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Original Research Article

Comparative Evaluation of Intravenous Dexmedetomidine versus Fentanyl for Attenuation of Haemodynamic Response during Laryngoscopy and Endotracheal Intubation: A Randomized Comparative Study

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Abstract

Background: Laryngoscopy and endotracheal intubation produce a transient sympathoadrenal response that may manifest as tachycardia, hypertension and increased myocardial oxygen demand. Although these changes are often tolerated by healthy individuals, they can be clinically important in patients with limited cardiovascular reserve.

Aim: To compare the efficacy of intravenous dexmedetomidine and intravenous fentanyl in attenuating haemodynamic responses during laryngoscopy and endotracheal intubation.

Methods: This prospective cross sectional comparative study was planned in sixty adult patients of ASA physical status I-II undergoing elective surgery under general anaesthesia. Patients were allocated into Group D receiving dexmedetomidine 1 µg/kg diluted in 100 mL normal saline over 10 minutes before induction, and Group F receiving fentanyl 2 µg/kg as a slow intravenous bolus 3 minutes before induction. Heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were recorded at baseline, after study drug administration, at intubation, and at 1, 3, 5 and 10 minutes after intubation.

Results: The demographic characteristics were comparable between the two groups ($p > 0.05$). Following administration of the study drug, a significant reduction in heart rate and mean arterial pressure was observed in the dexmedetomidine group compared to the fentanyl group ($p < 0.05$). At the time of laryngoscopy and intubation, the fentanyl group demonstrated a marked increase in heart rate (98.6 ± 14.8 bpm) and mean arterial pressure (108.9 ± 14.6 mmHg), whereas the dexmedetomidine group showed minimal changes from baseline (76.2 ± 10.3 bpm and 92.5 ± 11.2 mmHg respectively), which was statistically significant ($p < 0.001$). The attenuation of haemodynamic response in the dexmedetomidine group was sustained up to 10 minutes post-intubation. Bradycardia was more frequently observed in the dexmedetomidine group, while nausea and vomiting were more common in the fentanyl group; however, these differences were not statistically significant.

Conclusion: Intravenous dexmedetomidine at a dose of 1 µg/kg is significantly more effective than fentanyl 2 µg/kg in attenuating the haemodynamic response to laryngoscopy and endotracheal intubation. It provides superior control of heart rate and blood pressure with sustained effects, thereby ensuring better perioperative haemodynamic stability. Although associated with mild bradycardia, dexmedetomidine remains a safe and preferable agent, especially in patients where haemodynamic fluctuations may be detrimental.

Keywords: Dexmedetomidine; fentanyl; laryngoscopy; endotracheal intubation; haemodynamic response; general anaesthesia.

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Introduction

Laryngoscopy and endotracheal intubation are indispensable steps during administration of general anaesthesia, yet they are also potent noxious stimuli. Mechanical stimulation of the supraglottic structures, larynx and trachea evokes a reflex sympathetic discharge characterized by tachycardia, hypertension and occasional dysrhythmias. The classical pressor response was

documented decades ago and remains an important peri-intubation concern in anaesthetic practice [1]. The haemodynamic changes usually begin within seconds of laryngoscopy, peak within 1 to 2 minutes and may persist for several minutes [2]. In otherwise healthy individuals these alterations are generally transient, but in patients with hypertension, coronary artery disease, cerebrovascular disease, raised intracranial pressure or other states of limited physiological reserve, even a brief surge in heart rate and blood pressure may increase myocardial oxygen consumption and precipitate adverse events [3].

A variety of pharmacological strategies have therefore been explored to blunt this response, including local anaesthetics, opioids, beta blockers, calcium channel blockers, vasodilators, magnesium sulphate and α2-adrenergic agonists [4]. Among the commonly used drugs, fentanyl and dexmedetomidine remain clinically relevant because both are familiar to anesthesiologists and can be incorporated into standard induction protocols [5].

Fentanyl is a potent synthetic opioid with rapid onset and short duration of action. By reducing sympathetic outflow and modulating nociceptive transmission, it attenuates the cardiovascular response to airway manipulation. However, the response may not always be fully abolished, especially when laryngoscopy is intense or prolonged [6].

Dexmedetomidine is a highly selective α2-adrenergic receptor agonist with sedative, analgesic and sympatholytic properties, notably without clinically significant respiratory depression at routinely used doses [7]. By lowering circulating catecholamine levels and reducing central sympathetic activity, it can provide smoother peri-intubation haemodynamic control [8].

At the same time, excessive sympatholysis may predispose to bradycardia or hypotension, making dose and mode of administration important.[9]

The reference study by Gunalan et al. [5] compared dexmedetomidine 1 µg/kg with fentanyl 2 µg/kg and reported better attenuation of post-intubation heart rate and pressure responses with dexmedetomidine, although clinically relevant bradycardia remained uncommon.

We followed a similar clinical question and timing framework [10]. Against this background, the present study was designed to compare intravenous dexmedetomidine with intravenous fentanyl for attenuation of haemodynamic response during laryngoscopy and endotracheal intubation among adult patients undergoing elective surgery under general anaesthesia.

