Section: Anaesthesiology

Original Research Article

COMPARATIVE EVALUATION OF INTUBATING CONDITIONS AND HEMODYNAMIC RESPONSES TO ROCURONIUM AND VECURONIUM IN PATIENTS UNDERGOING LAPAROSCOPIC SURGERIES: A PROSPECTIVE RANDOMIZED DOUBLE-BLIND STUDY

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ABSTRACT

Background: Laparoscopic surgeries are associated with significant hemodynamic alterations due to pneumoperitoneum. Certain patient populations may not tolerate extreme hemodynamic fluctuations and require smooth endotracheal intubation and stable haemodynamics throughout the surgery. This study compared conditions for endotracheal intubation and hemodynamic responses to intubation between two commonly used muscle relaxants, rocuronium and vecuronium, in patients undergoing laparoscopic surgeries. **Materials and Methods:** Hundred ASA physical status I–II patients undergoing laparoscopic surgeries electively under general anaesthesia were randomly assigned to one of the two groups of 50 each and patients received either rocuronium 0.6 mg/kg body weight (BW) or vecuronium 0.1 mg/kg BW intravenously. Conditions for endotracheal Intubation were assessed after three minutes as per the Cooper scoring system. Systolic and diastolic blood pressures, and heart rate were noted down at predefined intervals. Data was analysed using appropriate statistical tests. **Result:** Excellent intubating conditions with overall Cooper scores of 8-9 were observed in 72% of patients with rocuronium and only 20% with vecuronium ($p < 0.0001$). Jaw relaxation and response to intubation were significantly better with rocuronium. Heart rate trends were comparable between groups. Blood pressure values, systolic and diastolic, were significantly lower in the vecuronium group at multiple intraoperative time-points ($p < 0.05$). **Conclusion:** Rocuronium provided better conditions for endotracheal intubation with good hemodynamic stability compared to vecuronium in laparoscopic surgeries. It may be considered the preferred neuromuscular blocking agent when smooth intubation is required and also when hemodynamic fluctuations could be dangerous for certain population.

INTRODUCTION

Skeletal muscle relaxants are essential components in contemporary anesthetic practice as they facilitate tracheal intubation, optimize surgical exposure and ensure patient immobility.[1,2] The ideal skeletal muscle relaxant must have rapid onset, a predictable duration, provide optimal intubating conditions, with minimal adverse or hemodynamic effects. Among intermediate-acting non-depolarizing agents, rocuronium bromide and vecuronium bromide are commonly used due to their favorable pharmacological profiles.[1]

Vecuronium is associated with cardiovascular stability and minimal histamine release but it has a relatively slower onset of action.[3] Rocuronium, a monoquaternary aminosteroid analogue of vecuronium, was developed to provide faster onset. Due to its lower potency, it requires administration of higher molar doses leading to more rapid neuromuscular junction receptor occupancy and hence faster onset.[4] This pharmacodynamic

property makes rocuronium a suitable alternative when rapid and smooth intubation is required.

Optimal intubating conditions are important to prevent airway trauma, coughing, bucking, and exaggerated sympathetic responses during laryngoscopy. Inadequate relaxation can itself lead to difficult intubation and adverse hemodynamic fluctuations.[5,6] The Cooper et al. scoring system is an objective method for assessing conditions for endotracheal intubation [Table 1].[1]

Laparoscopic surgeries are associated with additional anesthetic challenges due to carbon dioxide pneumoperitoneum and positional variations. There is reduction in venous return due to raised intra-abdominal pressure. There is elevated systemic vascular resistance and sympathetic stimulation, resulting in tachycardia and hypertension.[2,7] These physiological alterations necessitate careful selection of neuromuscular blockers that provide cardiovascular stability while providing adequate relaxation.

Previous studies have compared intubating conditions with rocuronium and vecuronium and observed that the onset is faster with rocuronium.[4,8] However, there are variations in terms of their hemodynamic effects, particularly in laparoscopic settings where pneumoperitoneum may exaggerate cardiovascular responses.[9] While vecuronium is traditionally considered hemodynamically stable, reports of bradycardia and blood pressure reduction have been documented.[3,8]

Revisiting comparison of conditions for endotracheal intubation provided by rocuronium and vecuronium using the Cooper scoring system provides a more objective comparison. In view of atraumatic airway control with stable peri-intubation hemodynamics, a direct comparison of these two agents in laparoscopic procedures remains clinically relevant. Therefore, this study was undertaken to compare rocuronium and vecuronium with respect to conditions for endotracheal intubation using the Cooper scoring system and to evaluate their hemodynamic responses during laparoscopic surgeries under general anesthesia.

