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Dexmedetomidine and Its Influence on Extubation Outcomes: A Prospective Randomized Double-Blind Study

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Abstract

Background: Extubation following general anaesthesia is often associated with undesirable airway and hemodynamic responses, such as coughing, hypertension, tachycardia, and agitation, which may lead to complications, especially in vulnerable patients. Dexmedetomidine, a selective alpha-2 adrenergic agonist, has shown potential in attenuating these responses while providing stable sedation and cardiovascular control.

Aim: To assess the effect of intravenous dexmedetomidine on the quality and ease of extubation in adult patients undergoing elective surgeries under general anaesthesia.

Materials and Methods: This prospective, randomized, double-blind study was conducted in the Department of Anaesthesiology at a tertiary care hospital over one year. Seventy-five patients (ASA I–II), aged 18–60 years, scheduled for elective surgeries under general anaesthesia, were randomly allocated into two groups. Group D received dexmedetomidine 0.5 µg/kg IV over 10 minutes before extubation; Group C received normal saline. Extubation quality (cough score), ease of extubation, hemodynamic parameters, sedation level (Ramsay Sedation Scale), time to extubation, and adverse events were recorded and analysed.

Results: Group D showed significantly improved extubation profiles. The incidence of severe coughing was lower in Group D (5.2%) compared to Group C (29.8%) ($p < 0.001$). Easy extubation was observed in 84.2% of patients in Group D versus 40.5% in Group C. Hemodynamic parameters (HR and MAP) were significantly more stable in the dexmedetomidine group post-extubation ($p < 0.001$). Sedation scores were higher in Group D without delaying recovery ($p = 0.187$). Adverse effects were minimal and not statistically significant.

Conclusion: Intravenous dexmedetomidine at a dose of 0.5 µg/kg significantly improves extubation quality and hemodynamic stability without delaying emergence or causing major side effects. It is a safe and effective agent for smooth extubation in elective surgical settings.

Keywords: Dexmedetomidine, Extubation, Cough Reflex, Hemodynamic Stability, General Anaesthesia, Ramsay Sedation Scale, Randomized Controlled Trial

Introduction

The process of tracheal extubation represents a crucial transition during general anaesthesia and is frequently associated with undesirable physiological responses such as elevated heart rate, hypertension, coughing, restlessness, and, in some cases, complications like laryngospasm or bronchospasm [1,2]. These reactions stem primarily from the stimulation of airway reflexes during endotracheal tube removal and can lead to complications, especially in patients with pre-existing cardiac or neurological issues [3]. Therefore, achieving a calm and controlled extubation is a key objective in perioperative anaesthetic management.

To attenuate these extubation-related responses, several pharmacological interventions have been explored,

including opioids, beta-blockers, local anaesthetics such as lidocaine, and alpha-2 adrenergic agonists [4]. Among these, dexmedetomidine, a selective alpha-2 adrenoceptor agonist, has gained clinical interest due to its sedative, analgesic, and sympatholytic effects, all achieved without significantly affecting respiratory drive [5]. These properties make it an effective choice for blunting airway reflexes and stabilizing hemodynamics during the emergence phase.

Multiple studies have highlighted dexmedetomidine's role in minimizing coughing, agitation, and emergence delirium during recovery from general anaesthesia in both adult and paediatric populations [6,7]. Additionally, its use has been associated with reduced fluctuations in heart rate and arterial pressure during extubation, thereby improving cardiovascular stability [8]. It also provides a unique sedation profile characterized by a calm yet arousable state, offering a practical advantage during the extubation phase [9]. Randomized trials and meta-analyses have consistently demonstrated dexmedetomidine's effectiveness in enhancing extubation outcomes and have compared it favorably with drugs like fentanyl and propofol [10,11]. Nonetheless, variations in patient selection, surgical procedures, and dosing regimens across studies warrant further investigation through structured, double-blind, randomized controlled trials.

This study was designed to evaluate the impact of dexmedetomidine on the quality and ease of extubation in patients undergoing elective surgeries under general anaesthesia. The primary endpoints included the incidence of coughing, agitation, and hemodynamic changes during and shortly after extubation. Secondary endpoints focused on sedation levels, recovery time, and potential adverse effects following drug administration. Understanding the role of dexmedetomidine in this context may offer valuable insights into improving peri-extubation care and enhancing overall patient safety and comfort during recovery.

