ORIGINAL RESEARCH PAPER

Anaesthesiology

"COMPARISON OF DEXMEDETOMIDINE - PROPOFOL VERSUS FENTANYL -PROPOFOL ON INDUCTION DOSAGE AND INTUBATION RESPONSE"

KEY WORDS: DEXMEDETOMIDINE, PROPOFOL, FENTANYL, INTUBATION STRESS RESPONSE, INDUCTION DOSE

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ABSTRACT

Background and Objective: Laryngoscopy and endotracheal intubation during general anesthesia can provoke noxious stimuli, leading to laryngosympathetic stimulation, characterized by hypertension, tachycardia, and arrhythmias. This study aims to compare the effectiveness of dexmedetomidine and fentanyl in mitigating the hemodynamic stress responses associated with laryngoscopic endotracheal intubation in adult patients undergoing surgeries under general anesthesia. **Materials and Methods:** Sixty adult participants aged between 18-55 years of diverse gender representation,, scheduled for elective surgeries under general endotracheal anesthesia, were divided into two groups, each comprising 30 patients. - Group D (Dexmedetomidine):Patients received intravenous (IV) dexmedetomidine at a dose of 1 mcg/kg body weight, diluted to 20 ml of normal saline (NS) IV over 10 minutes using a syringe pump. Group F (Fentanyl Group):Patients received intravenous fentanyl at a dose of 1 mcg/kg body weight, diluted to 20 ml of NS IV over 10 minutes using a syringe pump. Anesthesia induction was accomplished with IV Propofol 2mg/kg and IV vecuronium at a dose of 0.1 mg/kg body weight to facilitate endotracheal intubation. Anesthesia maintenance was achieved with a combination of oxygen, nitrous oxide, 1-2% sevoflurane, and IV vecuronium. Heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were recorded at various time intervals. **Results-** In group F, one minute after laryngoscopy and intubation, there was a rise in heart rate (HR) by 14 beats per minute (bpm) and an increase in systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) by 2 mmHg each compared to baseline values. Conversely, in group D, HR, SBP, DBP, and MAP decreased significantly by 4 bpm, 23 mmHg, 25 mmHg, and 24 mmHg respectively, compared to baseline values, with a high level of statistical significance (p=0.0001). **Interpretation and Conclusion-** Both IV Dexmedetomidine at a dose of 1 mcg/kg body weight administered over 10 minutes and IV Fentanyl at a dose of 1 mcg/kg body weight administered over 2 minutes prior to induction effectively mitigate the hemodynamic stress response to laryngoscopy and intubation without notable side effects. However, Dexmedetomidine exhibits greater efficacy and superiority over Fentanyl in attenuating the hemodynamic response to laryngoscopy and endotracheal intubation .Group D experienced faster recovery and required less propofol for induction, highlighting a more efficient sedation profile in this group compared to Group F.

INTRODUCTION

Laryngoscopy and endotracheal intubation are crucial skills for anesthesiologists, providing a secure airway and allowing for the administration of anesthesia gases while minimizing the risk of aspiration. However, these procedures often lead to increases in arterial blood pressure (BP) and heart rate (HR) due to a sympathetic response involving heightened catecholamine activity. [1] which healthy individuals can generally tolerate these transient hemodynamic changes, patients with cardiovascular diseases face potential risks such as myocardial ischemia, pulmonary edema, and stroke.[2-4]

To mitigate these risks, various pharmacological interventions have been explored, including lidocaine, volatile anesthetics, opioids, vasodilators, calcium channel blockers, beta-blockers, and more recently, alpha-2 agonists like clonidine and dexmedetomidine. Dexmedetomidine, in particular, is highly selective for the alpha-2 receptor and has shown effectiveness in blunting the hemodynamic stress response to laryngoscopy and intubation.[5]

Both fentanyl [6] , a potent opioid analgesic, and dexmedetomidine can suppress the sympathetic response to these procedures. Therefore, a study was conducted to compare their efficacy in attenuating the hemodynamic stress response.The study evaluated dexmedetomidine (1mcg/kg), an alpha-2 adrenergic receptor agonist, against fentanyl (1mcg/kg), a mu-opioid receptor agonist. Side effects such as hypotension, bradycardia, sedation, nausea, and vomiting were also assessed.