Objectives

- To compare heart rate changes following administration of dexmedetomidine and fentanyl.
- To compare systolic, diastolic and mean arterial pressure changes during laryngoscopy and endotracheal intubation.
- To assess overall haemodynamic stability in the two study groups.
- To record adverse effects such as bradycardia, hypotension, nausea, vomiting and respiratory depression.

Materials and Methods

Study Design and Setting: Prospective cross sectional comparative study conducted in the Department of Anaesthesiology, RKDF Medical College Hospital & Research Centre, and Bhopal.

Study Duration: Three months.

Study Population: Adult patients aged 18-65 years, ASA physical status I and II, posted for elective surgery under general anaesthesia requiring endotracheal intubation.

Sample Size: Sixty patients in total, with 30 patients each in Group D and Group F, as specified in the approved synopsis.

Intervention: Group D received dexmedetomidine 1 µg/kg diluted in 100 mL normal saline administered intravenously over 10 minutes before induction. Group F received fentanyl 2 µg/kg diluted in 5 mL normal saline as a slow intravenous bolus 3 minutes before induction.

Anaesthetic Technique: Standard monitoring with ECG, non-invasive blood pressure, pulse oximetry and heart rate recording was instituted. Baseline parameters were documented. An intravenous line was secured and patients were preloaded with 500 mL Ringer's lactate.

Preoxygenation with 100% oxygen for 3 minutes was followed by induction with propofol 2-2.5 mg/kg IV and neuromuscular blockade with vecuronium 0.1 mg/kg IV.

Laryngoscopy and endotracheal intubation were performed by an experienced anaesthesiologist. Anaesthesia was maintained with oxygen, nitrous oxide and inhalational agent as per standard institutional practice.

Outcome Variables: Heart rate, systolic blood pressure, diastolic blood pressure, mean arterial pressure and oxygen saturation were recorded at baseline, after administration of study drug, at laryngoscopy/intubation, and at 1, 3, 5 and 10 minutes after intubation.

Adverse effects including bradycardia, hypotension, nausea, vomiting and respiratory depression were recorded.

Rescue drugs were administered as per protocol:

- **Bradycardia (HR <50 bpm):** Inj. Atropine 0.6 mg IV
- **Hypotension (MAP ↓ >20% from baseline or SBP <90 mmHg):** Inj. Mephentermine 6 mg IV bolus (repeat as required) / IV fluids
- **Hypertension/Tachycardia (>20% rise from baseline):** Inj. Esmolol 0.5 mg/kg IV
- **Respiratory depression (SpO_2<94% or apnea):** Assisted ventilation with 100% oxygen ± airway support
- **Nausea/Vomiting:** Inj. Ondansetron 4 mg IV

Inclusion criteria: Age 18-65 years; ASA I or II; elective surgery under general anaesthesia; willing to provide written informed consent

Exclusion criteria: Patient refusal, ASA III or higher, known cardiac disease, known allergy to study drugs, pregnancy and current beta blocker therapy

Results

Table 1: Demographic Profile

Parameter	Group D (Dexmedetomidine)	Group F (Fentanyl)	p value
Age (years)	34.2 ± 9.8	33.6 ± 10.1	0.78
Gender (M/F)	18 / 12	17 / 13	0.79
Weight (kg)	62.4 ± 11.2	63.1 ± 10.8	0.82

Interpretation: Both groups were comparable with respect to demographic variables ($p > 0.05$), ensuring homogeneity.

Table 2: Comparison of Heart Rate (beats/min)

Time Interval	Group D	Group F	p value
Baseline	82.1 ± 9.6	83.4 ± 8.9	0.61
After drug	68.3 ± 8.4	78.9 ± 9.2	<0.001
Intubation	76.2 ± 10.3	98.6 ± 14.8	<0.001
1 min	72.5 ± 9.7	92.3 ± 13.5	<0.001
3 min	70.1 ± 8.9	87.6 ± 12.2	<0.001
5 min	68.9 ± 8.3	83.2 ± 11.6	0.002
10 min	67.4 ± 7.9	79.5 ± 10.8	0.01

Interpretation:

- Significant attenuation of HR in dexmedetomidine group
- Fentanyl group showed marked tachycardic response at intubation
- Effect sustained up to 10 minutes

Table 3: Comparison of Mean Arterial Pressure (MAP mmHg)

Time Interval	Group D	Group F	p value
Baseline	96.8 ± 10.5	95.7 ± 9.8	0.69
After drug	84.2 ± 9.1	88.7 ± 10.4	0.04
Intubation	92.5 ± 11.2	108.9 ± 14.6	<0.001
1 min	88.1 ± 10.4	102.6 ± 13.5	<0.001
3 min	85.3 ± 9.8	98.4 ± 12.9	<0.001
5 min	82.9 ± 9.2	94.2 ± 11.8	0.002
10 min	80.7 ± 8.6	90.1 ± 10.7	0.01

Interpretation:

- Dexmedetomidine prevented pressor response effectively
- Fentanyl group showed significant rise at intubation

