

Attenuation of Hemodynamic Responses to Intubation in Patients Undergoing Surgeries under General Anesthesia: A Comparative Analysis of Nebulization with Ropivacaine (0.75%) and Nebulization with Dexmedetomidine

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Conflict of interest: Nil

Abstract:

Background: The purpose of the study was to compare the effects of nebulization with ropivacaine (0.75%) and nebulization with Dexmedetomidine on the hemodynamic response to intubation in patients undergoing surgery under general anaesthesia.

Introduction: Laryngoscopy and tracheal intubation are known to cause significant sympathetic stimulation, leading to hemodynamic fluctuations such as increased heart rate and blood pressure.

This study aims to compare the efficacy of nebulisation with ropivacaine, a local anaesthetic, with nebulization by dexmedetomidine, an alpha-2 adrenergic agonist, in mitigating these responses.

Methods: A prospective observational study was conducted with 120 randomised patients scheduled for elective surgery under general anaesthesia. Patients were divided into three equal groups: Group R received nebulization with ropivacaine (0.75%), Group D received nebulization with dexmedetomidine (1 µg/kg), and Group P received a placebo. Hemodynamic parameters, including heart rate (HR) and mean arterial pressure (MAP), were recorded at baseline, during intubation, and at different interims post-intubation and during extubation.

The primary aim was to compare the outcomes of the above 3 groups in reducing the stress response to laryngoscopy and intubation. The secondary objectives were to compare the hemodynamic parameters during extubation, postoperative sore throat & cough reflex to extubation.

Results: Demographically all groups were similar. Group R and Group D significantly attenuated the hemodynamic response at intubation and extubation compared to the placebo group. Group D demonstrated a more pronounced reduction in HR and MAP during intubation and extubation.

Specifically, Group D had a mean MAP of 90 ± 18.4 mmHg compared to 92.4 ± 16.1 mmHg in Group R and 99.5 ± 15.9 mmHg in Group C. Additionally, both groups exhibited a significant reduction in cough response and postoperative sore throat compared to the placebo group.

Conclusion: Nebulized dexmedetomidine and ropivacaine both effectively reduced the hemodynamic response to intubation in patients undergoing surgery under general anesthesia. Dexmedetomidine may offer superior control of HR and MAP, making it a preferable choice in clinical settings where hemodynamic stability is crucial.

Keywords: Hemodynamic response, laryngoscopy, Intubation, Ropivacaine, Dexmedetomidine, Sore throat, Cough.

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Introduction

The larynx is a richly innervated structure with abundant neurovascular supply. Both intubation and extubation can increase the concentration of catecholamines in the blood resulting in hemodynamic changes and complications such as myocardial

infarction, arrhythmias and cerebrovascular hemorrhage [1,2].

Various drugs such as α_2 agonists, short-acting opioids, local anesthetics, and beta blockers are used to

attenuate the response to extubation [3]. These include opioids with unwanted effects like decreased respiratory drive, drowsiness, and postoperative nausea and vomiting (PONV), as well as selective alpha 2 agonists like dexmedetomidine with bradycardia and hypotension.

The majority of drugs are prophylactically given via I.V/I.M, although only few are given by nebulization. Direct instillation through nebulization is a new area with lesser systemic effects, which needs to be explored.

Ropivacaine, a long-acting local anesthetic, had been widely used through various routes for anesthesia and postoperative analgesia. Administration of local anesthetic ropivacaine topically [4] at intubation also attenuates the hemodynamic fluctuation, histamine-induced bronchospasm[5] and also cough response at extubation due to a longer duration of action as compared to lignocaine [6].

Dexmedetomidine, an alpha 2 agonist, had been used to suppress the hemodynamic stress response, but systemic side effects such as hypotension and bradycardia are commonly associated, which may be troublesome [7-8]. However, the nebulization route has better bioavailability: nasal mucosa—65% and buccal mucosa—82%. Nebulized dexmedetomidine has been reported with a very short distribution half-life (6 minutes) and elimination half-life (2 hours) without being associated with systemic side effects.

Thus, the primary aim of this study was to compare the hemodynamic response of 0.75% nebulized ropivacaine with nebulized dexmedetomidine (1 µg/kg) and with nebulized saline during intubation in patients who underwent surgeries under General Anaesthesia.