MATERIALS AND METHODS

The present study was designed as a prospective, randomized, double-blind comparative study. After approval from the Institutional Ethics Committee (SDMIEC/2023/474) and prospective registration at the CTRI (CTRI/2023/05/067492), this study was carried out over a period extending from May 2023 to November 2024 in the Department of Anaesthesiology, SDM College of Medical Sciences and Hospital, Dharwad, India, a tertiary care hospital. With written informed consent, 100 adult patients aged between 20 and 60 years, with American Society of Anesthesiologists (ASA) physical status I and II, scheduled for elective laparoscopic surgeries under general anesthesia, and with body mass index between 18 and 24.9 kg/m², were recruited in the study. Patients with anticipated difficult airway, neuromuscular disorders, significant cardiovascular, hepatic or renal disease, pregnancy, known allergy to the study drugs, body mass index < 18 and >24.9 kg/m2 or those requiring conversion to open surgery were excluded from the study.

The sample size calculation was based on results from a previous study.[4] Using the formula for comparing the means of two independent groups, with a power of 90% and an alpha error of 5%, the minimum sample size was calculated as 50 in each group, resulting in a total sample size of 100 patients for the current study.

Participants were assigned to one of the two equal groups of 50 each using a computer-generated randomization sequence. Sealed opaque envelopes were used for allocation concealment. Both the patient and the anesthesiologist performing tracheal intubation were blinded to the group allocation. Study drugs were prepared in identical syringes labelled as “study drug” by an anesthesiologist not involved in patient assessment.

All the patients underwent a thorough pre-operative evaluation, which included history taking, physical examination and relevant laboratory investigations. Patients having any of the exclusion criteria were excluded from the study.

Standard fasting guidelines were advised to all the patients during routine preoperative evaluation along with oral alprazolam 0.5mg and oral pantoprazole 40 mg an hour before sleep on the day before and at 6 am on the morning of surgery to allay anxiety and for aspiration prophylaxis, respectively, as per institutional protocols. In the operating room, standard ASA monitors including pulse oximetry, electrocardiography, and non-invasive blood pressure were applied, and hemodynamic parameters such as pulse rate, non-invasive blood pressure and oxygen saturation at baseline were recorded. After securing an intravenous access, pre-oxygenation was done with 100% oxygen for three minutes. Anesthetic induction was done with IV fentanyl 2 µg/kg body weight (BW) followed by propofol 2 mg/kg BW with additional doses given in titration till loss of verbal response. After confirmation of adequate mask ventilation, patients received the assigned neuromuscular blocking agent. Patients in Group R were administered with rocuronium bromide 0.6 mg/kg BW IV, and those in Group V were given vecuronium bromide 0.1 mg/kg BW IV. Mask ventilation was continued with oxygen and Isoflurane for three minutes following study drug administration, maintaining a minimum alveolar concentration (MAC) of 1.0. Direct laryngoscopy was performed using a Macintosh laryngoscope, and endotracheal intubation was attempted at the end of three minutes. Conditions for intubation were assessed as per the Cooper et al. scoring system.[1] This scoring system consisted of 3 parameters: jaw relaxation, which was rated from a score of 0 to 3 as per the ease of intubation; vocal cords position, which

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was also rated on a scale of 0 (closed) to 3(open); and response to intubation which was rated based on coughing, bucking or diaphragmatic movement during intubation on a scale of 0 to 3(no response).[1] [Table 1]

Table 1: Cooper et al,[1] scoring system for assessment of intubating conditions

Parameter	Score 0	Score 1	Score 2	Score 3
Jaw relaxation	Poor	Minimal	Moderate	Good
Vocal cord position	Closed	Closing	Moving	Open
Response to intubation	Severe coughing	Mild bucking	Diaphragmatic movement	None
Overall intubation score catergories: Excellent (score 8-9) Good (score 6-7) Fair (score 3-5) Poor (score 0-2)				
Footnote: Adapted from Cooper et al. (1992)1. Intubating conditions are assessed using three parameters—jaw relaxation, vocal cord position, and response to intubation. The individual scores are summed to obtain the overall grading.				

Following successful intubation, anesthetic maintenance was done with a mixture of oxygen and air in a 50:50 ratio along with isoflurane at a MAC of 1.0. Intermittent doses of the assigned neuromuscular blocker were administered as required to maintain adequate muscle relaxation. Throughout mechanical ventilation, normocapnia (EtCO2 35 to 45 mmHg) was maintained with titrations in tidal volume in the range of 6 to 8 ml per kg ideal BW and respiratory rate.