Objectives

Primary Objective

To compare the effectiveness of Dexmedetomidine, 1mcg/kg body weight and fentanyl 1mcg/kg body weight in attenuating haemodynamic response i.e heart rate, systolic blood pressure, diastolic blood pressure & mean arterial pressure, to laryngoscopy and endotracheal intubation.

Secondary Objectives:

a) To study the effects of Dexmedetomidine/fentanyl in decreasing the requirements of propofol as induction agent.
b) To study any adverse effects associated with the administration of Dexmedetomidine/fentanyl , such as perioperative hypotension, bradycardia, respiratory depression ,pruritis and postoperative excessive sedation and recovery status.

Besides minimizing the cardiovascular response, anaesthesia induction for patients at risk must also satisfy the following requirements: It must be applicable regardless of the patient

group, prevent impairment of cerebral blood flow and avoid awareness of the patient; it should neither be time consuming nor affect the duration or modality of the anaesthetic technique and also should not have any effect on the recovery characteristics of the patient.[7-8]

Hence there is a need to find drugs which can suppress the cardiovascular response to intubation and also help in potentiating the effects of induction agents to meet the above requirements.[9-10]

Alpha-2 adrenergic agonists have been used for attenuating the sympathetic response to intubation. Among α-2 agonists both clonidine and dexmedetomidine appear to fulfill all the above criteria. They have actions on both α-1 and α-2 receptors centrally and peripherally. Dexmedetomidine is highly specific and selective α-2 adrenoceptor agonist with α2:α1 binding selectivity ratio of 1620:1 compared to 220:1 for clonidine.

Fentanyl is a fast-acting narcotic with a short duration of action, commonly used as part of balanced general anesthesia. It mitigates the hemodynamic stress response by acting on opioid receptors and reducing sympathetic outflow.[11]

MATERIALS AND METHODS

Inclusion Criteria For The Study

1) Adult patients aged between 18 and 55 years of both sex
2) Patients belonging to ASA class I and II
3) Elective surgeries under general anaesthesia

Exclusion Criteria For The Study

1) Patients with cardiac, coronary, renal, hepatic, cerebral diseases and peripheral vascular diseases.
2) Patients with hypertension.
3) Patients with difficult airway and obese patients (BMI>30).
4) Patients with endocrinal diseases like hyperthyroidism, hypothyroidism and diabetes mellitus etc.
5) Patients coming for emergency surgeries
6) Pregnant females

Patients were randomly assigned to two groups using shuffled opaque sealed envelopes containing the group names. A senior anesthesiologist not involved in the study opened the selected envelope and prepared the assigned test drug. After routine pre-anesthetic check-up and obtaining written informed consent, patients were kept nil per oral as per fasting guidelines.

In the operation theatre, baseline parameters including heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were recorded using a multipara monitor. Intravenous access was established using an 18G cannula, and ringer lactate fluid was initiated followed by administration of the study drugs.

The groups were defined as follows.

- **Group D (Dexmedetomidine):** Received IV dexmedetomidine 1 mcg/kg body weight diluted to 20ml of NS IV over 10 minutes using a syringe pump before induction.
- **Group F (Fentanyl):** Received IV fentanyl 1 mcg/kg body weight diluted to 20 ml of NS IV over 10 minutes using a syringe pump before induction.

All patients were premedicated with IV Glycopyrollate 0.02 mg/kg body weight after receiving the test drug. Patients were preoxygenated with 100% oxygen for 3 minutes. Anesthesia was induced with IV propofol 2mg/kg body weight, and endotracheal intubation was facilitated with IV vecuronium 0.1 mg/kg body weight.