Aims & Objectives

Primary: The main goal of this study is to compare the outcomes in reducing the stress response to laryngoscopy and intubation.

Secondary: The secondary objectives were to compare the hemodynamic changes during extubation, the postoperative sore throat & cough response to intubation

Materials and Methodology

Type of Study: Prospective observational hospital based study.

Location: Operating room of Gandhi Medical College, Bhopal.

Sample Size: 120.

Inclusion Criteria:

- Patients posted for elective surgery (Duration < 120 minutes)
- ASA Grade I, II
- Age between 18 – 60 years

Exclusion Criteria:

- Patient with a history of sore throat or upper respiratory tract infection
- Hemodynamically unstable patients
- Emergency patients
- Patients with a history of allergy to local anesthetics
- Patients with a history of allergy to dexmedetomidine
- Patients with a history of cardiac, liver, or renal disorders.

Patient with a difficult airway where the anticipated duration of laryngoscopy exceeded 15 seconds.

This study includes 120 patients who were posted for elective surgeries of duration <120 minutes after taking informed and written consent.

120 patients were divided into three groups of 40 each:

Group D(n=40) received nebulization with dexmedetomidine (1µg/kg) + normal saline (5ml)

Group R (n=40) received nebulization with ropivacaine (0.75%) (5ml)

Group C (n=40) received a placebo(normal saline) (5ml)

Nebulization Procedure: The procedure was performed by ultrasonic nebulization machine for 15 minutes before the anticipated intubation. During nebulization, we looked for important side effects such as bradycardia, hypotension, increased sedation, and coughing.

Patient was taken under standard general anaesthesia protocol. The duration of laryngoscopy was kept at <20 seconds. If in any case, a second attempt or duration exceeded >20 seconds, the patient were excluded from the study.

post operative care was provided according to standard institutional protocols.

we measured Hemodynamic parameters at various time lines

T0—baseline before the procedure of nebulisation

T1—after nebulization

T2—before tracheal intubation

T3—after tracheal intubation

T4—5 minutes after tracheal intubation

T5—at the closure of skin incision

T6—immediately after tracheal extubation

T7—5 minutes after tracheal extubation

The severity of the cough at the time of extubation was assessed with the following grade:

None—no cough

Mild—a single cough

Moderate—cough of the duration of less than 5 seconds

Severe—continuous coughing of the duration of more than 5 seconds

POST (post operative sore throat) was assessed with grade of

0—no complaint of any sore throat

1—(mild) complains of sore throat only when asked

2—(moderate) patient complains of sore throat even without asking

3—(severe) patient complaints of change in voice or hoarseness and pain in the throat

Patients were kept in the postoperative care unit for an additional 3 h and discharged to the ward once they met the criteria for discharge.

Data Analysis: Analysis was performed with Statistical Package for the Social Sciences (SPSS) version 25.0 (SPSS Inc., Chicago, USA).

An unpaired two-tailed Student's *t*-test was used to compare normally distributed continuous variables.

An ANNOVA test was used to find the significance of hemodynamic parameters among all three groups at various time intervals.

The Chi-square test or Fisher's exact test was used for categorical data.

