Section: Anaesthesiology

Original Research Article

COMPARING DEXMEDETOMIDINE AND ESMOLOL FOR HEMODYNAMIC CONTROL DURING EXTUBATION IN LAPAROSCOPIC SURGERIES: A TERTIARY CARE HOSPITAL STUDY

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Abstract

Background: This study aimed to compare the efficacy of Dexmedetomidine and Esmolol in controlling heart rate (HR) and blood pressure (BP) during extubation in laparoscopic surgeries, a critical phase with potential hemodynamic challenges. The study also assessed extubation quality, sedation levels, and adverse events associated with these drugs. **Materials and Methods:** A randomized controlled clinical trial was conducted at a tertiary care hospital in Odisha, India. Eighty-two patients undergoing elective laparoscopic Cholecystectomy were randomly assigned to receive either Dexmedetomidine or Esmolol. Various parameters, including HR, SBP, DBP, MAP, and SpO2, were monitored at specific time intervals. Extubation quality was rated using a 5-point scale, and sedation levels were evaluated using the Ramsay Sedation Scale. Adverse events, such as bradycardia and hypotension, were also recorded. **Result:** Both Dexmedetomidine and Esmolol effectively reduced HR at extubation and facilitated its return to baseline within 30 minutes post-extubation. Significant differences in SBP, DBP, and MAP were observed between the two groups at various time points. Dexmedetomidine demonstrated superior extubation quality with significantly less coughing. Ramsay Sedation Scores indicated varying sedation levels without Grade 4 or 5 sedation in either group. Adverse events were minimal and comparable between the groups. **Conclusion:** This study highlights the efficacy of Dexmedetomidine and Esmolol in managing HR and BP during extubation in laparoscopic surgeries. Dexmedetomidine offers advantages in terms of extubation quality. Clinicians should consider the specific hemodynamic goals and extubation requirements of individual patients when selecting between these agents. Further research and clinical experience will refine their utilization in perioperative care.

INTRODUCTION

Endotracheal extubation is a critical procedure demanding a high degree of skill and experience in the medical field.[1] It marks the final step in removing a patient from mechanical ventilation, particularly prevalent in intensive care units and post-anesthesia care units. The purpose of endotracheal tubes ranges from safeguarding the airway to facilitating positive-pressure mechanical ventilation and administering anesthesia.[1] Deciding when to extubate a patient requires careful consideration due to the potential for respiratory and airway complications. While many extubation-related issues are minor, they can lead to serious complications, including cardiovascular stress, pulmonary aspiration, hypoxemia, and even mortality, either immediately or later.[2]

Extubation-related effects, such as hypertension and tachycardia, are well-documented and result from stimulation of the sympathoadrenal reflex in the pharyngeal and laryngopharyngeal regions, leading to catecholamine activation of alpha and beta adrenergic receptors.[3,4] These transient and unpredictable elevations in heart rate and blood pressure can increase the risk of bleeding, congestive heart failure, stroke, arrhythmias, and myocardial infarction.[5,6]

Numerous non-pharmacological and pharmacological strategies have been explored to

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mitigate these hemodynamic responses, including deeper plane extubation under anesthesia and the use of drugs such as Esmolol,[5-7] Labetalol,[8] Verapamil,[9] Diltiazem,[10] Nicardipine,[11] Propofol,[12,13] Lignocaine,[14,15] Opioids,[16] Nitroglycerine, Clonidine,[17] and Dexmedetomidine,[18] each with its own advantages and disadvantages.

This study aims to compare the effectiveness of Dexmedetomidine (at a dose of 0.5mcg/kg),[19-21] and Esmolol (at a dose of 1mg/kg),[22-24] in controlling heart rate (HR) and blood pressure (BP) responses during extubation in laparoscopic surgeries, as limited research has explored this comparison in the context of laparoscopic procedures.

MATERIALS AND METHODS

Study Design: This research employed a randomized controlled clinical trial design to compare the effects of Dexmedetomidine and Esmolol on hemodynamic responses during extubation in laparoscopic surgeries.

Study Population: The study was conducted at the Surgical Operation Theater of the Institute of Medical Sciences and SUM Hospital in Bhubaneswar, Odisha. The participants included patients meeting the specified inclusion criteria.

Sampling Procedure: The study utilized a convenience sampling method to select eligible patients.

Sample Size: A total of 82 cases were included in the study between March 2022 and May 2023 following approval by the Institute Ethical Committee [Ref.no/IMS.SH/SOA/2022/310].