After ventilating the patient with 100% oxygen for 3 minutes, laryngoscopy was performed using a Macintosh laryngoscope blade, and a high volume low-pressure cuffed endotracheal tube was inserted into the trachea. Anesthesia was maintained with 50% nitrous oxide, 50% oxygen, and 1-2% sevoflurane using intermittent positive pressure ventilation and intermittent doses of IV vecuronium at 0.01 mg/kg to facilitate muscle relaxation. At the end of the surgery, neuromuscular blockade was reversed with IV neostigmine 0.05 mg/kg and IV glycopyrrolate 0.01 mg/kg.[12-13]

Intraoperatively, HR, SBP, DBP, and MAP were recorded at the following time intervals: baseline, pre induction, 1 minute, 2 minutes, 5 minutes and 10 minutes after endotracheal intubation.

Statistical Analysis

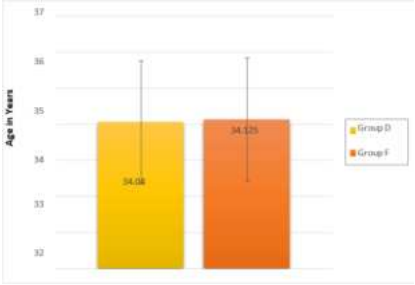
The sample size was determined using the Statistical Package for the Social Sciences (SPSS) software, version Creative Research Systems, with a significance level (alpha) of 0.05 and a confidence interval of 95% for a population assumed to be infinite. The study's power was calculated to be 88%. Parametric data were analyzed using the Student's t-test (z-test), while nonparametric data were assessed using the Chi-square test. All analyses were conducted utilizing the SPSS software. A significance threshold of $p < 0.05$ was applied for determining statistical significance.

RESULTS

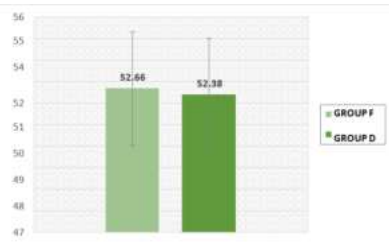
Table 1 : Comparison of clinical characteristics of patients

Variables	Group D	Group F	Significance	Remarks
Age in years	34.04± 11.1	34.125 ±9.2	0.9669	Samples are age Matched
Gender; Male: Female	15:15	17:13	0.689	Samples Gender Matched
Weight in kg	52.66± 7.01	52.38± 8.78	0.8604	Samples are weight Matched
ASA	16:13	14:17	0.6007	Samples are ASA Matched

The study compared Groups D and F with matched samples. Group D had an average age of 34.04±11.1 years, while Group F had 34.125±9.2 years (p=0.9669). Gender distribution was 15 males to 15 females in Group D and 17 males to 13 females in Group F (p=0.689). The average weight was 52.66±7.01 kg in Group D and 52.38±8.78 kg in Group F (p=0.8604). ASA classifications were 16:13 in Group D and 14:17 in Group F (p=0.6007).



Graph 1: Comparison of Age Distribution



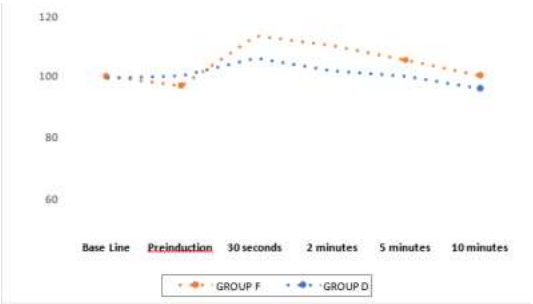
Graph 2: Comparison of Weight Distribution

Table 2 : Comparison of Heart rate in two groups of patients

Heart rate (bpm)	GROUP F	GROUP D	Significance
Base Line Parameters	86.36±7.34	85.48±6.3	t=0.6435;p=0.5215
Preinduction	81±7.57	86.76±7.01	t=3.9503;p=0.0002**
1 minute after ETI	108.72±8.13	96.7±10.94	t=6.2415;p=0.0001**
2 minutes after ETI	103.48±8.74	89.64±10.08	t=7.3378;p=0.0001**
5 minutes after ETI	95.24±6.16	86.52±7.13	t=6.546;p=0.0001**
10 minutes after ETI	86.58±7.53	79.58±6.65	t=4.9325;p=0.0001**

