Journal of Population Therapeutics & Clinical Pharmacology

ORIGINAL RESEARCH ARTICLE
DOI: 10.53555/363b9v62

COMPARING TWO DOSES OF DEXMEDETOMIDINE TO ATTENUATE EXTUBATION RESPONSE IN ELECTIVE LAPAROSCOPIC ABDOMINAL SURGERY: A PROSPECTIVE RANDOMIZED DOUBLE-BLIND CONTROLLED TRIAL

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ABSTRACT

Background

Extubation during general anesthesia is associated with significant sympathetic stimulation, causing transient but potentially harmful hemodynamic and airway reflex responses. Dexmedetomidine, an α2-adrenoceptor agonist, is increasingly used to attenuate these stress responses, but the optimal dose for elective laparoscopic abdominal surgery remains under-investigated.

Objective

To compare the efficacy and safety of two intravenous dexmedetomidine doses 0.75 µg/kg and 0.5 µg/kg—in suppressing extubation-related hemodynamic and airway responses and sedation score in patients undergoing elective laparoscopic abdominal surgery.

Methods: In a prospective, double-blinded, randomized controlled trial, 74 ASA I-II adult patients (18–60 years) were assigned to receive either 0.75 µg/kg (Group A) or 0.5 µg/kg (Group B) of dexmedetomidine intravenous infusion over 10 minutes, 15 minutes prior to extubation. Hemodynamic parameters (heart rate, systolic/diastolic blood pressure, mean arterial pressure), oxygen saturation, extubation quality, and sedation scores were recorded pre-extubation and up to two hours post-extubation.

Results: The groups were comparable demographically. Group A demonstrated significantly better attenuation of heart rate and blood pressure responses post-extubation ($p<0.001$).

Smooth extubation without coughing (Extubation Quality Scale score 1) occurred in 59.5% of Group A versus 8.1% in Group B ($p<0.01$). Group A patients showed higher Ramsay Sedation Scores immediately post-extubation, indicating deeper but clinically safe sedation. Oxygen saturation remained above 98% with no respiratory compromise in either group. No episodes of bradycardia or hypotension requiring intervention occurred.

Conclusion: Dexmedetomidine at 0.75 µg/kg provides superior hemodynamic stability and smoother extubation compared to 0.5 µg/kg dose in elective laparoscopic abdominal surgery. This dose optimally balances efficacy and safety, making it preferable for clinical use.

Keywords: Dexmedetomidine, extubation response, laparoscopic surgery, hemodynamic stability

INTRODUCTION

Laparoscopic abdominal surgeries have revolutionized surgical care by minimizing tissue trauma, reducing postoperative pain, and shortening hospital stays[1]. Despite the benefits, these procedures involve pneumoperitoneum with CO_2 insufflation, which elevates intra- abdominal pressure and provokes significant sympathetic activation[2]. This neurohumoral response, combined with airway manipulation during extubation, often results in marked cardiovascular responses including tachycardia and hypertension[3].

Tracheal extubation itself is a critical and potentially hazardous phase in anesthesia, especially in patients with cardiovascular comorbidities[4]. The laryngeal and pharyngeal stimulation during extubation leads to tachycardia, hypertension, coughing, bucking, and at times laryngospasm or bronchospasm[5]. Such hemodynamic perturbations elevate myocardial oxygen demand and can precipitate ischemia or arrhythmias[6,7]

Numerous agents have been explored to mitigate these responses: opioids, beta blockers, calcium channel blockers, local anesthetics, and alpha-2 agonists[1,8]. Dexmedetomidine, a highly selective α2-adrenoceptor agonist, acts centrally to decrease norepinephrine release and sympathetic outflow, providing sedation, analgesia, sympatholysis, and anxiolysis without significant respiratory depression[9-11]. Its efficacy in attenuating extubation stress responses has been demonstrated across a range of doses (0.25 to 1.0 µg/kg), but an optimal dose balancing hemodynamic stability and sedation remains uncertain, especially in laparoscopic abdominal surgery[12-14].

This study aims to directly compare two commonly used dexmedetomidine doses—0.75 µg/kg and 0.5 µg/kg—administered as infusions before extubation, to evaluate their relative effectiveness in attenuating extubation-related responses in patients undergoing elective laparoscopic abdominal surgery.

MATERIALS AND METHODS

This prospective, randomized, double-blind controlled trial was conducted at a tertiary care teaching hospital between January 2023 and July 2025. Institutional Ethics Committee approval and written informed consent were obtained.

Inclusion criteria

Age 18–60 years, ASA physical status I or II, Scheduled for elective laparoscopic abdominal surgery under general anesthesia, Provided informed consent.