Table 4: Adverse Effects

Adverse Effect	Group D	Group F	p value
Bradycardia	3 (10%)	0	0.07
Hypotension	2 (6.7%)	1 (3.3%)	0.55
Nausea/Vomiting	1 (3.3%)	4 (13.3%)	0.16

Interpretation:

- Slightly higher bradycardia with dexmedetomidine
- More nausea with fentanyl
- No serious complications

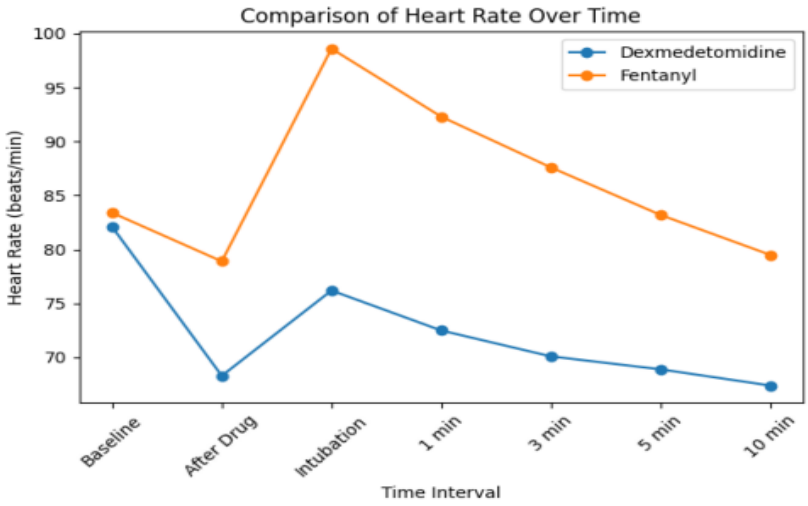

Figure 1: Comparison of heart rate over time

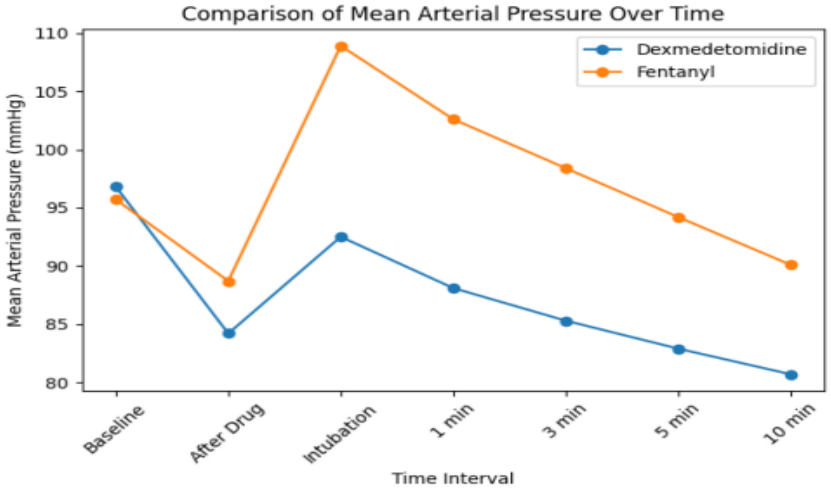

Figure 2: Comparison of mean arterial pressure over time

Discussion

The present study demonstrates that dexmedetomidine is significantly more effective than fentanyl in attenuating haemodynamic responses to laryngoscopy and endotracheal intubation. Laryngoscopy induces a sympathoadrenal response due to stimulation of the laryngeal and tracheal receptors, resulting in catecholamine release. This leads to tachycardia and hypertension, which may increase myocardial oxygen demand and predispose to ischemic events.

In our study, dexmedetomidine produced a significant reduction in heart rate and MAP immediately after drug administration and effectively prevented the rise during intubation. In contrast, fentanyl showed partial attenuation, with a marked increase in heart rate and blood pressure at intubation. The superior efficacy of dexmedetomidine can be explained by its mechanism of action as a highly selective α2-adrenergic agonist. It reduces sympathetic outflow and plasma catecholamine levels, thereby providing stable haemodynamics. Additionally, it has sedative and analgesic properties without causing respiratory depression. Similar results have been reported by Keniya et al., Yildiz et al., and Bajwa et al [3,4,6]., where dexmedetomidine showed superior control of haemodynamic parameters.

However, dexmedetomidine was associated with a slightly higher incidence of bradycardia, which is attributable to its central sympatholytic action. This

was transient and manageable. Fentanyl, although widely used, may not completely abolish the pressor response, especially at standard doses. Increasing its dose may improve efficacy but at the cost of respiratory depression and delayed recovery. Thus, dexmedetomidine emerges as a more reliable agent for attenuating intubation stress response.

Conclusion

Dexmedetomidine in a dose of 1 µg/kg administered intravenously before induction provides superior attenuation of haemodynamic response to laryngoscopy and endotracheal intubation compared to fentanyl 2 µg/kg. It effectively prevents tachycardia and hypertension, ensuring better perioperative haemodynamic stability. Although associated with mild bradycardia, it is clinically manageable and does not lead to significant adverse outcomes. Dexmedetomidine can therefore be considered a preferred agent for attenuating intubation response, especially in patients where haemodynamic stability is crucial.

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