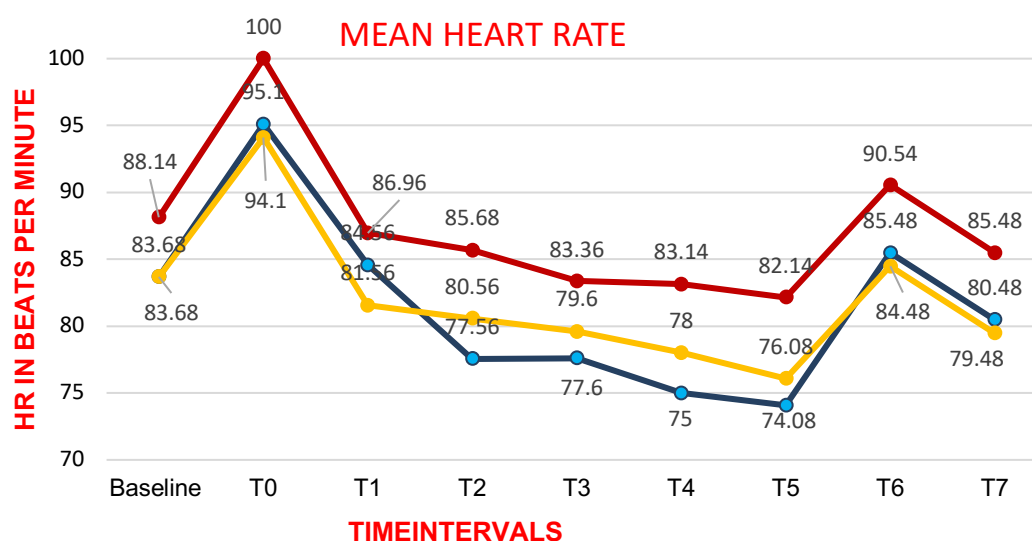
A *P* value of < 0.05 was taken as statistically significant.

Results

On analysing the Demographic data statistically, *p*-values were found to be >0.05 .hence the difference was statistically insignificant between the groups in terms of Age, Gender, BMI,ASA grade, Duration of surgery and therefore the groups were comparable.

Table showing Mean heart rate trends between the groups.

Time Intervals	Red Line (Group C - Control)	Blue Line (Group D - Dexmedetomidine)	Yellow Line (Group R - Ropivacaine)
Baseline	83.68	83.68	83.68
T0	100	95.1	94.1
T1	85.96	84.56	80.56
T2	85.68	77.5	77.6
T3	83.36	77.6	79.6
T4	83.14	75	76.08
T5	82.1	74.08	76.08
T6	90.54	85.48	84.48
T7	85.48	79.48	80.48



(*P* value was significant at T3 ($P < 0.0001$), T6 ($P < 0.0001$), and T7 ($P < 0.005$))

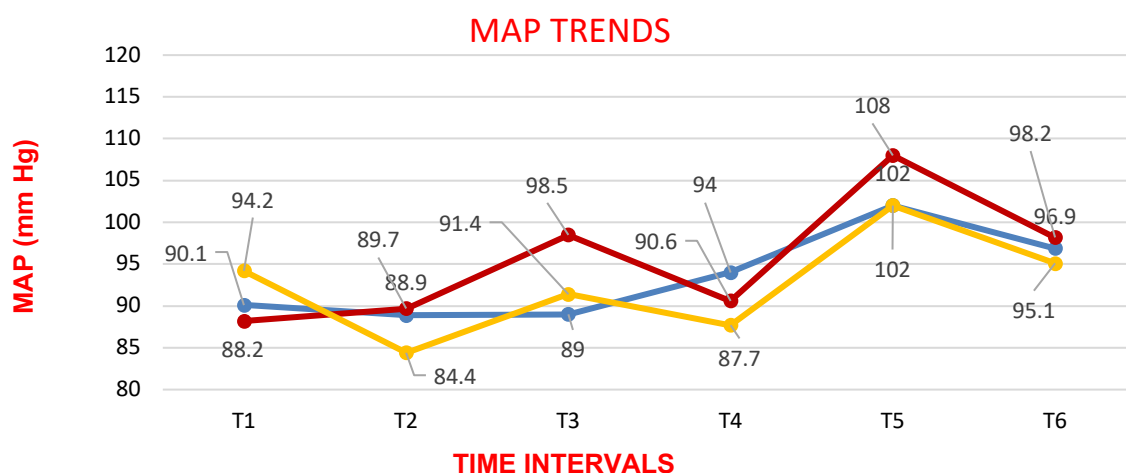
At T3 in group D (blue line) has better control of heart rate compared to other groups

At T6 and T7 group R (yellow line) has slightly lesser heart rate than the other groups.

This shows both groups D and R have better control of heart rate throughout the intubation and extubation periods.

Table showing **MEAN MAP Values** between the groups at various timelines.

