Section: Anesthesia

Original Research Article

A COMPARATIVE STUDY OF ESMOLOL VERSUS DEXMEDETOMIDINE FOR ATTENUATION OF HEMODYNAMIC STRESS RESPONSE TO TRACHEAL EXTUBATION AFTER GENERAL ANAESTHESIA

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Abstract

Background: Endotracheal extubation is a common procedure performed in anaesthesia practice. It involves removing the endotracheal tube from the trachea. The current study aims to compare the effectiveness of dexmedetomidine and esmolol in attenuating the hemodynamic stress response during tracheal extubation after general anaesthesia. **Materials and Methods:** This randomised controlled trial was conducted at Thoothukudi Medical College and Hospital in Thoothukudi for 18 months. One hundred patients were randomly assigned to either Group D or Group E. Data collection involved pre-anaesthetic evaluation, including assessing co-morbid conditions, allergies, ASA risk grading, and airway assessment. Routine blood investigations and other necessary investigations were conducted. **Results:** The mean heart rate was similar between Group D and Group E, except for a significant rise in heart rate observed at 3 minutes post-extubation in Group E. Significant differences were found in the variation of SBP, with Group E exhibiting higher levels throughout the entire duration of observation. Similarly, Group E showed significantly higher DBP than Group D at multiple time points. The quality of extubation was significantly better in Group D, as 94% of the patients compared to only 54% in Group E. Sedation evaluation indicated that most patients in both groups had a sedation score of 2. Still, patients in Group D exhibited higher levels of sedation and calmness. **Conclusion:** This study suggests significant differences in cardiovascular and respiratory responses during the extubation process between Group D and Group E. Group E showed a significant rise in heart rate and higher SBP, DBP, and MAP levels compared to Group D.

INTRODUCTION

Endotracheal extubation is a common procedure performed in anaesthesia practice. It involves removing the endotracheal tube from the trachea. Complications during and after extubation are more frequent than those during tracheal intubation. These complications can include tachycardia, arrhythmias, hypertension, myocardial ischemia, bronchospasm, and laryngospasm, leading to respiratory and cardiac decompensations.[1] Extubation is a critical component of airway management and can be more challenging than intubation. The depth of anaesthesia, preoperative physical status, increasing age, and male gender can increase complications during extubation. Hypertension and tachycardia are well-documented events associated with extubation. Tracheal extubation typically leads to a 10-30% increase in arterial pressure and heart rate, usually lasting 5-15 minutes.[2,3]

This hemodynamic imbalance is caused by the sympathoadrenal reflex response resulting from stimulation of the epipharynx and laryngopharynx. It leads to increased plasma catecholamine levels and

the activation of alpha and beta-adrenergic receptors. The increase in plasma catecholamines leads to elevated blood pressure and heart rate. In patients with coronary artery disease, this can cause a significant decrease in ejection fraction.

Respiratory complications associated with tracheal extubation include coughing and sore throat (which can range from 38% to 96% incidence), laryngospasm, bronchospasm, and subsequent hypoxemia. Laryngospasm is the most common cause of post-extubation upper airway obstruction, and pharmacological interventions such as opioids, calcium channel blockers, β blockers, lidocaine, propofol, clonidine, and others can help attenuate these reflexes. While various strategies have been used to control cardiovascular and respiratory adverse responses during intubation, there are no established standard therapies or guidelines for preventing hemodynamic responses during the peri-extubation period.[4,5]

The hemodynamic changes that occur during extubation and anaesthesia emergence can have dangerous consequences. Several drugs, including esmolol, lidocaine, dexmedetomidine, fentanyl, and morphine, have been recommended for controlling hemodynamic events. Dexmedetomidine is a newer, highly selective alpha-2 adrenoceptor agonist. Previous studies have evaluated the usefulness of dexmedetomidine as an adjuvant to general anaesthesia, reducing the requirements for inhalational agents and opioids and attenuating intubation stress.[6,7] This study aims to compare the effectiveness of dexmedetomidine and esmolol in attenuating the hemodynamic stress response during tracheal extubation after general anaesthesia. The study also examines these drugs' impact on reducing respiratory complications and assesses the quality of extubation.

MATERIALS AND METHODS

This randomised controlled trial was conducted at Thoothukudi Medical College and Hospital in Thoothukudi for 18 months. Ethical clearance for the study was obtained from the institutional ethics committee.

Inclusion Criteria

Patients aged 18-65 who underwent elective surgery under general anaesthesia, American Society of Anesthesiologists Physical status class I or II and, regardless of gender, were included.