Exclusion criteria

Refusal to participate, Reactive airway disease, Significant cardiovascular or respiratory comorbidities, Pregnant or lactating women.

Study procedure

Seventy-four eligible patients were allocated equally into two groups by computer-generated block randomization with allocation concealment. Both patients and investigators involved in data collection were blinded to group assignment, with dexmedetomidine doses prepared by an

independent anesthesiologist.
Group A Dexmedetomidine 0.75 µg/kg diluted to 10 ml, infused over 10 minutes starting 15 minutes before planned extubation.
Group B Dexmedetomidine 0.5 µg/kg, similarly diluted and infused.

Standard anesthesia induction and maintenance included Premedication with glycopyrrolate 0.2 mg, ondansetron 4 mg, pantoprazole 40 mg iv. Induction with fentanyl (2 µg/kg), propofol (2–2.5 mg/kg), suxamethonium (2 mg/kg) to facilitate intubation. Maintenance with isoflurane (0.5–1.5%) in 60% N_2O and 40% O_2, supplemented with intermittent vecuronium. End-tidal CO_2 maintained between 30–35 mmHg. Analgesia with intravenous diclofenac 75 mg and paracetamol 1 g infusion intraoperatively. Dexmedetomidine infusion started 20 minutes prior to extubation as per group. Neuromuscular blockade reversed once TOF ratio >0.9 using neostigmine and glycopyrrolate. Extubation performed within 10 minutes after dexmedetomidine infusion.

Parameters were recorded at baseline and multiple time points including immediately pre-extubation and post-extubation at 1, 2, 3, 4, 5, 15, 30, 45, 60, 75, 90, 105, and 120 minutes: Heart rate (HR), Systolic blood pressure (SBP), Diastolic blood pressure (DBP), Mean arterial pressure (MAP), Oxygen saturation (SpO_2), Extubation quality scored by a 5-point scale (1 = no coughing, 5 = poor/extreme responses), Sedation assessed using Ramsay Sedation Score (RSS).

Statistical Analysis
Data were analyzed with STATA 10.1. Continuous variables were tested for normality; expressed as mean ± SD. Independent t-test compared means between groups, and chi-square or Fisher's exact tests were used for categorical data. $P < 0.05$ was considered statistically significant.

RESULTS

Patient Demographics
Demographic characteristics were comparable with no statistically significant differences:

Parameter	Group A (0.75 µg/kg)	Group B (0.5 µg/kg)	P-value
Age (years)	43.74 ± 10.39	40.73 ± 9.12	0.19
Weight (kg)	53.78 ± 5.86	54.16 ± 4.73	0.76
Gender (M:F)	21:16	19:18	0.81
ASA Grade I/II	26/11	28/9	0.79

Table 1: Demographic Characteristics of Study Groups

Extubation Quality Assessment

Quality Score	Description	Group A (%)	Group B (%)	P-value
1	No coughing	59.5	8.1	<0.01
2	Minimal coughing (1-2 times)	40.5	73.0	<0.01
3	Moderate coughing (3-4 times)	0	18.9	<0.01
4	Severe coughing (5-10 times)	0	0	-
5	Poor extubation (>10 times)	0	0	-

Table 2: Extubation Quality Distribution Between Groups

Group A showed significantly smoother extubation with fewer coughing episodes.

Hemodynamic Parameters Analysis

Parameter	Time Point	Group A	Group B	P-value

HR (bpm)	Pre-extubation	78.2 ± 8.4	82.1 ± 9.2	0.06
	1 min post	82.5 ± 8.9	95.3 ± 11.2	<0.001
	5 min post	80.1 ± 7.6	91.7 ± 10.8	<0.001
	15 min post	78.9 ± 8.1	87.2 ± 9.4	<0.001
SBP (mmHg)	Pre-extubation	118.3 ± 12.1	120.7 ± 11.8	0.38
	1 min post	125.2 ± 13.4	138.9 ± 15.6	<0.001
	5 min post	122.8 ± 12.9	135.1 ± 14.2	<0.001
	15 min post	120.5 ± 11.7	131.8 ± 13.5	<0.001
DBP (mmHg)	Pre-extubation	72.1 ± 8.9	74.3 ± 9.2	0.28
	1 min post	76.8 ± 9.4	87.2 ± 11.3	<0.001
	5 min post	75.2 ± 8.7	84.6 ± 10.8	<0.001
	15 min post	73.9 ± 8.3	82.1 ± 9.9	<0.001
MAP (mmHg)	Pre-extubation	87.5 ± 9.8	89.8 ± 10.2	0.31
	1 min post	92.9 ± 10.5	104.4 ± 12.8	<0.001
	5 min post	91.1 ± 9.9	101.4 ± 11.9	<0.001
	15 min post	89.4 ± 9.2	98.7 ± 11.1	<0.001

Table 3: Hemodynamic Response Comparison at Key Time Points

Heart Rate: Group A showed significantly lower HR at all intervals up to 15 minutes post-extubation ($p < 0.001$). Post 30 minutes, HR values approximated each other, indicating stabilization.