Time Interval	Red Line (Group C - Control)	Blue Line (Group D - Dexmedetomidine)	Yellow Line (Group R - Ropivacaine)
T1	88.2	90.1	94.2
T2	88.9	89.7	84.4
T3	98.5	89.0	91.4
T4	90.6	94.0	87.7
T5	108.0	102.0	102.0
T6	98.2	96	95.1

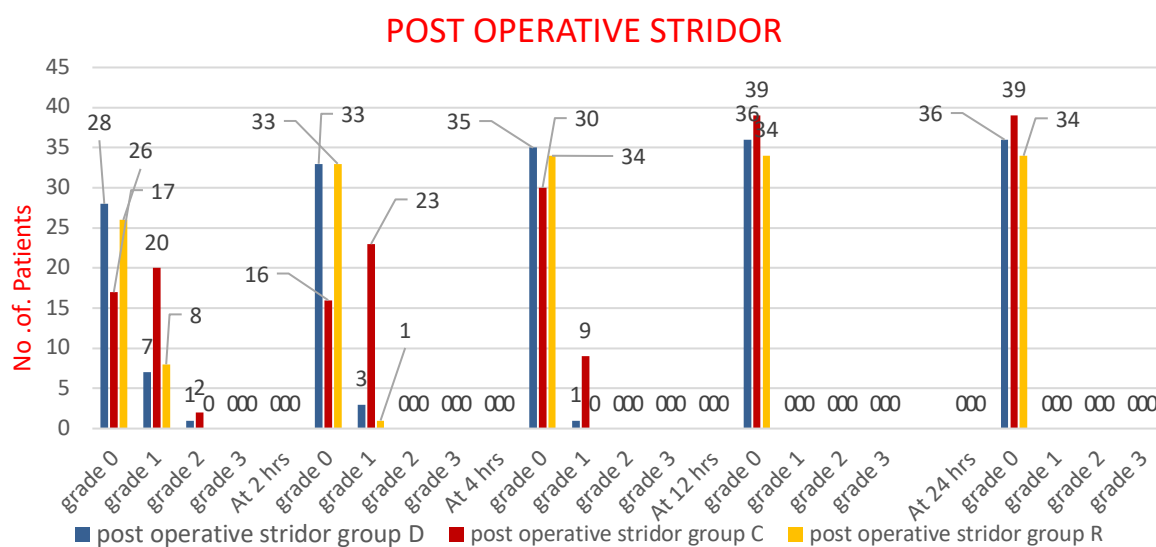


(*P* value was significant at T3 ($P < 0.0001$), T4 ($P < 0.0001$)).

This graph shows that groups have significant difference in MAP at intubation and after intubation

time points. Thus both the drug groups provide better control of hemodynamics perioperatively.

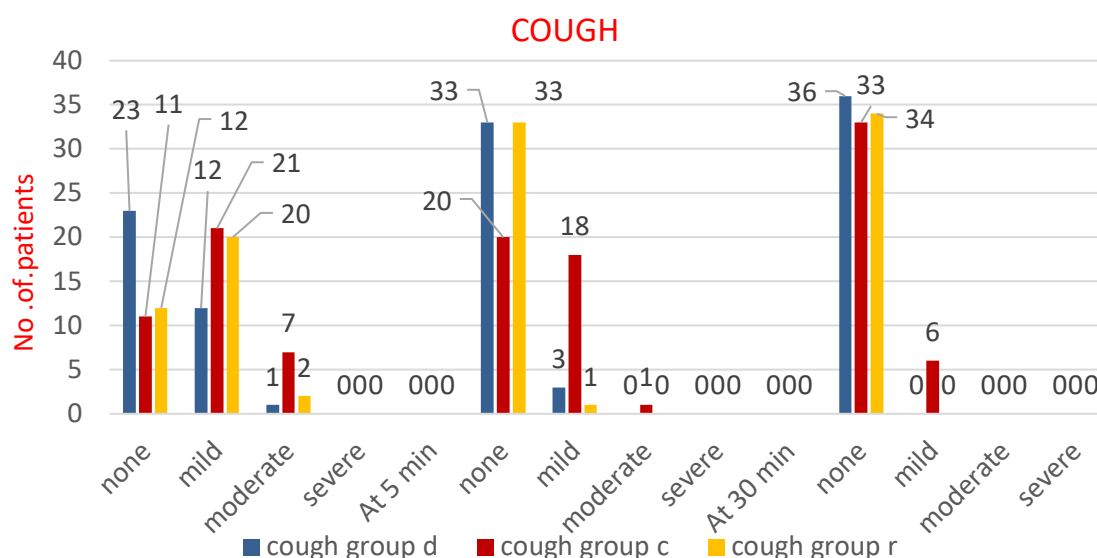
Post operative stridor grade at consecutive timelines between the group.