Hemodynamic parameters namely systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) were recorded at predefined intervals: at baseline, post-induction, after administration of the study drugs, immediately after intubation, at the creation of pneumoperitoneum, and at 1, 5, 10, 15, and 30 minutes thereafter, as well as at tracheal extubation. Ondansetron 4mg as antiemetic and paracetamol 1g for analgesia were given IV 30 min prior to the end of surgery.

At the end of surgery, neostigmine and glycopyrrolate were administered for reversal for residual neuromuscular blockade in standard doses. Patients were extubated after meeting standard extubation criteria and were monitored in the post-anaesthesia care unit.

Data was analysed using statistical software R version 4.4.0 and Microsoft Excel. Categorical variables are represented in the form of frequency tables, continuous variables the form of Mean ± Standard Deviation (SD). Chi square test was used to check the association of variables with groups. Normality of variables was tested by Shapiro Wilk test and QQ plot. The data obtained were normally distributed, hence parametric tests were used for statistical analysis. Mann Whitney U test was used to compare the distribution of variables over groups. A p-value less than 0.05 was considered to be statistically significant.

RESULTS

The study was conducted as per CONSORT guidelines for RCTs. A hundred patients were recruited and randomized into two groups of 50 each. All patients completed the study, and the data was included for analysis. [Figure 1]

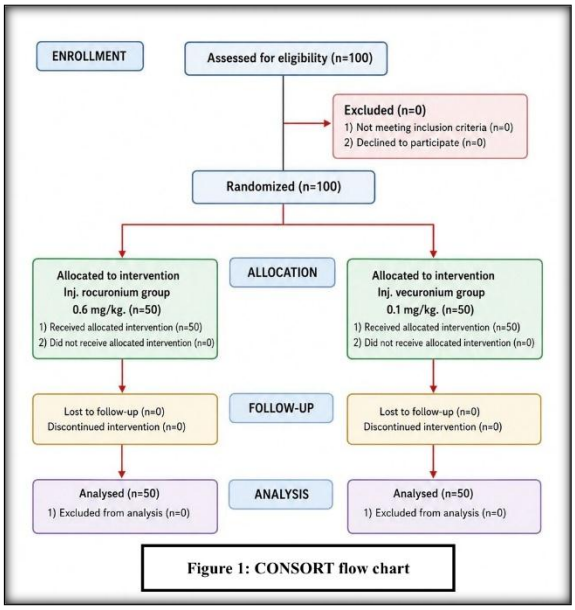


Figure 1: CONSORT flow chart

Demographic characteristics: The distribution of age across the rocuronium and vecuronium groups was comparable and showed no statistically significant differences (p = 0.141). The majority of patients in the rocuronium group were in the >51 years age group (30%), while in the vecuronium group, 44% were in the 41-50 years range. The overall distribution of surgical procedures was as follows: laparoscopic cholecystectomy 23 (23%), total laparoscopic hysterectomy 20 (20%), laparoscopic appendicectomy 15%, laparoscopic ovarian cystectomy 12%, laparoscopic myomectomy 11%, diagnostic hysterolaparoscopy 10%, and laparoscopic hernioplasty 9%. There was a significant difference in gender distribution between the two groups (p = 0.005). The rocuronium group had 18 males (36%) and 32 females (64%), whereas the vecuronium group had 6 (12%) males and 44 (88%) females. Overall there were a greater number of females than males, but rocuronium group had more males than females. [Table 2]

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Table 2: Comparison of the demographic profile in the two groups

Profile	Rocuronium group	%	Vecuronium group	%	Total	Chi-square	p-value
Age							
<=30yrs	12	24.00	10	20.00	22	5.4530	0.1410
31-40yrs	10	20.00	11	22.00	21		
41-50yrs	13	26.00	22	44.00	35		
>=51yrs	15	30.00	7	14.00	22		
Gender							
Male	18	36.00	6	12.00	24	7.8950	0.0050*
Female	32	64.00	44	88.00	76		
Total	50	100.00	50	100.00	100		

Intubating conditions: Excellent jaw relaxation was noted in 98% of patients administered with rocuronium compared to 74% in the vecuronium group, with a statistically significant difference (p = 0.001). [Figure 2] Vocal cords were noted to be fully open in 76% of patients receiving rocuronium and 62% receiving vecuronium; however, this difference was not statistically significant (p = 0.130). [Figure 3]