Exclusion Criteria

Exclusion criteria encompassed patient refusal, cardiovascular and respiratory disorders, pregnancy, breastfeeding, morbid obesity, uncontrolled systemic hypertension, coronary artery disease or valvular heart disease, history of cerebrovascular accidents, major kidney and liver diseases, allergies to study drugs, history of sleep apnea, preexisting rhythm disturbances and ECG changes, emergency surgeries, and age below 18 years or above 65 years.

Data collection involved pre-anaesthetic evaluation, including assessing co-morbid conditions, allergies, ASA risk grading, and airway assessment. Routine blood investigations and other necessary investigations were conducted. Informed written consent was obtained from the patients, and 100 patients were randomly assigned to either Group D or Group E.

Group D received dexmedetomidine (0.5 mcg/kg) diluted in 10 ml of normal saline, administered over 10 minutes. Group E received 10 ml of normal saline over 10 minutes. The administration of nitrous oxide was discontinued at the end of the infusion. Patients in Group E also received Esmolol (1 mg/kg) diluted in 10 ml of normal saline, administered 3 minutes before reversing the patient with Inj. Neostigmine (0.05 mg/kg) and Inj. Glycopyrrolate (0.005 mg/kg). Tracheal extubation was performed a minimum of two minutes after administering the study drug. Hemodynamic stability, adverse effects, and the quality of tracheal extubation were monitored and recorded.

Statistical Analysis

Descriptive and inferential statistics were used for data analysis, and the results were presented using tables. The association between categorical variables was assessed using the chi-square test, while independent t-tests were used to compare hemodynamic parameters between the two groups at different intervals. Fisher exact test was used for the extubation quality between the two groups, and a p-value < 0.05 was considered significant.

RESULTS

Table 1: Gender-wise distribution of study participants

Group	Male	Female	P value
D	7	43	0.086
E	14	36	

The mean age in the Dexmedetomidine group was 41.86 ±14.387 years, and the mean age in the Esmolol group was 39.34±12.729 years. There was no significant difference between the two groups for age distribution; hence, both groups were comparable in age.

Table 2: Comparison of mean heart rate between both the groups at different intervals of time

Heart rate-	Group D	Group E	P-value
Baseline	85.12±9.109	87.12±9.716	0.291

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10 mins before Extubation	83.24±14.485	88.40±11.6 90	0.053
3 mins before Extubation	83.12±17.668	88.88±13.175	0.068
Extubation	94.14±18.110	99.88±13.266	0.074
1 min	88.82±17.344	95.44±12.888	0.069
3 min	85.46±17.212	91.86±12.868	0.038
5 min	83.20±15.786	88.60±12.345	0.060
10 min	82.52±15.131	87.82±12.98	0.058

The baseline mean HR was 85.12±9.109 bpm in Group D and 87.12±9.716 bpm in Group E. There is no significant difference in baseline heart rate (P>0.05). Hence both groups are comparable in Heart rate. Throughout the procedure, the variation in the mean Heart rate was similar in both groups except at 3 mins post-extubation, where a significant rise in heart rate was recorded in Group E- 91.86±12.868 (P<0.05).

Table 3: Comparison of SBP between both the groups at different intervals of time

SBP (In mm Hg)	Group D	Group E	P-value
Baseline	125.40±9.225	128.50±7.985	0.075
10 mins before extubation	122.0±20.241	132.12±12.098	0.003
3 mins before extubation	125.06±14.921	133.84±16.382	0.006
Extubation	132.02±15.622	146.90±15.319	0.000
1 min	125.60±11.676	141.06±15.560	0.000
3 min	120.28±9.957	135.12±14.928	0.000
5 min	118.26±10.486	130.26±16.969	0.000

The mean systolic blood pressure at baseline was 125.40±9.225 mmHg in group D and 28.50±7.985 mm Hg in group E. Both groups are comparable at baseline, as there was no significant difference in SBP. However, there was significant variation in SBP variation between both groups throughout the entire duration of observation from 10 mins before extubation to 10 min after extubation (P<0.05). The mean SBP was high in Group E compared to Group D.

