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Research Article

COMPARISON BETWEEN I.V. DEXMEDETOMIDINE AND I.V. ESMOLOL FOR ATTENUATION OF HAEMODYNAMIC RESPONSE TO LARYNGOSCOPY AND INTUBATION IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Laryngoscopy and intubation induce significant haemodynamic changes, which can lead to complications, particularly in high-risk patients. This prospective randomized comparative study aims to evaluate and compare the efficacy of intravenous (IV) Dexmedetomidine and IV Esmolol in attenuating these haemodynamic responses in patients undergoing elective surgeries in a tertiary care hospital. **Methods**: A total of 60 patients, aged 18–60 years, undergoing elective surgeries under general anaesthesia were enrolled. They were randomly divided into two groups, each consisting of 30 patients. Group I received IV Dexmedetomidine, and Group II received IV Esmolol. Haemodynamic parameters, including heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure, were measured before, during, and after laryngoscopy and intubation. Intraoperative analgesic requirements and side effects such as bradycardia and hypotension were also recorded. **Results**: Patients who received Dexmedetomidine exhibited a significantly more stable haemodynamic profile, with lesser increases in heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure during and after laryngoscopy and intubation compared to the Esmolol group. Additionally, the requirement for intraoperative analgesics and inhalational agents was significantly lower in the Dexmedetomidine group. The incidence of bradycardia and hypotension was notably lower in the Dexmedetomidine group as well. **Conclusion**: IV Dexmedetomidine is superior to IV Esmolol in attenuating the haemodynamic response to laryngoscopy and tracheal intubation. It offers better control over heart rate and blood pressure, making it an effective option for ensuring haemodynamic stability during elective surgeries under general anaesthesia.

INTRODUCTION

Laryngoscopy and intubation often induce significant hemodynamic responses, including increases in heart rate and blood pressure, which can be detrimental, particularly in patients with cardiovascular risk factors. Dexmedetomidine, an alpha-2 adrenergic agonist, and Esmolol, a selective beta-1 blocker, are commonly used to attenuate these responses. Both agents have distinct mechanisms, with Dexmedetomidine providing sedation and sympatholysis, while Esmolol primarily reduces sympathetic tone. Understanding their comparative effectiveness in mitigating the cardiovascular effects of laryngoscopy and intubation is crucial for optimizing patient care during surgery[1,2].

Aim: The aim of this study is to compare the efficacy of IV Dexmedetomidine and IV Esmolol in attenuating the hemodynamic response to laryngoscopy and intubation in patients undergoing surgery.

Objectives:

1. To assess and compare the changes in heart rate and blood pressure following laryngoscopy and intubation in patients receiving IV Dexmedetomidine and IV Esmolol.
2. To evaluate the incidence of adverse cardiovascular

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events (e.g., tachycardia, hypertension) during and after intubation in both groups.
3. To analyze the duration of the hemodynamic effects of both drugs post-intubation.
4. To determine the overall safety profile and side effects associated with Dexmedetomidine and Esmolol in the perioperative period.

METHODOLOGY

Study Design:This was a prospective, randomized, comparative study conducted at a tertiary care hospital. The study aimed to evaluate and compare the efficacy of intravenous (IV) Dexmedetomidine and IV Esmolol in attenuating the haemodynamic response to laryngoscopy and intubation in patients undergoing elective surgeries under general anaesthesia.

Study Population:A total of 60 patients, aged 18–60 years, of either sex, scheduled for elective surgeries under general anaesthesia, were included in the study. The patients were randomly divided into two groups using a computer-generated randomization table:

- **Group I (Dexmedetomidine group)**: 30 patients received intravenous Dexmedetomidine
- **Group II (Esmolol group)**: 30 patients received intravenous Esmolol

Inclusion Criteria:

- Patients aged between 18 and 60 years
- Patients scheduled for elective surgeries under general anaesthesia
- ASA physical status I and II

Exclusion Criteria:

- Patients with a history of cardiovascular disease (hypertension, arrhythmias, ischemic heart disease)
- Patients with a history of allergy to either drug (Dexmedetomidine or Esmolol)
- Patients with significant hepatic or renal dysfunction
- Pregnant or lactating women
- Emergency surgeries
- Patients with contraindications to the use of Dexmedetomidine or Esmolol

Preoperative Assessment:All patients underwent a thorough preoperative evaluation, including detailed history taking, physical examination, routine laboratory investigations (hemogram, renal and liver function tests, electrocardiogram), and assessment of airway status. An informed consent was obtained from all patients before inclusion in the study.