Occurrence of POST of grade 1 & 2 is little higher in group D compared to group R & C at immediate post op, 2 hr, 4 hr and after 12hr, 24hr the stridor was completely absent in all groups.

Post operative **cough severity** at various timelines

Time Interval	Severity	Group D (Dexmedetomidine) (Blue)	Group C (Control) (Red)	Group R (Ropivacaine) (Yellow)
At 5 min	None	23	12	11
	Mild	12	20	12
	Moderate	7	21	2
	Severe	1	1	0
At 30 min	None	33	20	33
	Mild	3	18	1
	Moderate	1	10	0
	Severe	0	0	0
After 30 min	None	36	33	34
	Mild	0	6	0
	Moderate	0	0	0
	Severe	0	0	0



The occurrence of post op cough was almost same in group D and R but resolved within 30 minutes in all groups. The incidence of cough was less in drug groups compared to placebo, this suggests these drugs reduces the immediate post op cough given via nebulization.

Discussion

The findings of our study demonstrate that ropivacaine used in Group R led to a statistically significant reduction in heart rate (HR) and mean arterial pressure (MAP) at both intubation and extubation. This attenuation can be attributed to its action on sympathetic nerves, leading to reduced reflex responses during airway manipulation. Similar results were documented in the study published by Gao et al. [9], which emphasized

ropivacaine's efficacy in controlling hemodynamic fluctuations.

Additionally, ropivacaine was effective in reducing the incidence of postoperative sore throat (POST) and cough, aligning with the findings of Thangavelu et al. [6]. These effects highlight its local anesthetic properties and ability to suppress airway irritation, a key advantage in perioperative airway management.

Dexmedetomidine, used in Group D, also demonstrated a significant reduction in hemodynamic responses during intubation and extubation without major side effects. Our findings are consistent with the study conducted by Kumar et al. [10], which concluded that dexmedetomidine is effective in maintaining hemodynamic stability due to its selective α_2 -adrenergic agonist activity. By

reducing sympathetic outflow, dexmedetomidine contributes to smoother intubation and extubation, minimizing cardiovascular stress in patients undergoing general anesthesia.

Both ropivacaine and dexmedetomidine compared to placebo group C proved efficacious in reducing post operative sore throat (POST) and cough significantly which are common adverse events after surgeries. This suggests that both drugs have a lasting effect on airway protection, reducing early postoperative discomfort. The prolonged benefits of these agents may also decrease the need for additional analgesic or anti-inflammatory medications in the immediate postoperative period.

Niu et al [11] studied the effect of dexmedetomidine and ropivacaine individually, and in combination, and they also found a significant reduction in the incidence of POST and cough suggesting that these drugs can be hugely helpful in perioperative management of neurosurgery and cardiac surgery

Overall, both drugs are beneficial in managing hemodynamic responses and reducing POST and cough, especially during extubation. none of the patients in the intervention groups had POST after 4 hours, similar to study done by saxena p et al [12].

While both drugs have demonstrated significant efficacy, their combined use and potential synergistic effects warrant further exploration. Future research should focus on determining optimal dosing strategies, evaluating possible additive actions, and minimizing any associated limitations. Large-scale clinical trials could provide further insights into the best practices for integrating these agents into perioperative protocols, particularly in high-risk surgical populations with least possible limitations for better outcomes.

Conclusion

Both pre-induction ropivacaine and dexmedetomidine, when applied topically via nebulization for airway management in general anesthesia cases, successfully reduced intubation and extubation stress responses compared to a placebo.

Hence from our study, we conclude that ropivacaine and dexmedetomidine study groups are not statistically significant at any time.

Both drugs might be used as effective alternative substitutes to attenuate the hemodynamic pressor response, stop coughing, POST, in the perioperative period

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