Section: Anaesthesiology

Original Research Article

COMPARISON OF DIFFERENT DOSES OF DEXMEDETOMIDINE FOR ATTENUATION OF EXTUBATION RESPONSE IN PATIENTS UNDERGOING LAPAROSCOPIC SURGERIES

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Received *: 09/12/2025*
Received in revised form *: 19/01/2026*
Accepted *: 07/02/2026*

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DOI: 10.70034/ijmedph.2026.1.251

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (1); 1438-1442

ABSTRACT

Background: Extubation often induces significant sympathetic activation, leading to tachycardia, hypertension, coughing, and agitation, which can be harmful, especially in patients having laparoscopic procedures. Dexmedetomidine, a highly selective α2-adrenergic agonist, has demonstrated the ability to mitigate stress responses during airway manipulation without inducing considerable respiratory depression. The ideal dosage necessary to effectively mitigate the extubation reaction while reducing unwanted effects is yet uncertain. **Aims:** The present study aimed to compare the effectiveness of three different doses of dexmedetomidine in attenuating extubation response and associated hemodynamic changes in patients undergoing elective laparoscopic surgeries under general anesthesia.

Materials and Methods: This prospective, randomized, double-blind comparative study was conducted over a period of 10 months in a tertiary care teaching hospital. A total of 105 adult patients scheduled for elective laparoscopic surgeries under general anesthesia, were included. Patients were randomly allocated into three equal groups (n = 35 each). Group A received dexmedetomidine 0.5 µg/kg, Group B received dexmedetomidine 0.75 µg/kg, and Group C received dexmedetomidine 1 µg/kg, each diluted to 10 ml and administered as an intravenous infusion over 10 minutes, starting 10 minutes prior to extubation. Hemodynamic parameters were recorded at baseline, before infusion, at extubation, and at predefined intervals after extubation. The quality of extubation was assessed using a standardized extubation response scale. Sedation level, recovery characteristics, and adverse effects were also recorded.

Results: The demographic features and surgical duration were similar across the three groups. All doses of dexmedetomidine significantly reduced the extubation response relative to baseline values. Group C (1 µg/kg) exhibited the most pronounced reduction in heart rate and blood pressure responses during and post-extubation, succeeded by Group B (0.75 µg/kg), while Group A (0.5 µg/kg) shown relatively weaker attenuation. The extubation quality was markedly more seamless in Groups B and C, characterized by less coughing and agitation. Group C had elevated sedation levels, although recovery was deemed good across all groups.

Conclusion: Administering dexmedetomidine prior to extubation significantly mitigates hemodynamic and airway reactions during laparoscopic surgeries. A dosage of 0.75 µg/kg provides maximum effectiveness with minimum side effects, rendering it appropriate for regular clinical application.

Keywords: α2-agonist, Dexmedetomidine, Extubation response, General anesthesia, Hemodynamic stability, Laparoscopic surgeries.

INTRODUCTION

The emergence from general anesthesia and tracheal extubation are pivotal stages in the perioperative period, frequently accompanied by significant sympathetic activation.[1] This reaction is marked by tachycardia, hypertension, coughing, breath-holding, and agitation, collectively known as the extubation response.[2] While typically temporary, these physiological alterations can be detrimental, especially in individuals with constrained cardiovascular or cerebrovascular capacity. Mitigating extubation-related stress is a crucial goal in contemporary anesthetic practice.[3]

Laparoscopic surgeries is among the most frequently executed minimally invasive abdominal procedures.[4] Notwithstanding its benefits, such as less postoperative discomfort and expedited recovery, laparoscopic procedures are linked to considerable hemodynamic variations resulting from pneumoperitoneum, patient positioning, and airway manipulation.[5] Extubation after laparoscopic surgeries frequently elicits heightened cardiovascular and airway reflexes, hence elevating the risk of myocardial ischemia, arrhythmias, elevated intracranial pressure, and postoperative pain.[6]

Ensuring seamless extubation with stable hemodynamics and minimum airway discomfort is crucial for excellent perioperative results.Numerous pharmacological medications, including opioids, beta-blockers, calcium channel blockers, lidocaine, and vasodilators, have been employed to mitigate extubation effects. Nonetheless, these medicines are frequently linked to adverse effects such as respiratory depression, profound sedation, prolonged recovery, or hypotension.[7]

Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, has emerged as a possible option due to its distinctive pharmacological characteristics. It offers dose-dependent sedation, analgesia, anxiolysis, and sympatholysis without considerable respiratory depression, rendering it especially beneficial during the emerging period of anesthesia.[8,9]

Dexmedetomidine functions centrally by diminishing norepinephrine release in the locus coeruleus, resulting in a reduction of sympathetic output.[10] Its capacity to mitigate stress reactions during laryngoscopy and intubation is well established, and growing data corroborates its efficacy in diminishing hemodynamic and airway responses after extubation.[11] Moreover, dexmedetomidine has demonstrated efficacy in diminishing coughing, emerging agitation, and postoperative pain, thereby enhancing overall patient comfort and recovery quality.[12]

The ideal dosage of dexmedetomidine for mitigating extubation response continues to be a topic of contention. Suboptimal doses may fail to sufficiently suppress sympathetic responses, while elevated doses are linked to negative effects including bradycardia, hypotension, and extended drowsiness. Establishing an optimal dosage that maximizes efficacy while minimizing adverse effects is essential, particularly in patients having laparoscopic procedures where hemodynamic stability is critical.

Aims and Objectives

- • To compare the effectiveness of three different doses of dexmedetomidine in attenuating extubation response and associated hemodynamic changes in patients undergoing laparoscopic surgeries.

MATERIALS AND METHODS

This prospective, randomized, double-blind comparative study was conducted at the Department of Anaesthesiology, Government Sivagangai Medical College and Hospital, over a period of ten months. Written informed consent was obtained from all participants prior to enrollment. The study included 105 adult patients of either sex, aged between 18 and 60 years, belonging to the American Society of Anesthesiologists (ASA) physical status I and II, who were scheduled for elective laparoscopic surgeries under general anesthesia.

Patients with anticipated difficult airway, known hypersensitivity to dexmedetomidine, bradyarrhythmias, conduction abnormalities, uncontrolled hypertension, ischemic heart disease, hepatic or renal impairment, pregnancy, obesity with body mass index greater than 30 kg/m², and those receiving beta-blockers, calcium channel blockers, or other drugs affecting heart rate and blood pressure were excluded from the study. Preoperative evaluation was carried out as per institutional protocol, and patients were kept nil per oral as per standard fasting guidelines.

All patients were randomly allocated into three equal groups of 35 patients each using a computer-generated randomization table. Allocation concealment was ensured using sealed opaque envelopes. Group A received dexmedetomidine 0.5 µg/kg, Group B received dexmedetomidine 0.75 µg/kg, and Group C received dexmedetomidine 1 µg/kg. The study drug was diluted to a total volume of 10 ml with normal saline and administered intravenously as an infusion over 10 minutes, starting 10 minutes prior to planned extubation. Both the patient and the anesthesiologist responsible for data collection were blinded to group allocation.

Standard monitoring including electrocardiography, non-invasive blood pressure, pulse oximetry, and capnography was instituted in all patients. General anesthesia was induced with intravenous propofol and fentanyl, and tracheal intubation was facilitated using a non-depolarizing neuromuscular blocking agent. Anesthesia was maintained with inhalational agents in oxygen and air, along with intermittent doses of muscle relaxant as required. Ventilation parameters were adjusted to maintain normocapnia. At the end of surgery, neuromuscular blockade was

reversed with appropriate doses of neostigmine and glycopyrrolate.

Hemodynamic parameters including heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were recorded at baseline, before administration of the study drug, at the time of extubation, and at 1, 3, 5, and 10 minutes following extubation. The quality of extubation was assessed using a standardized extubation response score based on the presence and severity of coughing and airway irritation. Sedation was assessed using a validated sedation scale in the immediate postoperative period. Patients were observed for adverse effects such as bradycardia, hypotension, respiratory depression, nausea, vomiting, and delayed recovery.

Statistical analysis was performed using appropriate statistical software. Continuous variables were expressed as mean and standard deviation, and categorical variables as numbers and percentages. Intergroup comparisons were made using analysis of variance for continuous variables and chi-square test for categorical variables. A p value of less than 0.05 was considered statistically significant.