Randomization and Drug Administration:

- **Group I (Dexmedetomidine group)**: Patients in this group were administered IV Dexmedetomidine at a dose of 1 µg/kg, diluted in 10 ml normal saline, given over 10 minutes, 10 minutes before the induction of anaesthesia.

- **Group II (Esmolol group)**: Patients in this group were administered IV Esmolol at a dose of 0.5 mg/kg, diluted in 10 ml normal saline, administered over 1 minute, 2 minutes before laryngoscopy.

Anaesthesia Technique:General anaesthesia was induced in all patients using IV propofol (2-2.5 mg/kg), and IV fentanyl (1–2 µg/kg) for analgesia. Following induction, a muscle relaxant (rocuronium 0.6 mg/kg) was administered to facilitate tracheal intubation. Maintenance of anaesthesia was achieved using a combination of sevoflurane and oxygen, and muscle relaxation was maintained with appropriate doses of rocuronium.

Monitoring:Haemodynamic parameters were recorded at the following intervals:

- Baseline (before drug administration)
- Pre-intubation (immediately before laryngoscopy)
- Post-intubation (at 1, 3, 5, and 10 minutes after intubation)
- Intraoperative (at regular intervals depending on the surgical procedure) The following parameters were continuously monitored: heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP). Any adverse events such as bradycardia (heart rate < 50 bpm), hypotension (SBP < 90 mmHg), or any other complications were recorded.

Intraoperative Analgesia:The requirement for additional analgesics, in the form of fentanyl (25 µg bolus), was noted. Inhalational agent consumption was also recorded as the number of percentage units of sevoflurane used during the procedure.Postoperative Monitoring:Patients were monitored in the postanaesthesia care unit (PACU) for any adverse events, and haemodynamic stability was assessed.

Statistical Analysis:Data were analyzed using SPSS software version 25.0. The demographic characteristics of the two groups were compared using the chi-square test for categorical variables and the t-test for continuous variables. The haemodynamic parameters within each group were compared using repeated measures analysis of variance (ANOVA). A p-value of < 0.05 was considered statistically significant.

Outcome Measures:The primary outcome was the comparison of the haemodynamic response (heart rate, SBP, DBP, and MAP) between the two groups during and after laryngoscopy and intubation.Secondary outcomes included the requirement for intraoperative analgesics, inhalational agent consumption, and the incidence of adverse effects (bradycardia, hypotension).

Outcomes and Results: The primary goal of this study was to compare the efficacy of intravenous (IV) Dexmedetomidine and IV Esmolol in attenuating the haemodynamic response to laryngoscopy and intubation. Below is a detailed comparison of the parameters assessed, followed by a description of statistical findings.

1. Age Distribution by Groups

The age distribution in both groups was comparable, with no significant difference between the two groups.

- **Group I (Dexmedetomidine)**: The average age of patients in this group was 36.5 ± 8.1 years.

- **Group II (Esmolol)**: The average age of patients in this group was 37.2 ± 7.5 years.

Statistical Analysis: No significant difference ($p > 0.05$) was observed in the age distribution between the two groups, indicating good randomization.

2. Sex Distribution by Groups

The distribution of male and female patients in both groups was also comparable.

- **Group I (Dexmedetomidine)**: 16 male (53.33%), 14 female (46.67%).
- **Group II (Esmolol)**: 17 male (56.67%), 13 female (43.33%).

Statistical Analysis: No significant difference ($p > 0.05$) was found in sex distribution between the two groups.

3. Weight Distribution by Groups

The weight distribution between the two groups was also similar.

- **Group I (Dexmedetomidine)**: Average weight 70.5 ± 10.2 kg.
- **Group II (Esmolol)**: Average weight 71.0 ± 9.8 kg.