Inclusion Criteria

- Patient belongings ASA grade 1 and 2
- Age above 18years and below 65 years
- Elective Laparoscopic Cholecystectomy

Exclusion Criteria

- Known sensitivities to research drugs
- Lactating women
- Patient with sleep apnea
- Patients already on beta blockers for hypertension
- Patients with suspicious difficult intubation

Human Subjects Protection

All procedures were conducted in accordance with ethical guidelines, and written and informed consent was obtained from each participant. The study adhered to strict exclusion criteria to ensure patient safety.

Description of Intervention

The study involved two groups:

- **Group D:** Received Dexmedetomidine at a dose of 0.5 mcg/kg diluted in 10 ml of 0.9 percent normal saline.
- **Group E:** Received Esmolol at a dose of 1 mg/kg diluted in 10 ml of normal saline (0.9%).

Patients were monitored using electrocardiography (ECG), oxygen saturation (SpO2), non- invasive blood pressure (NIBP), and end-tidal carbon dioxide (EtCO2). They were also premedicated with injection glycopyrolate 4 mcg/kg IV, injection midazolam 0.03 mg/kg IV, and injection fentanyl 2 mcg/kg IV. Anesthesia induction involved propofol 2 mg/kg and intubation facilitated with atracurium 0.5 mg/kg IV. Anesthesia maintenance included 66% nitrous oxide in oxygen, Isoflurane 1-2%, and repeated IV injections of atracurium 0.08 mg/kg. Dexmedetomidine or saline was administered before port closure. Nitrous oxide was discontinued at the end of infusion, and neuromuscular blockade was reversed using neostigmine 0.05 mg/kg IV and glycopyrolate 8 mcg/kg IV. Extubation was performed when criteria were met.

Data Collection Procedure

Various parameters were observed at multiple time points, including pulse rate (PR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), and oxygen saturation (SpO2) at specified intervals. Extubation quality was assessed using a 5-point scale, and sedation levels were evaluated using the Ramsay Sedation Scale.

Data Analysis Procedure

Data were entered into a Microsoft Excel workbook, documented in a case record proforma, and analyzed using SPSS v21.0. Statistical tests, such as the Chi-square test, Shapiro-Wilk test, and independent t-test, were used to analyze the data, with significance set at $p < 0.05$. The paired t- test was employed for intra-group comparisons over various time points.

RESULTS

The study compared the effectiveness of Dexmedetomidine and Esmolol in controlling heart rate (HR) and blood pressure (BP) during extubation in laparoscopic surgeries. Age and gender distribution were similar between the two groups. Demographic data of the study population is shown in [Table 1]. Both drugs successfully reduced HR at extubation and restored it to baseline levels within 30 minutes post-extubation. Notably, significant differences in systolic blood pressure (SBP) were observed at various time points, while diastolic blood pressure (DBP) showed significant differences from 5 minutes post-infusion to 30 minutes post-extubation. Mean arterial pressure (MAP) also displayed significant variations during and post-extubation. Various hemodynamic parameters in both the treatment groups at different stages of extubation are depicted in [Table 2].

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Table 1: Demographic data of the study population.

		Dexmedetomidine	Esmolol	P- value
Age (in years)	≤20	2 (4.87%)	3 (7.31%)	0.218
	21-30	10 (24.39%)	17 (41.46%)	
	31-40	12 (29.29%)	13 (31.70%)	
	41-50	13 (31.70%)	5 (12.19%)	
	>50	4 (9.75%)	3 (7.31%)	
Gender	Male	21 (51.21%)	22 (53.65%)	0.825
	Female	20 (48.78%)	19 (46.34%)	
Duration of Surgery In Minutes		69.85±14.17	70.60±13.68	0.807
BMI		23.01±4.53	25.61±4.53	0.270

Table 2: Various hemodynamic parameters in both the treatment groups at different stages of extubation.