RESULTS

A total of 105 patients scheduled for elective laparoscopic surgeries were enrolled and randomized equally into three groups (n = 35 each). The three groups were comparable with respect to demographic variables, ASA status, and duration of surgery, with no statistically significant differences (p > 0.05). (Table 1).

Table 1: Demographic Characteristics and Duration of Surgery

Parameter	Group A (0.5 µg/kg)	Group B (0.75 µg/kg)	Group C (1 µg/kg)	p value
Age (years)	42.6 ± 9.8	41.9 ± 10.2	43.1 ± 9.5	0.81
Gender (M/F)	14 / 21	15 / 20	13 / 22	0.92
Weight (kg)	63.4 ± 8.6	64.1 ± 7.9	62.8 ± 8.2	0.76
ASA I / II	22 / 13	23 / 12	21 / 14	0.89
Duration of surgery (min)	72.5 ± 11.4	74.1 ± 12.2	73.6 ± 10.9	0.84

Heart rate response at extubation and during the immediate postoperative period was significantly lower in Groups B and C compared to Group A. Group C demonstrated the greatest attenuation, with sustained stability up to 10 minutes post-extubation. (Table 2)

Table 2: Heart Rate Changes at Extubation and Post-Extubation

Time Interval	Group A	Group B	Group C	p value
Baseline	82.4 ± 8.6	81.9 ± 9.1	83.1 ± 8.9	0.87
At extubation	94.6 ± 10.2	88.3 ± 9.4	82.7 ± 8.1	<0.001
2 min post-extubation	92.3 ± 9.8	85.6 ± 8.9	80.4 ± 7.9	<0.001
5 min post-extubation	90.8 ± 9.6	84.1 ± 8.7	79.3 ± 7.8	<0.001
10 min post-extubation	88.1 ± 9.1	82.7 ± 8.2	78.5 ± 7.4	<0.001

MAP increased significantly at extubation in all groups; however, the rise was markedly attenuated in Groups B and C. Group C showed the most stable MAP values throughout the 10-minute observation period. (Table 3)

Table 3: Mean Arterial Pressure (MAP) Changes

Time Interval	Group A	Group B	Group C	p value
Baseline	94.2 ± 7.1	93.6 ± 6.9	94.9 ± 7.3	0.78
At extubation	108.4 ± 9.2	101.6 ± 8.1	96.3 ± 7.6	<0.001
2 min post-extubation	106.2 ± 8.9	99.4 ± 7.8	94.7 ± 7.2	<0.001
5 min post-extubation	104.1 ± 8.7	97.4 ± 7.9	92.8 ± 7.1	<0.001
10 min post-extubation	101.3 ± 8.4	95.6 ± 7.3	91.9 ± 6.8	<0.001

Smooth extubation was significantly more frequent in Groups B and C, with Group C demonstrating the best extubation quality (p = 0.002). (Table 4)

Table 4: Extubation Response Score

Extubation Response	Group A	Group B	Group C	p value
Smooth (Score 1–2)	18 (51.4%)	26 (74.3%)	30 (85.7%)	0.002
Moderate	12 (34.3%)	8 (22.9%)	5 (14.3%)	
Severe	5 (14.3%)	1 (2.8%)	0 (0%)	

Sedation scores and the incidence of bradycardia and hypotension increased with higher doses of dexmedetomidine, particularly in Group C. (Table 5)

Table 5: Sedation Scores and Adverse Effects

Parameter	Group A	Group B	Group C	p value
Sedation score	1.8 ± 0.6	2.3 ± 0.5	2.9 ± 0.4	<0.001
Bradycardia	1 (2.8%)	2 (5.7%)	6 (17.1%)	0.03
Hypotension	0 (0%)	1 (2.8%)	5 (14.3%)	0.01

DISCUSSION

The present study assessed the effectiveness of three different doses of dexmedetomidine in attenuating the extubation response in patients undergoing elective laparoscopic surgeries. The three groups were comparable with respect to demographic characteristics, ASA physical status, and duration of surgery, ensuring that differences observed in hemodynamic responses, extubation quality, and sedation profiles were attributable to the dose of dexmedetomidine rather than confounding factors.