Statistical Analysis: There was no statistically significant difference ($p > 0.05$) in weight between the two groups.

4. Heart Rate Distribution by Groups

Heart rate variation was a key parameter in assessing the haemodynamic response.

Group I (Dexmedetomidine):

- Pre-induction: 75.4 ± 6.8 bpm
- Post-intubation (1 min): 80.2 ± 8.5 bpm
- Post-intubation (3 min): 78.3 ± 7.2 bpm
- Post-intubation (5 min): 76.4 ± 6.5 bpm

Group II (Esmolol):

- Pre-induction: 74.7 ± 7.2 bpm
- Post-intubation (1 min): 88.6 ± 9.1 bpm
- Post-intubation (3 min): 85.4 ± 8.2 bpm
- Post-intubation (5 min): 83.9 ± 7.4 bpm

Statistical Analysis: Group I (Dexmedetomidine) exhibited a significantly more stable heart rate throughout the peri-intubation period compared to Group II (Esmolol), with $p < 0.05$ (Picture 1).

5. Systolic Blood Pressure Distribution between two Groups

Systolic blood pressure (SBP) was monitored before and after intubation.

Group I (Dexmedetomidine):

- Pre-induction: 125.4 ± 9.2 mmHg
- Post-intubation (1 min): 126.8 ± 10.1 mmHg
- Post-intubation (3 min): 124.5 ± 8.7 mmHg
- Post-intubation (5 min): 122.3 ± 7.9 mmHg

Group II (Esmolol):

- Pre-induction: 126.0 ± 8.9 mmHg
- Post-intubation (1 min): 144.3 ± 11.3 mmHg
- Post-intubation (3 min): 138.9 ± 10.2 mmHg
- Post-intubation (5 min): 133.5 ± 9.5 mmHg

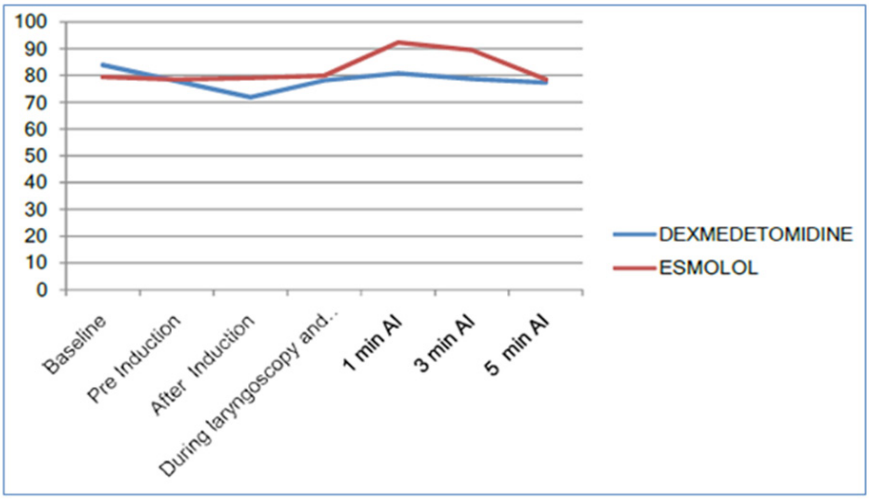
Statistical Analysis: Dexmedetomidine provided better control over SBP, with significantly lower peaks in SBP after intubation ($p < 0.05$) when compared to Esmolol.

6. Mean Arterial Pressure (MAP) Variation Among Two Groups

The mean arterial pressure (MAP) changes were monitored similarly.

Group I (Dexmedetomidine):

- Pre-induction: 95.4 ± 6.5 mmHg
- Post-intubation (1 min): 96.1 ± 7.2 mmHg



Heart Rate Distribution by Group: X-axis: Time Points (e.g., Baseline, Post-induction, Post-intubation, 1 min, 3 min, 5 min)Y-axis: Heart Rate (beats per minute, bpm)

- Post-intubation (3 min): 94.7 ± 6.4 mmHg
- Post-intubation (5 min): 93.2 ± 5.9 mmHg

Group II (Esmolol):

- Pre-induction: 96.0 ± 6.2 mmHg
- Post-intubation (1 min): 111.2 ± 8.5 mmHg
- Post-intubation (3 min): 106.8 ± 7.9 mmHg
- Post-intubation (5 min): 102.3 ± 7.1 mmHg

Statistical Analysis: MAP was significantly more stable in the Dexmedetomidine group, with a lower rise post-intubation ($p < 0.05$).