+ Suggestive significance (P value: 0.05<P<0.10)
* Moderately significant (P value: 0.01<P <=0.05)
** Strongly significant (P value: P<=0.01)

At preinduction level there was more decrease in mean heart rate in group D than in group F. But at 1 minute ,2minute and 5 minute the percentage increase in mean heart rate from baseline were significantly lesser in group D than in group F. At1 minute, 2 minute and 5 minutes heart rate response to laryngoscopy and intubation in the group D is clinically lesser than group F and statistically highly significant at 30 seconds, 2 minutes, and 5 minutes (P=0.0001). The fall to baseline value in the group F was after 10th minute and in group D was after 5th minute but before 10th and statistically it was strongly significant (P<0.0001) indicating earlier recovery to baseline values in group D compared to group F (Table -2)



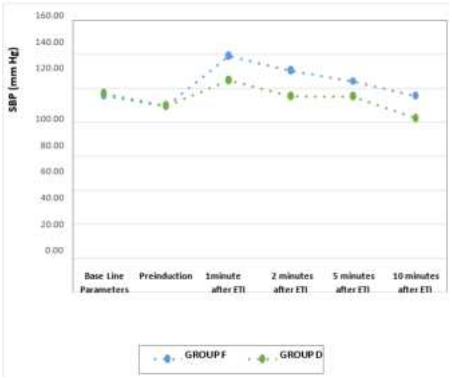
Graph 3: Comparison of Heart Rate

Table 3: Comparison of Systolic Blood Pressure in two groups of patients

SBP (mm Hg)	GROUP F	GROUP D	Significance
Base Line Parameters	115.84±12.68	117.08±6.34	t=0.6221;p=0.5354
Preinduction	109.84±12.5	109.64±6.24	t=0.1013;p=0.9196
1 minute after ETI	139.24±12.23	125.04±11.65	t=5.9469;p=0.0001**
2 minutes after ETI	130.48±12.61	115.52±10.72	t=6.3942;p=0.0001**
5 minutes after ETI	124.2±11.49	115.28±9.9	t=4.1605;p=0.0001**
10 minutes after ETI	115.64±11.19	102.5±8.25	t=6.6871;p=0.0001**

+ Suggestive significance (P value: 0.05<P<0.10)
* Moderately significant (P value: 0.01<P <=0.05)
** Strongly significant (P value: P<=0.01)

At preinduction level the decrease in mean systolic blood pressure is not significant between 2 groups (p=0.9196) . But at 1 minute the percentage increase in mean systolic blood pressure from baseline were significantly lesser in group D than in group F. At 2 minute and 5 minutes, systolic blood pressure response to laryngoscopy was still present in group F , but in group D the mean systolic blood pressure fell below the baseline values and were statistically highly significant at 1 minute, 2 minutes, 5 minutes and 10 minutes(Graph-4).The fall to approximate baseline value in the group F was after 10th minute and in group D was after 2nd minute, statistically it was strongly significant (P<0.0001) indicating Group D showed earlier recovery to baseline values compared to group F.(Table -3)

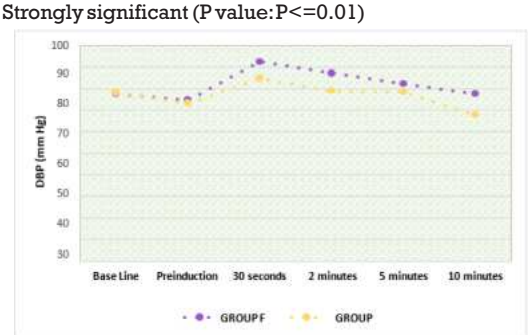


Graph 4: Comparison of Systolic Blood Pressure

Table 4: Comparison of Diastolic BP (mm Hg) in two groups of patients

DBP (mm Hg)	GROUP F	GROUP D	Significance
Base Line Parameters	77.52±5.68	78.24±5.21	t=0.6607;p=0.5104
Preinduction	74.54±5.9	73.06±5.29	t=1.3219;p=0.1893
1 minute after ETI	92.22±5.19	84.66±6.21	t=6.6132;p=0.0001**
2 minutes after ETI	86.92±5.6	78.76±5.15	t=7.5941;p=0.0001**
5 minutes after ETI	82.04±4.92	78.36±5.72	t=3.4526;p=0.0009**
10 minutes after ETI	77.44±5.45	67.64±5.65	t=8.8418;p=0.0001**

