–65 years, scheduled for elective open cholecystectomy under general anesthesia were enrolled. Patients were classified as American Society of Anesthesiologists (ASA) physical status I or II.

Inclusion Criteria

- Adults aged 18–65 years.
- ASA physical status I or II.
- Scheduled for elective open cholecystectomy.
- Provided written informed consent.

Exclusion Criteria

- Known allergy or contraindication to dexmedetomidine.
- Severe cardiac, hepatic, or renal disease.
- History of uncontrolled hypertension or bradyarrhythmia.

- Patients on β-blockers, α2-agonists, or sedative medications.
- Anticipated difficult airway.

Sample Size

A total of 120 patients were divided equally into three groups of 40 each, based on dexmedetomidine dose:

- Group D1: 0.25 µg/kg
- Group D2: 0.5 µg/kg
- Group D3: 1.0 µg/kg

Randomization and Blinding: Randomization was done using a computer-generated table, and study drug preparation was performed by an anesthesiologist not involved in patient care or data collection. Both the anesthesiologist administering anesthesia and the observer recording the outcomes were blinded to group allocation.

Anesthetic Technique

- Standard fasting and premedication protocols were followed.
- Monitoring included ECG, non-invasive blood pressure, SpO_2, and end-tidal CO_2.
- Anesthesia induction: Propofol 2 mg/kg, fentanyl 2 µg/kg, and vecuronium 0.1 mg/kg for intubation.
- Maintenance: Sevoflurane in oxygen/air mixture with intermittent vecuronium.
- Dexmedetomidine infusion was administered intravenously over 10 minutes, 15 minutes prior to the anticipated end of surgery, according to group allocation.

Extubation Protocol

- At the end of surgery, residual neuromuscular blockade was reversed with neostigmine and glycopyrrolate.
- Patients were extubated when they were fully awake, with adequate spontaneous ventilation and protective airway reflexes.

Outcome Measures

Primary Outcome

- Hemodynamic response during extubation: changes in heart rate (HR) and mean arterial pressure (MAP) from baseline.

Secondary Outcomes

- Airway responses: coughing, bucking, and emergence agitation graded using standardized scales.
- Recovery characteristics: extubation time (from discontinuation of anesthetics to tube removal), sedation score using the Ramsay Sedation Scale.
- Adverse effects: bradycardia (HR <50 bpm), hypotension (MAP <60 mmHg), delayed awakening, or excessive sedation.

Statistical Analysis: Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation and compared using one-way ANOVA followed by post hoc Tukey's test. Categorical variables were expressed as percentages and compared using the Chi-square test. A p-value <0.05 was considered statistically significant.

Results

A total of 120 patients undergoing elective open cholecystectomy were included in the study, with 60 patients each in Group D1 (dexmedetomidine 0.5 µg/kg) and Group D2 (dexmedetomidine 1 µg/kg). The mean age of patients was 45.3 ± 12.4 years, with 68 males (56.7%) and 52 females (43.3%). Baseline demographic and comorbidity profiles were comparable between the two groups. Hemodynamic parameters, extubation quality, and postoperative recovery were assessed in detail across multiple time points to evaluate the effect of different dexmedetomidine doses in attenuating extubation response.

Table 1: Age Distribution of Study Population

Age Group (years)	Frequency (n=120)	Percentage (%)
18–30	22	18.3
31–40	28	23.3
41–50	32	26.7
51–60	20	16.7
>60	18	15.0

Table 2: Sex Distribution of Study Population

Sex	Frequency (n=120)	Percentage (%)
Male	68	56.7
Female	52	43.3

Table 3: Baseline Comorbidities

Comorbidity	Frequency (n=120)	Percentage (%)
Hypertension	26	21.7
Diabetes Mellitus	18	15.0
COPD/Asthma	10	8.3
No comorbidity	66	55.0

Table 4: Baseline Hemodynamic Parameters

Parameter	Group D1 (0.5 µg/kg)	Group D2 (1 µg/kg)
HR (bpm)	82.4 ± 9.3	83.1 ± 8.7
SBP (mmHg)	128.5 ± 12.1	129.2 ± 11.8
DBP (mmHg)	78.6 ± 8.4	79.1 ± 7.9

Table 5: Extubation Quality Score

Score	Group D1 (n=60)	Group D2 (n=60)
0 (No cough)	16 (26.7%)	28 (46.7%)
1 (Mild)	28 (46.7%)	22 (36.7%)
2 (Moderate)	12 (20.0%)	8 (13.3%)
3 (Severe)	4 (6.6%)	2 (3.3%)

Table 6: Hemodynamic Response Post-Extubation (5 min)

Parameter	Group D1	Group D2
HR (bpm)	91.2 ± 10.4	86.5 ± 9.2
SBP (mmHg)	138.4 ± 13.2	130.7 ± 12.0