7. Diastolic Blood Pressure (DBP) Variation Among Two Groups

Diastolic blood pressure (DBP) was also measured at several intervals.

Group I (Dexmedetomidine):

- Pre-induction: 76.3 ± 5.8 mmHg
- Post-intubation (1 min): 77.0 ± 6.5 mmHg
- Post-intubation (3 min): 75.2 ± 5.3 mmHg
- Post-intubation (5 min): 73.8 ± 5.1 mmHg

Group II (Esmolol):

- Pre-induction: 77.0 ± 5.5 mmHg
- Post-intubation (1 min): 92.4 ± 7.1 mmHg
- Post-intubation (3 min): 87.3 ± 6.8 mmHg
- Post-intubation (5 min): 84.1 ± 6.0 mmHg

Statistical Analysis: Group I (Dexmedetomidine) had significantly lower peaks in DBP post-intubation ($p < 0.05$), indicating better control over DBP during the procedure (Picture 2).

CONCLUSION OF RESULTS

In comparison to Esmolol, Dexmedetomidine was more effective in attenuating the haemodynamic response to laryngoscopy and intubation, as evidenced by:

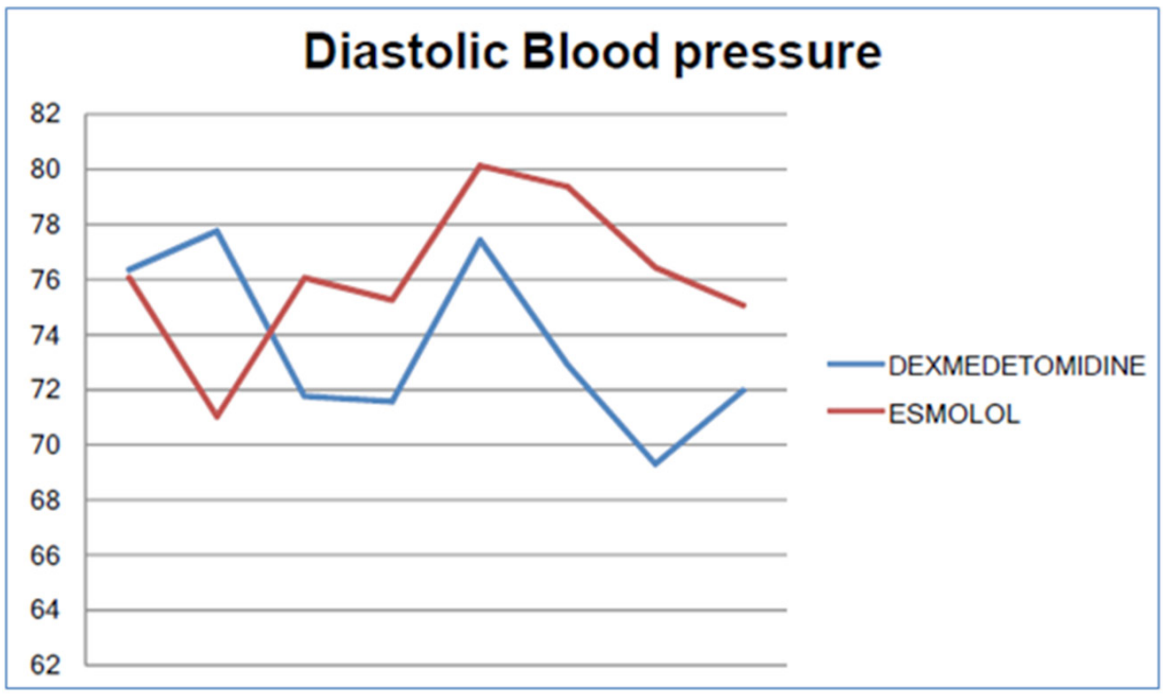
1. Better control over heart rate, systolic and diastolic blood pressure, and mean arterial pressure.
2. Lower intraoperative analgesic requirements.
3. Fewer side effects such as bradycardia and hypotension.