+ Suggestive significance (P value: 0.05<P<0.10)
* Moderately significant (P value: 0.01<P <=0.05)
** Strongly significant (P value: P<=0.01)



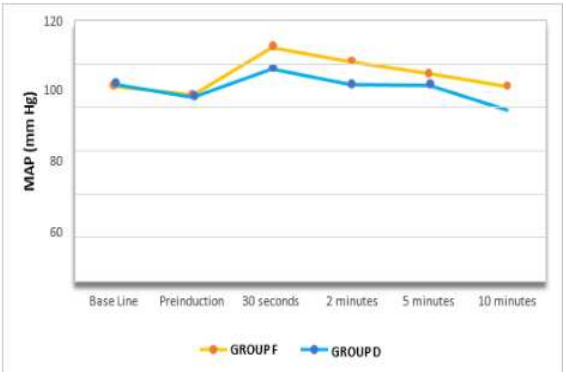
Graph 5: Comparison of Diastolic Blood Pressure

At preinduction level the decrease in mean systolic blood pressure is not significant between 2 groups (p=0.1893) . But at 1 minute the percentage increase in mean diastolic blood pressure from baseline were significantly lesser in group D than in group F. At 2 minute and 5 minutes diastolic blood pressure response to laryngoscopy was still present in group F , but in group D the mean systolic blood pressure fell below the baseline values and were statistically highly significant at 1 minute, 2 minutes, 5 minutes and 10 minutes (P=0.0001). The fall to approximate baseline value in the group A was after 10th minute and in group D it was after 2nd minute, statistically it was strongly significant (P<0.0001) indicating Group D showed earlier recovery to baseline values compared to group F(Table -4)

Table 5 - Comparison of Mean Arterial Pressure between two groups

MAP (mm Hg)	GROUP F	GROUP D	Significance
Base Line Parameters	90.32±6.17	91.19±4.52	t=0.802;p=0.4246
Preinduction	86.31±6.33	85.26±4.46	t=0.9624;p=0.3383
1 minute after ETI	107.9±6.55	98.12±6.7	t=7.3795;p=0.0001**
2 minutes after ETI	101.44±6.84	91.02±5.86	t=8.1909;p=0.0001**
5 minutes after ETI	96.1±5.45	90.67±5.89	t=4.7859;p=0.0001**
10 minutes after ETI	90.18±5.47	79.26±5.3	t=10.1342;p=0.0001**

+ Suggestive significance (P value: 0.05<P<0.10)
* Moderately significant (P value: 0.01<P <=0.05)
** Strongly significant (P value: P<=0.01)



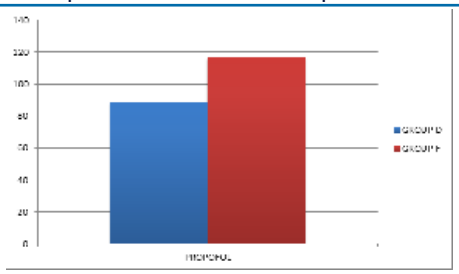
Graph 6: Comparison of Mean Arterial Pressure

At preinduction level the decrease in mean arterial pressure is not significant between 2 groups (p=0.3383). But at 1 minute the percentage increase in mean arterial pressure from baseline were significantly lesser in group D than in group F. At 2 minute and 5 minutes systolic blood pressure response to laryngoscopy was still present in group F, but in group D the mean arterial pressure fell below the baseline values and were statistically highly significant at 2 minutes, 5 minutes and 10 minutes (P=0.0001). The fall to approximate baseline value in the group F was after 10th minute and in group D was after 2nd minute (Graph- 6). Statistically it was strongly significant (P<0.0001) indicating Group D showed earlier recovery to baseline values compared to group F. (Table -5)