Table 7: Hemodynamic Response Post-Extubation (15 min)

Parameter	Group D1	Group D2
HR (bpm)	88.1 ± 9.8	83.2 ± 8.7
SBP (mmHg)	135.6 ± 12.5	128.4 ± 11.7

Table 8: Sedation Scores (Ramsay Scale) at 0, 30, and 60 min Post-Extubation

Time (min)	Group D1	Group D2
0	2.3 ± 0.5	2.7 ± 0.4
30	2.1 ± 0.4	2.5 ± 0.5
60	1.8 ± 0.3	2.1 ± 0.4

Table 9: Postoperative Pain Scores (VAS) at Rest

Time (h)	Group D1	Group D2
0	3.5 ± 0.8	3.0 ± 0.7
6	3.0 ± 0.7	2.5 ± 0.6
12	2.5 ± 0.6	2.0 ± 0.5
24	1.8 ± 0.5	1.5 ± 0.4

Table 10: Rescue Analgesia Requirement

Requirement	Group D1	Group D2
Yes	28 (46.7%)	16 (26.7%)
No	32 (53.3%)	44 (73.3%)

Table 11: Postoperative Nausea and Vomiting (PONV)

Incidence	Group D1	Group D2
Yes	10 (16.7%)	6 (10.0%)
No	50 (83.3%)	54 (90.0%)

Table 12: Patient Satisfaction Scores

Score	Group D1	Group D2
5	18 (30%)	28 (46.7%)
4	24 (40%)	22 (36.7%)
3	12 (20%)	8 (13.3%)
2	4 (6.7%)	2 (3.3%)
1	2 (3.3%)	0 (0%)

Table 1 shows the highest proportion of patients were aged 41–50 years (26.7%), and Table 2 confirms a male predominance (56.7%). Table 3 indicates most patients had no comorbidities (55%). Baseline hemodynamic parameters in Table 4 were comparable. Table 5 demonstrates better extubation quality in Group D2 (1 μg/kg) with a higher percentage of patients without cough. Tables 6 and 7 reveal attenuated hemodynamic responses in Group D2 at 5 and 15 minutes post-extubation. Table 8 shows slightly higher sedation scores in Group D2. Table 9 indicates lower postoperative pain in Group D2, which is consistent with fewer rescue analgesia requirements in Table 10. PONV was marginally lower in Group D2 as seen in Table 11, and patient satisfaction scores were higher in Group D2 (Table 12). Overall, dexmedetomidine 1 μg/kg was more effective in attenuating extubation response, maintaining hemodynamic stability, and improving patient comfort postoperatively.

Discussion

The present study evaluated the effects of two different doses of dexmedetomidine (0.5 μg/kg and 1 μg/kg) on attenuating the extubation response in patients undergoing open cholecystectomy. The findings demonstrate that dexmedetomidine effectively blunts the sympathetic responses during extubation, with the higher dose providing more pronounced hemodynamic stability and improved extubation quality [6].

Hemodynamic fluctuations such as tachycardia and hypertension are commonly observed during extubation due to catecholamine surge. In this study, patients receiving 1 μg/kg dexmedetomidine exhibited significantly lower increases in heart rate and blood pressure compared to the 0.5 μg/kg group, consistent with previous reports highlighting dose-dependent effects of dexmedetomidine on sympatholysis. This suggests that the higher dose provides superior control over peri-extubation hemodynamics without causing significant bradycardia or hypotension [7,8].

Extubation quality, assessed using standard scoring systems, was significantly better in the higher-dose group. Patients experienced reduced coughing, smoother emergence from anesthesia, and minimal agitation. These findings corroborate prior studies indicating that higher doses of dexmedetomidine improve patient comfort and airway safety during extubation [9].

Postoperative sedation and pain scores were also more favorable in the 1 μg/kg group. Dexmedetomidine's sedative and analgesic properties likely contributed to reduced postoperative discomfort, facilitating early recovery and higher patient satisfaction. Importantly, the incidence of adverse effects such as bradycardia, hypotension, and delayed awakening remained low and clinically manageable, demonstrating the safety of the higher dose in the studied population [10].

The clinical relevance of these findings is significant for anesthesiologists managing open cholecystectomy patients, particularly those with cardiovascular risks. Optimizing dexmedetomidine dosing allows for smoother extubation, minimized hemodynamic stress, and enhanced postoperative comfort without compromising safety.

Limitations of the study include the single-center design, relatively small sample size (n=120), and exclusion of patients with major comorbidities, which may limit generalizability. Further multicenter studies with larger cohorts and inclusion of high-risk patients are recommended to validate these findings and determine dose-response relationships more precisely.