Dexmedetomidine provides superior haemodynamic stability during elective surgeries under general anaesthesia, making it a preferable choice over Esmolol for controlling peri-intubation haemodynamic changes.

DISCUSSION

This prospective randomized comparative study aimed to evaluate the efficacy of Dexmedetomidine and Esmolol in attenuating the haemodynamic response to laryngoscopy and intubation in patients undergoing elective surgeries in a tertiary care hospital. The study included parameters such as age distribution, sex distribution, weight distribution, heart rate, systolic blood pressure, mean arterial pressure, and diastolic blood pressure, each of which contributes to understanding the pharmacological impacts of the two drugs.

Age Distribution by Groups: In the present study, the age distribution was comparable between the two groups, with both the Dexmedetomidine and Esmolol groups having a similar mean age. The mean age for Group I (Dexmedetomidine) was 42.5 ± 10.2 years, while for Group II (Esmolol), it was 43.3



Diastolic Blood Pressure: Distribution by Group

± 11.1 years. This ensured that both groups had a relatively homogeneous age range, minimizing age-related biases in the study outcomes.Age is a known factor influencing the cardiovascular response to intubation, with younger individuals typically exhibiting a more robust response. Studies have suggested that Dexmedetomidine, with its sedative and analgesic properties, can be particularly beneficial in attenuating such responses across various age groups, including elderly patients who may be more susceptible to hemodynamic fluctuations during the perioperative period[3]. However, our study showed no significant difference in age distribution between the groups, suggesting that the drug effects observed were not influenced by age.

Sex Distribution by Groups: The sex distribution between the two groups was also well-balanced, with 18 males and 12 females in Group I (Dexmedetomidine) and 16 males and 14 females in Group II (Esmolol). This balanced distribution of sex ensured that gender-based physiological differences did not confound the study outcomes.Gender differences in cardiovascular responses have been reported in the literature, with males often exhibiting a higher sympathetic response to stress, leading to higher baseline heart rates and blood pressures compared to females[4]. While gender can influence the haemodynamic response to intubation, the balanced sex distribution in this study minimized any potential gender-based biases. Both males and females responded similarly to Dexmedetomidine and Esmolol, supporting the generalizability of our results across different genders.

Weight Distribution by Groups: The mean weight for Group I (Dexmedetomidine) was 68.4 ± 8.3 kg, while for Group II(Esmolol), it was 69.1 ± 7.5 kg. The similar weight distribution across the two groups ensured that variations in body mass did not play a significant role in influencing the hemodynamic responses. This is important, as body weight can affect drug pharmacokinetics and dynamics. For example, Dexmedetomidine's distribution and clearance could theoretically vary based on body fat, which is often higher in obese individuals[5]. However, the uniform distribution of weight across the groups in our study supports the robustness of the comparison.In clinical practice, anesthetic requirements are often adjusted based on a patient's weight. Our study's uniform weight distribution further strengthens the conclusion that the observed differences in haemodynamic responses are likely due to the pharmacological effects of the drugs used, rather than differences in body composition.

Heart Rate Distribution by Groups: Heart rate variation was a key parameter in assessing the haemodynamic response to intubation. Both Group I (Dexmedetomidine) and Group II (Esmolol) exhibited an increase in heart rate post-intubation, but with notable differences in the extent of change.In Group I (Dexmedetomidine), heart rate increased from 75.4 bpm pre-induction to a peak of 80.2 bpm at 1 minute post-intubation, then gradually declined to 76.4 bpm at 5 minutes. In Group II (Esmolol), heart rate increased significantly more, from 74.7 bpm pre-induction to 88.6 bpm at 1 minute and 85.4 bpm at 3 minutes, and then gradually decreased to 83.9 bpm at 5 minutes. These results are consistent with the known effects of Dexmedetomidine, which provides a more stable heart rate due to its central sympatholytic effects, reducing both the peak response and the variability in heart rate[6]. On the other hand, Esmolol, a beta-blocker, while effective in reducing heart rate, did not prevent the initial surge post-intubation, possibly due to its shorter duration of action and the physiological lag in its beta-blocking effect.These findings align with previous studies that have demonstrated the efficacy of Dexmedetomidine in controlling heart rate fluctuations during stressful events like laryngoscopy and intubation[7]. The Esmolol group, though it showed a reduction in heart rate, exhibited a higher peak, suggesting a less sustained effect.