Table 6 - Comparison of Propofol dosage requirement between two groups

Variables	Group D	Group F	Significance
Onset Of Sedation In Minutes	8.40+1.12	8.76+1.20	0.23
Procedure Time In Minutes	17.30+3.9	18.10+3.7	0.44
Recovery Time In Minutes	8.9+1.4	11.40+1.64	<0.0001
Induction dosage of propofol	88.55+30.50	106.63+40.41	<0.0001

Table 6 shows that Group D had similar onset of sedation (8.40 minutes) and procedure time (17.30 minutes) compared to Group F (8.76 minutes and 18.10 minutes, respectively; p = 0.23 and p = 0.44). However, Group D had a significantly shorter recovery time (8.9 minutes) versus Group F (11.40 minutes, p < 0.0001) and required a lower induction dosage of propofol (88.55 mg) compared to Group F (106.63 mg, p < 0.0001). These results suggest that Group D experienced faster recovery and required less propofol for induction, highlighting a more efficient sedation profile in this group compared to Group F.



Graph -7 : Comparison of propofol dosage requirement between two groups

DISCUSSION

Laryngoscopy and tracheal intubation induce a pronounced hemodynamic stress response, especially in patients with pre-existing cardiovascular and cerebrovascular disorders. This rapid surge in heart rate and blood pressure can precipitate detrimental consequences such as myocardial ischemia, pulmonary edema, and cerebral hemorrhage. Maintenance of adequate depth of anesthesia at the time of intubation is an important prerequisite to avoid any haemodynamic disturbances and at the same time reduces the awareness during intubation [14-15]

The most significant and intrusive stimulus during general anesthesia administration is direct laryngoscopic endotracheal intubation. This procedure triggers nociceptive receptors in laryngeal and tracheal tissues, leading to a sympatho-adrenal response characterized by the release of catecholamines, resulting in hypertension, tachycardia, laryngospasm, bronchospasm, and increased intraocular and intracranial pressures[16]. This response peaks around 1 minute after intubation and typically returns to baseline levels within 5-10 minutes. The intensity of the sympatho-adrenal response depends on factors such as the depth of anesthesia, type of anesthetic used, duration of laryngoscopy and intubation, as well as patient-specific factors.

Various pharmacological agents and methods have been explored to mitigate these hemodynamic stress responses, but each has its limitations. Alpha-2 agonists like Clonidine and Dexmedetomidine have gained popularity due to their effectiveness in suppressing stress responses. These agents act on presynaptic and postsynaptic α-2A receptors, leading to sedation and inhibition of sympathetic discharge, resulting in decreased heart rate and blood pressure.

Dexmedetomidine, in particular, has shown superiority over Clonidine due to its higher specificity for α-2 receptors. It is increasingly used for conscious sedation outside the operating room, as it minimizes the risk of respiratory depression and postoperative nausea and vomiting.

In studies, Dexmedetomidine has been administered at doses ranging from 0.5 mcg/kg to 2 mcg/kg intravenously, with higher doses showing better attenuation of hemodynamic responses but also increasing the risk of cardiovascular compromise and sedation. Fentanyl, a potent opioid analgesic, is commonly used to blunt the sympathoadrenal response at lower doses, although higher doses may lead to respiratory depression.

Various studies have demonstrated that dexmedetomidine mitigates the stress-induced sympathoadrenal responses to tracheal intubation, using different dosages of dexmedetomidine infusion. The earliest study by Jaakola et al [20]. found that dexmedetomidine, administered at a dose of 0.6 µg/kg, effectively reduced the increase in heart rate and blood pressure during intubation. This dosage is similar to the one used in our study, although we administered it as a bolus.

Guler et al[17]. concluded that a single-dose bolus injection of

0.5 mcg/kg dexmedetomidine before tracheal extubation attenuates airway-circulatory reflexes during extubation as compared to placebo.