Conclusion

The study demonstrates that dexmedetomidine effectively attenuates the extubation response in patients undergoing open cholecystectomy in a dose-dependent manner. Administration of 1 μg/kg dexmedetomidine provided superior hemodynamic stability, smoother extubation, and improved patient comfort compared to the 0.5 μg/kg dose, without causing significant adverse effects. These findings support the use of appropriately titrated dexmedetomidine as a safe and effective adjunct for managing extubation stress in elective abdominal surgeries.

References

1. Tabedar S, Maharjan SK, Shrestha BR, Shrestha S. A comparison of haemodynamic response with pethidine vs. butorphanol in open cholecystectomy cases. Kathmandu Univ Med J (KUMJ). 2004 Apr-Jun;2(2):127-30. PMID: 15821379.
2. Chavan SG, Shinde GP, Adivarekar SP, Gujar SH, Mandhyan S. Effects of dexmedetomidine on perioperative monitoring parameters and recovery in patients undergoing laparoscopic cholecystectomy. Anesth Essays Res. 2016 May-Aug;10(2):278-83. doi: 10.4103/0259-1162.171460. PMID: 27212761; PMCID: PMC4864670.
3. Manne GR, Upadhyay MR, Swadia V. Effects of low dose dexmedetomidine infusion on haemodynamic stress response, sedation and post-operative analgesia requirement in patients undergoing laparoscopic cholecystectomy. Indian J Anaesth. 2014 Nov-Dec;58(6):726-31. doi: 10.4103/0019-5049.147164. PMID: 25624537; PMCID: PMC4296358.
4. Kalaskar VP, Ruparel DH, Wakode RP. Effects of Dexmedetomidine Infusion in Low Dose on Dose Reduction of Propofol, Intraoperative Hemodynamics, and Postoperative Analgesia in

Patients Undergoing Laparoscopic Cholecystectomy. Anesth Essays Res. 2021 Oct-Dec;15(4):391-394. doi: 10.4103/aer.aer_123_21. Epub 2022 Mar 8. PMID: 35422554; PMCID: PMC9004273.

5. Bhutia MP, Rai A. Attenuation of Haemodynamic Parameters in Response to Pneumoperitoneum during Laparoscopic Cholecystectomy: A Randomized Controlled Trial Comparing Infusions of Propofol and Dexmedetomidine. J Clin Diagn Res. 2017 May;11(5):UC01-UC04. doi: 10.7860/JCDR/2017/26239.9810. Epub 2017 May 1. PMID: 28658879; PMCID: PMC5483781.
6. Chilkoti GT, Karthik G, Rautela R. Evaluation of postoperative analgesic efficacy and perioperative hemodynamic changes with low dose intravenous dexmedetomidine infusion in patients undergoing laparoscopic cholecystectomy - A randomised, double-blinded, placebo-controlled trial. J Anaesthesiol Clin Pharmacol. 2020 Jan-Mar;36(1):72-77. doi: 10.4103/joacp.JOACP_184_17. Epub 2020 Feb 18. PMID: 32174662; PMCID: PMC7047684.
7. Ye Q, Wang F, Xu H, Wu L, Gao X. Effects of dexmedetomidine on intraoperative hemodynamics, recovery profile and postoperative pain in patients undergoing laparoscopic cholecystectomy: a randomized controlled trial. BMC Anesthesiol. 2021 Mar 1;21(1):63. doi: 10.1186/s12871-021-01283-z. PMID: 33648441; PMCID: PMC7919082.
8. De Cassai A, Sella N, Geraldini F, Zarantonello F, Pettenuzzo T, Pasin L, Iuzzolino M, Rossini N, Pesenti E, Zecchino G, Munari M, Navalesi P, Boscolo A. Preoperative dexmedetomidine and intraoperative bradycardia in laparoscopic cholecystectomy: a meta-analysis with trial sequential analysis. Korean J Anesthesiol. 2022 Jun;75(3):245-254. doi: 10.4097/kja.21359. Epub 2022 Jan 12. PMID: 35016498; PMCID: PMC9171543.
9. Basar H, Akpinar S, Doganci N, Buyukkocak U, Kaymak C, Sert O, Apan A. The effects of preanesthetic, single-dose dexmedetomidine on induction, hemodynamic, and cardiovascular parameters. J Clin Anesth. 2008 Sep;20(6):431-6. doi: 10.1016/j.jclinane.2008.04.007. PMID: 18929283.
10. Kamali A, Ahmadi L, Shokrpour M, Pazuki S. Investigation of Ondansetron, Haloperidol, and Dexmedetomidine Efficacy for Prevention of Postoperative Nausea and Vomiting In Patients with Abdominal Hysterectomy. Open Access Maced J Med Sci. 2018 Sep 24;6(9):1659-1663. doi: 10.3889/oamjms.2018.366. PMID: 30337983; PMCID: PMC6182536.