	Heart Rate			Systolic Blood Pressure			Diastolic Blood Pressure			Mean Arterial Pressure			SpO2		
	Dexmedetomidine	Esmolol	P-value	Dexmedetomidine	Esmolol	P-value	Dexmedetomidine	Esmolol	P-value	Dexmedetomidine	Esmolol	P-value	Dexmedetomidine	Esmolol	P-value
Baseline	93.75±7.24	92.27±10.55	0.461	129.60±9.68	128.17±8.53	0.478	86.85±5.39	85.58±6.02	0.322	100.32±5.49	99.71±4.79	0.594	99.52±0.503	99.48±0.55	0.836
5 min Post infusion	92.07±7.72	93.43±8.29	0.442	118.21±7.30	132.65±8.81	<0.0001	76.65±5.75	86.04±6.26	<0.0001	90.51±4.29	100.91±5.28	<0.0001	99.51±1.03	99.48±0.50	0.828
At extubation	92.14±8.96	91.07±7.00	0.548	120.09±7.02	131.26±9.23	<0.0001	83.43±2.73	84.85±5.83	0.164	95.65±2.67	100.32±5.26	<0.0001	99.70±0.47	99.73±0.44	0.809
1 min	88.31±8.07	87.00±7.05	0.434	116.53±7.03	124.82±0.57	<0.0001	80.19±3.14	80.82±5.91	0.546	92.30±2.99	95.49±5.68	0.002	99.21±0.68	99.12±0.71	0.531
3 min	84.58±7.10	83.58±7.29	0.531	112.29±6.67	120.09±9.46	<0.0001	76.60±3.14	77.85±4.75	0.202	88.56±3.10	91.93±4.95	<0.0001	99.41±0.63	99.21±0.61	0.160
5 min	81.12±6.72	80.92±7.73	0.903	108.60±6.47	120.48±10.14	<0.0001	73.82±3.00	75.70±4.37	0.026	85.42±3.04	90.63±5.22	<0.0001	99.31±0.52	99.14±0.52	0.144
10 min	78.19±6.23	79.48±6.54	0.362	105.51±6.00	122.04±9.14	<0.0001	71.48±3.18	74.04±4.69	0.005	82.82±3.18	90.04±5.36	<0.0001	99.16±0.60	99.07±0.60	0.364
15 min	80.75±6.06	80.02±7.12	0.822	104.48±6.56	123.17±7.99	<0.0001	71.17±3.65	74.73±5.39	0.001	82.27±3.31	90.87±5.06	<0.0001	99.29±0.64	99.24±0.66	0.736
30 min	82.85±5.91	80.85±5.99	0.874	105.65±8.27	122.97±6.85	<0.0001	72.14±5.44	76.58±5.80	0.001	83.31±4.42	92.04±4.83	<0.0001	99.24±0.69	99.12±0.78	0.458

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Table 3: Extubation Quality Score and Ramsay Sedation Score comparison in both the treatment groups.

Extubation Quality Score				Ramsay Sedation Score				
	Dexmedetomidine	**Esmolol**	**P-value**			**Dexmedetomidine**	**Esmolol**	**P-value**
No Coughing	25 (60.98%)	8 (19.53%)	<0.0001	Grade 1	Anxious and agitated, restless	1	8	<0.0001
Minimal coughing	15 (36.59%)	16 (39.02%)		Grade 2	Co-operative, Oriented	17	27	
Moderate coughing	1 (2.43%)	16 (39.02%)		Grade 3	Asleep, responsive to light stimulation (loud noise, tapping)	23	6	
Severe coughing	0	1 (2.43%)		Grade 4	asleep, responsive to light stimulation (loud noise, tapping)	-	-	
Poor extubation	0	0		Grade 5	asleep, slow response to stimulation	-	-	
				Grade 6	no response to stimulation	-	-	

Table 4: Summary of Adverse Events in the Both the Treatment Groups.

Adverse Event		Dexmedetomidine	Esmolol	P- value
Bradycardia	Yes	1 (2.43%)	2 (4.87%)	0.556
	No	40 (97.57%)	39 (95.13%)	
Hypotension	Yes	2 (4.87%)	0	0.152
	No	39 (95.13%)	41 (100%)	

Oxygen saturation (SpO2) remained consistent across both groups. Line Diagram Showing Trends in Changes of different hemodynamic parameters at different stages of Extubation are depicted in Figure 1. Extubation quality favored Dexmedetomidine, with significantly fewer instances of coughing. Ramsay Sedation Scores reflected diverse sedation levels, with no Grade 4 or 5 sedation in either group [Table 3]. Adverse events were infrequent and did not significantly differ between the two groups [Table 4]. In summary, both Dexmedetomidine and Esmolol effectively controlled HR and BP during extubation, with Dexmedetomidine demonstrating superior outcomes in terms of extubation quality. These findings provide valuable insights for clinicians managing patients undergoing laparoscopic surgeries.

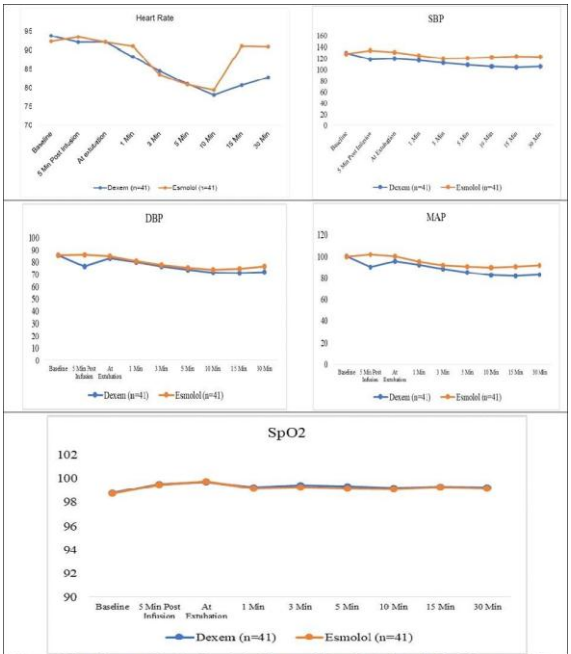

Figure 1: Line Diagram Showing Trends in Changes of Heart Rate, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP), Mean Blood Pressure (MAP), SpO2 at different stages of Extubation.