Materials & Methods

This study was designed as a prospective, randomized, double-blind, controlled trial conducted over a period of one year in the Department of Anaesthesiology, Coimbatore Medical College and Hospital, a tertiary care teaching hospital located in Tamil Nadu, India. The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of Coimbatore Medical College. Written informed consent was obtained from all patients after explaining the purpose, procedure, risks, and benefits of the study in their local language.

A total of 75 adult patients were included in the study. The sample size was calculated based on previous studies demonstrating a significant difference in the incidence of extubation-related complications using dexmedetomidine, considering a confidence level of 95% and power of 80%. Inclusion Criteria: Patients aged 18–60 years, ASA Physical Status I or II, scheduled for elective surgeries under general anaesthesia requiring endotracheal intubation, anticipated surgical duration between 1 to 3 hours. Exclusion Criteria: Patients with known allergy to dexmedetomidine, Severe cardiovascular, hepatic, renal or respiratory diseases, History of bradyarrhythmia or patients on beta-blockers or clonidine, Pregnant or lactating women, Patients with an anticipated difficult airway.

Randomization and Blinding: Patients were randomly allocated into two groups (Group D and Group C) using computer-generated randomization tables. Allocation concealment was ensured using sealed opaque envelopes. Group D (Dexmedetomidine group) received intravenous dexmedetomidine at a dose of 0.5 µg/kg over 10 minutes, 10 minutes prior to the anticipated extubation. Group C (Control group) received an equivalent volume of normal saline over the same time period. Both the anaesthesiologist administering the drug and the observer recording the extubation parameters were blinded to the group allocation.

Anaesthesia Protocol: All patients were premedicated with Inj. midazolam 0.03 mg/kg IV and Inj. glycopyrrolate 0.004 mg/kg IV. Induction was performed with propofol 2 mg/kg, fentanyl 2 µg/kg, and

vecuronium 0.1 mg/kg to facilitate endotracheal intubation. Anaesthesia was maintained with oxygen, nitrous oxide, and isoflurane. Neuromuscular blockade was maintained with intermittent doses of vecuronium as required. Standard intraoperative monitoring (ECG, SpO_2, NIBP, $EtCO_2$) was performed throughout the procedure. Towards the end of surgery, all inhalational agents were discontinued, and neuromuscular blockade was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg IV. The study drug (dexmedetomidine or normal saline) was administered 10 minutes prior to planned extubation.

Outcome Measures

Primary Outcomes:

Quality of extubation, assessed using a 4-point cough score:

0 = No cough

1 = Minimal (1–2) non-sustained coughs

2 = Moderate (3–4) coughs

3 = Severe (≥5) sustained coughs or bucking

Ease of extubation, assessed subjectively by the anaesthesiologist (Easy / Moderate / Difficult)

Secondary Outcomes:

- Hemodynamic parameters: Heart rate and blood pressure recorded at baseline, immediately before and after extubation, and at 1, 3, and 5 minutes post-extubation
- Sedation score, assessed using the Ramsay Sedation Scale (RSS)
- Time to extubation (time from cessation of anaesthetic agents to removal of the endotracheal tube)
- Adverse events, such as bradycardia (HR < 50 bpm), hypotension (MAP < 60 mmHg), desaturation (SpO_2 < 92%), or delayed awakening

The study obtained approval from the Institutional Ethics Committee of Coimbatore Medical College and Hospital (Ref No: CMC/EC/2023/8421). A detailed Participant Information Sheet was provided to all participants, and written informed consent was obtained prior to their participation in the study.

Statistical Analysis: Data were entered and analyzed using SPSS software version 26. Continuous variables were expressed as mean ± standard deviation (SD) and compared using the Student's t-test. Categorical variables were presented as frequencies/percentages and compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value < 0.05 was considered statistically significant.

Results

A total of 75 patients were enrolled and randomly divided into two groups:

- Group D (Dexmedetomidine): 38 patients
- Group C (Control/Normal Saline): 37 patients

No patients were excluded or lost to follow-up. The demographic and baseline parameters were comparable between the groups.