Table 4: Comparison of DBP between both the groups at different intervals of time

DBP	Group D	Group E	P-value
Baseline	79.72±5.429	80.52±6.66	0.51
10 mins before extubation	76.76±10.183	80.80±8.273	
10 mins before	76.76±10.183	80.80±8.273	0.032
3 mins before extubation	78.56±10.104	81.52±9.613	0.137
Extubation	81.46±12.276	89.74±13.222	0.002
1 min	75.92±9.269	84.28±10.280	0.000
3 min	71.94±8.01	80.52±10.8	0.00
5 min	70.10±7.906	78.50±10.531	0.000
10 min	69.04±9.067	75.78±9.904	0.001

The baseline mean DBP in Group D was 79.72±5.429 mmHg and in Group E was 80.526.616 mmHg. Both groups are comparable at baseline (P>0.05). There is a significant rise in DBP in Group E compared to Group D at 10 mins before extubation, 1, 3, 5 and 10 mins post-extubation. (P<0.05).

The baseline mean MAP in Group D was 94.945.89 mmHg, and at the end of observation was 84.769.093 mmHg. The maximum rise in mean MAP was found at Extubation 99.3413.196 mmHg. A significant fall in mean MAP was found 10 mins before extubation, 3 mins, 5 mins and 10 mins post-extubation (P<0.05).

Then mean MAP in group E was 96.515.80 mmHg and at 10 mins post extubation was 92.849.052 mm Hg. The peak rise in mean MAP was 109.5013.634 mmHg found at extubation. Compared to baseline mean MAP, a significant rise in mean MAP was found 10 mins before, at extubation, and 1 and 3 mins post-extubation. Also, a significant fall compared to baseline was observed 10 mins post-extubation.

Table 5: Comparison of mean MAP between both the groups at different intervals of time

MAP	Group D	Group E	P-value
Baseline	94.94±5.89	96.5±15.80	0.183
10 mins before extubation	94.00±12.034	100.06±11.127	0.10
3 mins before extubation	94.00±12.034	100.06±11.127	0.10
Extubation	99.34±13.196	109.50±13.634	0.000
1 min	93.18±10.462	102.90±11.511	0.000
3 min	87.60±8.827	98.36±10.212	0.000
5 min	85.86±9.024	96.26±10.90	0.000
10 min	84.76±9.093	92.84±9.052	0.000

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Groups D and E are comparable at baseline for mean MAP (P>0.05). However, significantly high MAP was found throughout the observation period (P<0.05), except at baseline and 3 mins before extubation.
The baseline Mean SPO2 in Group D was 98.96±0.493%, and at the end of observation, it was 98.96±81.133 %. The maximum SPO2 was recorded at extubation - 99.24±0.716 %. A significant rise in mean SPO2 compared to baseline was observed at extubation, 1 min and 3 mins post-extubation (p<0.05).
The mean SPO2 in Group E at baseline was 98.90±0.303%, and at 10 mins post-extubation was 98.82±0.482 mmHg. The maximum rise in SPO2 was observed 10 mins before extubation, and a plateau of rise was observed until 1 min after extubation.

Table 6: Comparison of mean SPO2 between both the groups at different intervals of time

SPO2	Group D	Group E	P-value
Baseline	98.96±0.493	98.90±0.303	0.485
10 mins before extubation	99.00±0.639	98.98±0.141	0.829
3 mins before	99.12±0.74	98.98±0.247	0.211
Extubation	99.24±0.716	98.98±0.247	0.017
1 min	99.18±0.596	98.98±0.377	0.048
3 min	99.10±0.661	98.92±0.396	0.019
5 min	98.92±0.829	98.82±0.482	0.463
10 min	98.96±81.133	98.82±0.482	0.423

Table: Extubation quality

Extubation quality	Group D	Group E	Total	P-value
1	47 (94%)	27(54%)	74	0.000
2	3(6%)	21(42%)	24	
3	0	2 (4%)	2	

Table 8: Ramsay sedation scale

Extubation quality	Group D	Group E	Total	P-value
1	0	0	0	0.000
2	48 (96%)	16 (32%)	64	
3	2 (4%)	31 (62%)	33	
4	0	2 (4%)	2	
5	0	1(2%)	1	

On the assessment of sedation scores, it was observed that 0 patients in Group D and nil in Group E were found anxious and restless (Ramsay score1). Those who were cooperative, oriented and tranquil (Ramsay score 2) accounted for 96% and 32% in groups D and E, respectively. Most patients in Group D and E had a sedation score of 2. A Ramsay score of 3 in Group D is only two persons (4%), and in Group E is 31%. A high sedation score of 4 and 5 was observed in 2% of patients in Group E, but no one in Group D. Sedation scores above five was observed in 1 patient in Group E.