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DISCUSSION

The present study compared the use of Dexmedetomidine and Esmolol in controlling heart rate (HR) and blood pressure (BP) during extubation in laparoscopic surgeries. The findings reveal important insights into the hemodynamic effects and overall outcomes associated with these two drugs in this clinical context.

Hemodynamic Effects: Both Dexmedetomidine and Esmolol proved effective in reducing HR at the time of extubation, aligning with previous research on their ability to attenuate sympathetic responses during this critical phase of anesthesia emergence.[25,26] This reduction in HR is desirable, as excessive tachycardia can lead to increased myocardial oxygen demand and potentially result in adverse cardiac events.[4] Importantly, both drugs also facilitated the return of HR to baseline levels within 30 minutes post-extubation, indicating their transient effect and suitability for maintaining hemodynamic stability.

In terms of SBP, significant differences between the two groups at various time points suggest distinct profiles of action. Dexmedetomidine's alpha-2 adrenergic agonism is known to reduce sympathetic outflow, leading to vasodilation and a reduction in SBP.[27] Conversely, Esmolol's beta-1 receptor antagonism primarily targets HR without substantial effects on SBP.[5] This discrepancy could explain the observed differences and may offer clinicians the flexibility to choose a drug based on the specific requirements of the patient.

While there were no significant differences in DBP at most time intervals, the significant difference observed from 5 minutes post-infusion to 30 minutes post-extubation in the Esmolol group is noteworthy. This suggests that Esmolol may exert a more sustained effect on DBP compared to Dexmedetomidine, potentially indicating a need for careful monitoring of DBP in Esmolol-administered patients.

The significant differences in MAP at various time intervals further underscore the differing hemodynamic effects of Dexmedetomidine and Esmolol. This information is crucial for clinicians managing patients with specific MAP targets during and after surgery. Dexmedetomidine's ability to effectively control MAP may be advantageous in situations where tight control of BP is essential.

Extubation Quality

Extubation quality, as assessed by the 5-point scale, favored Dexmedetomidine. Significantly fewer instances of coughing were observed in the Dexmedetomidine group. Coughing during extubation can lead to complications, including increased intracranial and intraocular pressures, airway irritation, and hemodynamic disturbances.[3] These findings suggest that Dexmedetomidine may offer superior airway control during extubation, contributing to a smoother emergence from anesthesia.

Sedation Levels

The Ramsay Sedation Score indicated varying levels of sedation in both groups, with no patients experiencing Grade 4 or 5 sedation. Dexmedetomidine patients displayed a higher proportion of Grade 3 sedation, possibly due to the drug's sedative properties. The choice between Dexmedetomidine and Esmolol may depend on the desired level of post-extubation sedation and the patient's clinical condition.

Adverse Events

The incidence of adverse events, specifically bradycardia and hypotension, was minimal in both groups, with no significant differences. These findings suggest that both drugs are generally well-tolerated in the context of extubation in laparoscopic surgeries. Nevertheless, careful patient selection and monitoring remain crucial to minimize potential risks.

Clinical Implications

The results of this study have clinical implications for anesthesiologists and perioperative care teams. The choice between Dexmedetomidine and Esmolol should be guided by the specific hemodynamic goals and extubation quality requirements of the patient. Dexmedetomidine may be preferred when smooth extubation and enhanced airway control are critical, while Esmolol could be considered in situations where sustained BP control is necessary.

Limitations of the Study

It's important to acknowledge certain limitations of this study, including the relatively small sample size and the single-center nature of the research. Future studies with larger cohorts and multi-center designs may provide further insights and enhance the generalizability of the findings.

CONCLUSION

In conclusion, this study demonstrates that both Dexmedetomidine and Esmolol are effective in controlling HR and BP during extubation in laparoscopic surgeries, with Dexmedetomidine showing an advantage in terms of extubation quality. Clinicians should consider the specific hemodynamic requirements and extubation goals of each patient when choosing between these two agents, as both drugs offer valuable options for optimizing patient care in the perioperative setting. Further research and clinical experience will help refine the selection criteria and dosing strategies for these agents in various clinical scenarios.

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