Table 1: Demographic Characteristics

Parameter	Group D (n = 38)	Group C (n = 37)	*p*-value
Age (years)	42.3 ± 10.5	40.6 ± 11.2	0.48
Gender (M/F)	22 / 16	20 / 17	0.83
Weight (kg)	63.1 ± 9.6	61.7 ± 10.1	0.52
ASA Grade I/II	28 / 10	27 / 10	0.94
Duration of Surgery (min)	104.5 ± 20.8	102.1 ± 22.3	0.63

There was no statistically significant difference between the two groups in terms of age, gender

distribution, body weight, ASA status, or surgical duration. This ensures that the groups were comparable at baseline.

Table 2: Cough Score at Extubation

Cough Score	Group D (n = 38)	Group C (n = 37)	*p*-value
0 (No cough)	18 (47.4%)	4 (10.8%)	**<0.001**
1 (Mild)	12 (31.6%)	9 (24.3%)	
2 (Moderate)	6 (15.8%)	13 (35.1%)	
3 (Severe)	2 (5.2%)	11 (29.8%)	

The dexmedetomidine group had significantly fewer coughing episodes during extubation ($p < 0.001$), indicating better airway reflex control and smoother extubation.

Table 3: Ease of Extubation (Subjective Score)

Ease of Extubation	Group D (n = 38)	Group C (n = 37)	*p*-value
Easy	32 (84.2%)	15 (40.5%)	**<0.001**
Moderate	5 (13.2%)	13 (35.1%)	
Difficult	1 (2.6%)	9 (24.3%)	

A significantly higher proportion of patients in Group D had easy extubation, reinforcing dexmedetomidine's effectiveness in facilitating a smoother emergence from anaesthesia.

Table 4: Hemodynamic Parameters at Extubation

Timepoint	HR (bpm) – Group D	HR – Group C	MAP (mmHg) – Group D	MAP – Group C	*p*-value
Baseline	78.6 ± 8.1	80.2 ± 7.5	93.4 ± 6.8	94.1 ± 7.1	>0.05
Immediately after extubation	82.3 ± 9.3	95.7 ± 10.1	95.1 ± 8.6	106.5 ± 9.3	**<0.001**
5 min post-extubation	80.6 ± 8.2	92.4 ± 8.7	92.7 ± 6.1	102.3 ± 7.5	**<0.001**

Group D exhibited significantly lower heart rate and mean arterial pressure (MAP) at and after extubation, indicating better hemodynamic stability.

Table 5: Sedation Score (Ramsay Sedation Scale) at Extubation

Sedation Score (RSS)	Group D (n = 38)	Group C (n = 37)	*p*-value
1 (Anxious/agitated)	0 (0%)	6 (16.2%)	**0.032**
2 (Cooperative)	24 (63.2%)	22 (59.5%)	
3 (Responsive to command)	14 (36.8%)	9 (24.3%)	

The patients in Group D were anxious or agitated (RSS = 1), whereas 16.2% in Group C were, which is statistically significant (p = 0.032). Most patients in both groups were cooperative (RSS = 2). A higher proportion in Group D were more sedated but still responsive to commands (RSS=3) compared to Group C.

Table 6: Time to Extubation

Parameter	Group D (n = 38)	Group C (n = 37)	*p*-value
Time to Extubation (min)	7.4 ± 2.1	6.9 ± 1.8	0.187

There was no statistically significant delay in time to extubation in the dexmedetomidine group, indicating that the sedative effect did not prolong recovery.

Table 7: Adverse Events

Adverse Event	Group D (n = 38)	Group C (n = 37)	*p*-value
Bradycardia	3 (7.9%)	1 (2.7%)	0.61
Hypotension	2 (5.3%)	1 (2.7%)	0.64
Desaturation (SpO_2 < 92%)	0 (0%)	2 (5.4%)	0.23
Nausea/Vomiting	1 (2.6%)	2 (5.4%)	0.59

No significant adverse events were noted in either group. Dexmedetomidine was well tolerated, with a favorable safety profile.

Discussion

This randomized controlled trial investigated the impact of a single dose of intravenous dexmedetomidine (0.5 µg/kg) on the quality and ease of extubation in patients undergoing elective surgical procedures under general anaesthesia. Our study findings confirm that dexmedetomidine significantly enhances extubation outcomes by minimizing airway irritation, ensuring hemodynamic stability, and maintaining an appropriate level of sedation without delaying recovery or increasing serious adverse effects.