Similar findings were observed by Turan et al [18] ., who administered same dose of dexmedetomidine over 60 seconds, 5 minutes before extubation.

Jain et al. 2015 found that an infusion of dexmedetomidine at a dose of 1 mcg/kg administered over 10 min before induction was equally effective as 2 mcg/kg IV fentanyl at induction to attenuate the sympathetic response to laryngoscopy and endotracheal intubation with minimal side effects[19]

Studies by Jaakola et al [20]. and Mowfi et al. demonstrated that Dexmedetomidine administered before anesthesia induction reduced intraocular pressure, HR, and BP post-intubation in patients undergoing ophthalmic surgeries. Jaakola et al. also noted decreased plasma catecholamine levels after Dexmedetomidine infusion, which did not rise post-intubation. Our study did not measure plasma catecholamine levels or intraocular pressure changes In our study, we administered Dexmedetomidine at a dose of 1 mcg/kg intravenously over 10 minutes to minimize peripheral actions and achieve adequate CNS suppression of sympathetic activity during laryngoscopic intubation. Fentanyl was given 2 minutes before induction to allow for peak effect during intubation.

Our findings demonstrated that Dexmedetomidine provided better attenuation of heart rate response compared to Fentanyl group, with heart rate remaining below baseline values throughout the observation period. Dexmedetomidine also significantly reduced systolic and diastolic blood pressure compared to control and Fentanyl groups. Both Dexmedetomidine and Fentanyl groups showed significant attenuation of mean arterial pressure .

Our observations are consistent with that of Gupta K et al [21]., and Shareef SM et al[22]., who observed that both dexmedetomidine (1 mcg/kg) and fentanyl (2 mcg/kg), when used as premedicant before induction attenuated the haemodynamic response to pneumoperitoneum during laparoscopic surgeries . Dexmedetomidine group showed less increase in SBP, DBP and more stabilization of intraoperative MAP and HR as compared to fentanyl group.

We did not find any excessive reduction in HR or SBP values in the dexmedetomidine group.

Although bradycardia and hypotension have been reported in studies pertaining to the effect of dexmedetomidine on peri-operative haemodynamics. We administered dexmedetomidine 1 mcg/kg slowly over 10 min in present study, hence no bradycardia or hypotension was found; also in fentanyl group there was no incidence of bradycardia and hypotension our results show a reduced requirement of propofol when dexmedetomidine infusion was given as co-induction agent,which was statistically significant .This observation was in accordance with the study of Sen s etal where they got the induction dose of propofol as 66.86 +12.54 mg in dexmedetomidine group after infusion of 1mcg/kg of dexmedetomidine over a period of 10 minutes where as in propofol group it was 124 + 16.033 mg/kg Dutta S et al also noted that propofol dose required for sedation and induction of anaesthesia was reduced in the presence of dex medetomidine.

Overall, Dexmedetomidine and Fentanyl were effective in mitigating hemodynamic responses to laryngoscopic intubation without significant cardiovascular side effects or nausea and vomiting[23].

Further studies are warranted to evaluate their efficacy in high-risk patients with cardiovascular diseases.

CONCLUSION

Our study highlights the efficacy of a single intravenous dose of Dexmedetomidine at 1 mcg/kg body weight infused over 10 minutes, and Fentanyl at 1 mcg/kg body weight administered over 2 minutes before induction, in attenuating the hemodynamic stress response to laryngoscopic endotracheal intubation. Both agents proved effective without significant side effects.

The induction dose of propofol was significantly reduced when dexmedetomidine was used as the co-induction agent .This may be effectively used as a co-induction agent .Bradycardia , hypotension or respiratory depression were not observed with the given doses of dexmedetomidine and fentanyl. However, Dexmedetomidine has proven to be more effective than Fentanyl in alleviating the hemodynamic stress response to laryngoscopic endotracheal intubation. This suggests that Dexmedetomidine may offer a significant advantage in managing these stress responses in clinical practice.[24-25]

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