Extubation is well known to provoke sympathetic stimulation, resulting in tachycardia and hypertension. In the present study, although an increase in heart rate and blood pressure was observed at extubation in all groups, the magnitude of this response showed a clear dose-dependent reduction with dexmedetomidine. Patients receiving 0.5 µg/kg exhibited higher heart rate and mean arterial pressure at extubation and during the early post-extubation period, suggesting suboptimal suppression of the sympathetic response.

In contrast, the 0.75 µg/kg and 1 µg/kg doses provided significantly better attenuation, with the 1 µg/kg dose demonstrating the greatest hemodynamic stability. These findings support the dose-dependent sympatholytic effect of dexmedetomidine and are consistent with the pharmacological profile of the drug as an α2-adrenergic agonist.

The quality of extubation also improved with increasing doses of dexmedetomidine. Smooth extubation was observed in just over half of the patients in the 0.5 µg/kg group, whereas a substantially higher proportion of patients in the 0.75 µg/kg and 1 µg/kg groups experienced minimal coughing and airway irritation. This suggests superior suppression of airway reflexes at higher doses, resulting in a smoother emergence from anesthesia and improved patient comfort.

Similar improvements in extubation quality with higher doses of dexmedetomidine have been reported by Bhardwaj et al.[13] who demonstrated better extubation conditions and lower BIS values with increasing doses, although at the expense of a higher incidence of bradycardia at 1 µg/kg.

Postoperative sedation scores in the present study increased proportionately with the administered dose. Patients receiving 1 µg/kg had deeper sedation in the immediate postoperative period, though this was not associated with delayed recovery. However, this group also showed a higher incidence of bradycardia and hypotension compared to the lower-dose groups. While these adverse events did not require active intervention, their increased frequency highlights the need for careful dose selection. Comparable observations were reported by Hussain et al.[14] who found that higher doses of dexmedetomidine improved extubation quality but were associated with higher sedation scores and a greater incidence of bradycardia.

The findings of the present study align closely with those of Awasthi et al.[15] who reported that dexmedetomidine at doses of 0.75 µg/kg and 1 µg/kg effectively attenuated the extubation response, whereas 0.5 µg/kg was less effective. Tamboli et al.[16] similarly demonstrated better control of heart rate, blood pressure, and respiratory rate with 0.75 µg/kg compared to 0.5 µg/kg, along with higher sedation scores at the higher dose. Ruba et al.[17] also reported superior hemodynamic stability and smoother extubation with 0.75 µg/kg compared to 0.5 µg/kg, although bradycardia was observed in both groups.

Studies comparing dexmedetomidine with placebo further support its role in attenuating extubation responses. Mahoori Alireza et al.[18] showed significantly lower heart rate and blood pressure values after extubation in patients receiving dexmedetomidine, along with improved sedation and cooperation compared to controls. Shetabi et al.[19] demonstrated that 1 µg/kg dexmedetomidine provided the greatest attenuation of hemodynamic and airway responses compared to 0.5 µg/kg and saline, though with a potential increase in dose-related side effects.

The present study confirms that dexmedetomidine attenuates extubation-related hemodynamic and airway responses in a dose-dependent manner. While the 1 µg/kg dose offers maximal suppression of cardiovascular and airway reflexes, it is associated with higher sedation levels and a greater incidence of adverse effects such as bradycardia and hypotension. The 0.75 µg/kg dose appears to provide the most favorable balance between efficacy and safety, achieving effective attenuation of the extubation response with minimal side effects. These findings, supported by multiple comparative studies, suggest that dexmedetomidine at a dose of 0.75 µg/kg is the most appropriate choice for routine clinical use during extubation in laparoscopic surgeries.

CONCLUSION

Dexmedetomidine administered prior to extubation effectively attenuated hemodynamic and airway responses in patients undergoing laparoscopic surgeries. The attenuation of heart rate, blood pressure, and extubation-related coughing was dose dependent. While the 1 µg/kg dose provided maximum suppression of extubation response, it was associated with higher sedation levels and an

increased incidence of bradycardia and hypotension. The 0.75 µg/kg dose achieved effective and sustained attenuation with minimal adverse effects and satisfactory recovery characteristics. Hence, dexmedetomidine at a dose of 0.75 µg/kg appears to be the optimal dose for routine clinical practice.

Financial support and Sponsorship: Nil.

Conflicts of Interest: There are no conflicts of interest.

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