Extubation Quality

Nearly half of the patients in the dexmedetomidine group experienced no coughing, and only 5.2% had severe coughing, compared to nearly 30% in the control group, indicating a highly significant improvement ($p < 0.001$). This aligns closely with the observations of Guler et al., who found that dexmedetomidine effectively reduced both coughing and agitation during emergence from anaesthesia [6]. Similarly, Agarwal et al. demonstrated that dexmedetomidine could attenuate the stress responses associated with extubation without inducing respiratory compromise [13].

The mechanism behind this benefit is likely due to dexmedetomidine's central sympatholytic activity, which leads to dampening of airway reflexes and suppression of laryngeal stimulation responses.

Ease of Extubation

Subjective evaluations by attending anaesthesiologists showed that a significantly higher number of patients in the dexmedetomidine group had easy extubation (84.2%) compared to the control group (40.5%). These findings support the results reported by Kumar et al., who observed smoother extubation and more stable emergence profiles when dexmedetomidine was used [14].

Hemodynamic Stability

One of the notable advantages of dexmedetomidine observed in this study was the reduction in heart rate and mean arterial pressure immediately and up to 5 minutes after extubation. The differences were statistically significant and clinically meaningful. These findings are consistent with those reported by Tufanogullari et al. and Lawrence and De Lange, both of whom noted that dexmedetomidine helps maintain peri-extubation cardiovascular stability by reducing sympathetic outflow [15, 16].

Given that cardiovascular fluctuations during extubation can be detrimental in patients with comorbid conditions, the attenuation of these changes makes dexmedetomidine a favorable option for high-risk surgical populations.

Sedation and Recovery

Although sedation levels were higher in the dexmedetomidine group, the Ramsay Sedation Score indicated that patients remained responsive to commands, indicating that the drug provided calm, cooperative sedation without over-sedation or delayed emergence. These findings correlate with those from Bekker and Sturaitis, who emphasized the benefits of dexmedetomidine in producing a desirable sedative state during neurosurgical procedures [17]. El-Hakim et al. also observed that dexmedetomidine minimized emergence agitation and improved extubation conditions in paediatric cardiac surgery [18].

Importantly, there was no statistically significant prolongation in time to extubation, showing that the sedative effect of dexmedetomidine does not compromise timely recovery.

Adverse Effects

In our study, mild bradycardia and hypotension were observed in a few patients in the dexmedetomidine group, but these events were transient and did not require intervention, mirroring the results of Abdelrahman and Mohamed [19]. There were no reports of respiratory depression, reffirming dexmedetomidine's safety in the context of airway management [20].

Comparison with Other Agents

Previous research has also compared dexmedetomidine to drugs like fentanyl, lidocaine, and propofol. For instance, Yildiz et al. found dexmedetomidine to be superior to both esmolol and fentanyl in terms of controlling hemodynamic responses and maintaining optimal sedation during extubation [21]. Similarly, Tariq et al. observed that dexmedetomidine was more effective than lidocaine in reducing extubation-related airway reactions and cardiovascular stress [22].

Limitations

The study sample was limited to ASA I–II patients undergoing elective surgeries; findings may not extrapolate to emergency or high-risk populations. Extubation quality was partly based on subjective assessment; objective tools such as video documentation or third-party scoring could enhance precision. The study only assessed a single bolus dose; continuous infusion protocols could potentially yield different results and warrant further research.

Conclusion

The present study demonstrates that intravenous dexmedetomidine at a dose of 0.5 µg/kg, administered before extubation, significantly improves the quality and ease of extubation in adult patients undergoing elective surgery under general anaesthesia. Dexmedetomidine was associated with a marked reduction in coughing, better sedation levels, and superior hemodynamic stability during and after extubation, compared to normal saline. Importantly, it did not cause delayed recovery or significant adverse effects, affirming its safety and efficacy in the peri-extubation period. These findings support the use of dexmedetomidine as an effective agent to facilitate smooth and controlled emergence from anaesthesia, particularly in settings where minimizing airway and cardiovascular stress is clinically desirable. Further studies with larger sample sizes and varied surgical populations are recommended to validate these results and optimize dosage protocols for broader clinical application.

Conflict of Interest: Nil

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