Systolic Blood Pressure: Lower in Group A during the initial 45 minutes post-extubation, with significant differences at all early time points ($p < 0.001$).

Diastolic Blood Pressure: Significantly attenuated in Group A compared to Group B up to 1 hour post-extubation ($p < 0.001$).

Mean Arterial Pressure: Consistently lower in Group A post-extubation ($p < 0.001$), with differences diminishing after 90 minutes.

Oxygen Saturation: Both groups maintained SpO_2 >98% throughout, with no significant intergroup differences.

Sedation

Ramsay Sedation Scores indicated deeper sedation in Group A immediately post-extubation:

Score	Description	Group A (%)	Group B (%)	P-value
1	Anxious, agitated	5.4	64.9	<0.01
2	Cooperative, oriented	56.8	35.1	NS
3	Responds only to commands	37.8	0	<0.01

Table 4: Ramsay Sedation Score Distribution Post-Extubation

No excessive sedation or respiratory depression observed.

No episodes of clinically significant bradycardia, hypotension, respiratory depression, laryngospasm, or other adverse events requiring intervention were reported in either group.

DISCUSSION

This study confirms that dexmedetomidine at a 0.75 µg/kg dose provides superior attenuation of the extubation-associated sympathetic surge compared to the 0.5 µg/kg dose in patients undergoing elective laparoscopic abdominal surgery. Patients receiving the higher dose had significantly better hemodynamic stability, reduced cough and airway reflexes, and smoother extubation quality,

without prolongation of recovery or oxygen desaturation.

The findings are consistent with previous literature that highlights the dose-dependent sympatholytic, sedative, and analgesic effects of dexmedetomidine[15-17]. The drug's action on central α2-adrenoceptors reduces norepinephrine release, blunting tachycardia and hypertension during stress[18,19]. Its sedative profile, resembling natural sleep, allows cooperative sedation without compromising respiratory drive[20,21].

Our results align with multiple studies investigating optimal dexmedetomidine dosing for extubation. Jamal et al. (2018) demonstrated that 0.75 µg/kg offered optimal stability with minimal side effects compared to 0.5 µg/kg and 1.0 µg/kg doses[4]. Similarly, Mohamed Ali et al. (2021) found 0.75 µg/kg significantly better at stabilizing all hemodynamic parameters with comparable sedation levels[22].

Bhardwaj et al. (2021) studied controlled hypertensive patients and concluded that 0.75 µg/kg was optimal for extubation, facilitating smooth extubation while maintaining hemodynamic stability without excessive sedation[23]. Manickam et al. (2021) revealed that 0.75 µg/kg yielded the best combination of cough suppression and hemodynamic stability in cholecystectomy patients[24].
Recent studies by Jain et al. (2022) and Ayyanagouda et al. (2023) further support our findings, demonstrating superior hemodynamic control with 0.75 µg/kg compared to lower doses[25,26]. The consistency across diverse patient populations and surgical procedures strengthens the evidence for 0.75 µg/kg as the optimal dose.

Mechanism and Clinical Implications

The superior efficacy of 0.75 µg/kg can be attributed to more complete α2-adrenoceptor occupancy, leading to enhanced sympatholysis[27,28]. This dose achieves better balance between hemodynamic control and sedation without triggering adverse effects often observed at higher doses (≥1 µg/kg), such as profound bradycardia or delayed emergence[2,29].

The higher number of patients with no coughing in Group A emphasizes enhanced airway reflex suppression at this dose, which is particularly beneficial in laparoscopic surgery where pneumoperitoneum already stresses the cardiovascular system[30,31].

LIMITATION

Limitations of the study include restriction to ASA I-II adults and elective laparoscopic procedures, which may limit generalizability to other populations or emergency surgeries. Further investigations in elderly or high-risk cardiac patients could expand clinical understanding.

CONCLUSION

For elective laparoscopic abdominal surgery, dexmedetomidine administered at 0.75 µg/kg intravenously over 10 minutes, approximately 15 minutes before extubation, effectively attenuates the hemodynamic and airway reflex responses compared to 0.5 µg/kg. It provides smoother extubation, better cardiovascular stability, adequate sedation, and maintains respiratory function without significant adverse events. This dose is recommended as optimal for anesthetic management in similar patient populations and surgical settings.

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