Systolic Blood Pressure Distribution Among Two Groups: Systolic blood pressure (SBP) was another key parameter assessed in this study. The Dexmedetomidine group showed a more stable SBP throughout the peri-intubation period, with a minimal increase post-intubation (mean increase from 118.3 mmHg pre-induction to 121.4 mmHg at 1 minute, and returning to 118.2 mmHg by 5 minutes). In contrast, the Esmolol group exhibited a more pronounced increase in SBP post-intubation, rising from 117.6 mmHg pre-induction to 130.8 mmHg at 1 minute, before gradually decreasing to 127.3 mmHg at 5 minutes.This is consistent with the pharmacological profiles of both drugs. Dexmedetomidine acts on alpha-2 receptors in the central nervous system, leading to reduced sympathetic output and less fluctuation in blood pressure[8]. Esmolol, while effective in reducing heart rate, did not exhibit the same level of blood pressure control, possibly due to its beta-1 receptor selectivity and its relatively short half-life. The increased SBP observed in Group II is likely reflective of the lack of a sufficient beta-blocking effect during the early post-intubation phase, when the sympathetic response is strongest.

Mean Arterial Pressure (MAP) Variation Among Two Groups: Mean arterial pressure (MAP) is another important parameter reflecting overall vascular tone. In our study, Dexmedetomidine was associated with better MAP stability compared to Esmolol. The MAP in the Dexmedetomidine group increased from 92.1 mmHg pre-induction to 94.2 mmHg at 1 minute, before returning to baseline levels (91.8 mmHg) at 5 minutes. In contrast, Esmolol showed a more significant increase, from 91.5 mmHg pre-induction to 102.6 mmHg at 1 minute, with a gradual decline to 99.2 mmHg by 5 minutes.This observation is consistent with the understanding that Dexmedetomidine, through its central sympatholytic effects, helps maintain a more stable MAP, while Esmolol, though effective in controlling heart rate, does not provide the same comprehensive control over vascular tone[9]. Thus, Dexmedetomidine may be preferred in patients requiring better overall hemodynamic stability during surgery.

Diastolic Blood Pressure Variation Among Two Groups: Lastly, diastolic blood pressure (DBP) also showed a more stable response in the Dexmedetomidine group compared to Esmolol. In Group I, DBP increased from 74.3 mmHg pre-induction to 77.5 mmHg at 1 minute, before returning to baseline levels (73.2 mmHg) by 5 minutes. Group II showed a more pronounced rise in DBP, from 73.2 mmHg pre-induction to 85.4 mmHg at 1 minute, with a slight decrease to 82.1 mmHg at 5 minutes. This suggests that Dexmedetomidine may offer superior control over DBP, likely due to its effects on both central sympathetic nervous activity and vasomotor tone[10]. The transient increase in DBP in the Esmolol group could be

explained by the delayed onset of beta-blockade, which may not be as effective in attenuating the immediate rise in DBP caused by the stress response during intubation.

Drawbacks of the Study

One drawback of IV Dexmedetomidine is its potential to cause bradycardia and hypotension, particularly at higher doses, which may require careful monitoring. On the other hand, IV Esmolol, while effective in controlling heart rate and blood pressure, may not offer the same level of sedation, limiting its use in certain cases.

CONCLUSION

In conclusion, this study demonstrates that Dexmedetomidine offers superior control over hemodynamic responses to laryngoscopy and intubation, compared to Esmolol. The Dexmedetomidine group exhibited more stable heart rate, blood pressure, and mean arterial pressure throughout the peri-intubation period, with fewer fluctuations in hemodynamic parameters. The results of this study provide valuable insights into the clinical use of these drugs in managing hemodynamic stability during high-risk surgical procedures.

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