DISCUSSION

Endotracheal extubation is a frequently performed procedure in the practice of anaesthesia. Endotracheal extubation is trans laryngeal removal of the endotracheal tube from the trachea. Complications that occur during and after extubation are three times more common than that of tracheal intubation. One of the Critical components of airway management is extubation, which may be far more difficult than intubation. Increased incidence of complications is correlated with the depth of anaesthesia, preoperative physical status, and increasing age and gender with a male preponderance.
Our study found no significant difference in the distribution of study participants based on gender between the two groups (p>0.005), which indicates that both groups are comparable in gender distribution. A study by Gupta et al.8 also reported an equal distribution of study participants among males and females.

The average resting heart rate at baseline was 85.12±9.109 beats per minute (bpm) in Group D, and 87.12±9.716 bpm in Group E. Statistical analysis revealed no significant difference in baseline heart rate between the two groups (P>0.05). Several studies conducted by Jain D et al.[9] Sriranga Rao et al.[10] Wang YQ et al.[11] Kovac AL et al.[12] and Vanish Priya et al.[13] compared the effectiveness of a single dose of dexmedetomidine or esmolol in attenuating hyperdynamic responses after extubation. Their findings indicated that both drugs effectively controlled the increase in pulse rate and blood pressure during the extubation phase. However, dexmedetomidine was considered superior due to its additional analgesic, sedative, and antiemetic properties.
Our study compared the baseline systolic blood pressure (SBP) between Group D and Group E and found no significant difference, indicating their comparability at baseline. However, throughout the observation period from 10 minutes before extubation to 10 minutes after extubation, there was a significant difference in SBP variation between the

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two groups (P<0.05), with Group E exhibiting a higher mean SBP than Group D. This aligns with the findings of Amarappa G et al.[14] demonstrated that dexmedetomidine and esmolol effectively reduced SBP before extubation and up to 10 minutes post-extubation (p<0.001). Regarding mean arterial pressure (MAP), both Group D and Group E were comparable at baseline (p>0.05). However, a significantly higher MAP was found throughout the observation period (except at baseline and 3 minutes before extubation) in Group E (p<0.05). A study by Sharma Subba et al.[15] showed a significant decrease in mean arterial pressure in the dexmedetomidine group compared to the esmolol group after extubation and after the release of pneumoperitoneum.

Kumar A et al.[16] conducted a study showing no difference in peripheral SPO2 levels between the dexmedetomidine and propofol groups during the intraoperative period. The SPO2 values in all patients in both groups were above 92%. Amarappa G et al. study showed that there was a statistically significant reduction in mean blood pressure from the baseline value in the dexmedetomidine group (25%) compared to the esmolol group (12%) before extubation (T1) (p<0.0001).[14]

Another study by Lee SH et al.[17] showed that the propofol and dexmedetomidine group had a lower extubation quality score than those receiving propofol and dexmedetomidine, with a statistically significant p-value.

Reviewing sedation scores using the Ramsay Scale showed no patients in Group D and Group E were anxious and restless (Ramsay score 1). Most patients in Group D and Group E were cooperative, oriented, and tranquil (Ramsay score 2), accounting for 96% and 32% of the groups, respectively. A sedation score of 3 was observed in only two persons (4%) in Group D and 31% in Group E. Higher sedation scores of 4 and 5 were observed in 2% of patients in Group E. In contrast, none were observed in Group D. Sedation scores above five were observed in only one patient in Group E.

Antony T et al.[18] conducted a study in 2016 using the Ramsay Scale to assess sedation scores. They found that higher sedation scores were observed in patients who received dexmedetomidine. Most patients (73.3% and 66.7%) who received dexmedetomidine at 0.5 µg/kg and 1 µg/kg were drowsy but responded to commands. None of the patients experienced respiratory depression.

CONCLUSION

In conclusion, dexmedetomidine and esmolol are safe and effective in attenuating the hemodynamic stress response during extubation. However, dexmedetomidine is superior in controlling heart rate, systolic and diastolic blood pressures during extubation. Therefore, dexmedetomidine provides stable hemodynamics and protects against the stress response to extubation in patients undergoing surgeries under general anaesthesia.

Limitations

Limitations of this study include the exclusion of the pediatric age group, emergency and sick cases, and cardiac patients, which restricts the generalizability of the findings. The study did not compare doses of Esmolol and Dexmedetomidine, preventing a comprehensive analysis of the dose-response relationship. The results may not apply to resource-limited environments for a hospital-based study conducted in a tertiary care setting. The sample size may be inadequate to measure complications, and the smaller size increases the risk of unknown confounding factors.

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