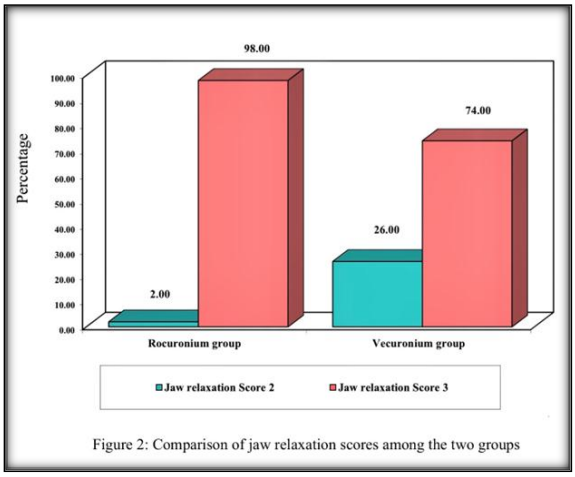


Figure 2: Comparison of jaw relaxation scores among the two groups

The patients' response to intubation demonstrated marked intergroup variation. Absence of diaphragmatic movement or coughing was observed in 94% of patients in the rocuronium group, whereas only 60% patients in the vecuronium group exhibited similar conditions with a difference that was statistically significant (p < 0.0001). [Figure 4]
Overall Cooper score of excellent intubating conditions (score 8–9) was seen in 72% of patients in the rocuronium group versus 20% in the vecuronium group. Good (Score 6-7) conditions were observed more frequently in the vecuronium group. Overall, rocuronium provided significantly superior intubating conditions (p < 0.0001). [Table 3]

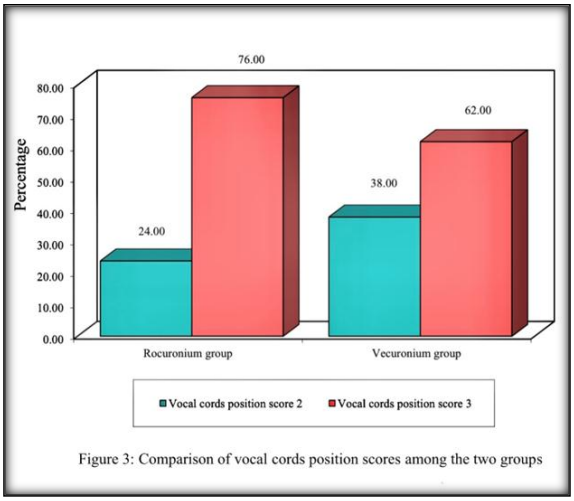


Figure 3: Comparison of vocal cords position scores among the two groups

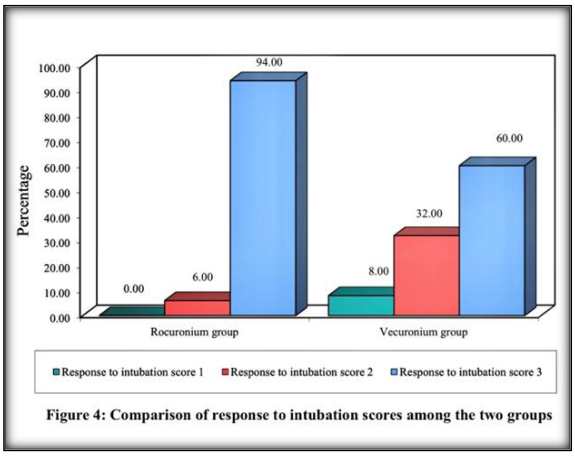


Figure 4: Comparison of response to intubation scores among the two groups

Table 3: Comparison of the overall Cooper scores between rocuronium group and vecuronium group

Overall Cooper scoring	Rocuronium group	%	Vecuronium group	%	Total	Chi-square	p-value
Score 6	0	0.00	2	4.00	2	28.9960	0.0001*
Score 7	2	4.00	12	24.00	14		
Score 8	12	24.00	26	52.00	38		
Score 9	36	72.00	10	20.00	46		
Total	50	100.0	50	100.00	100		

Hemodynamic parameters: The mean SBP ± SD of the rocuronium group was noted to be 135.63 ±2.61mmHg and of the vecuronium group was 142.01 ± 28mmHg. [Figure 5, A] The mean DBP ± SD of the rocuronium group was found to be 75.4 ± 19.93mmHg and in the rocuronium group was 79.96 ± 17.69mmHg. [Figure 5, B] The heart rate in the rocuronium group was significantly higher (81.28± 9.17bpm) after 5th minute of carboperitoneum insufflation when compared to the vecuronium group (87.04±9.35bpm), but the vecuronium group had higher values overall (94.24±10.36bpm) compared to

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the rocuronium group (91.79± 27.95bpm). (p = 0.0024). [Figure 5, C] This difference was transient and not clinically significant.

No adverse events such as bronchospasm, prolonged apnea, arrhythmias, or anaphylactic reactions occurred in either group during the entire study period.

Overall analysis indicated that rocuronium produced significantly better intubating conditions with more stable peri-intubation and intraoperative hemodynamic parameters compared to vecuronium in patients undergoing laparoscopic surgeries.

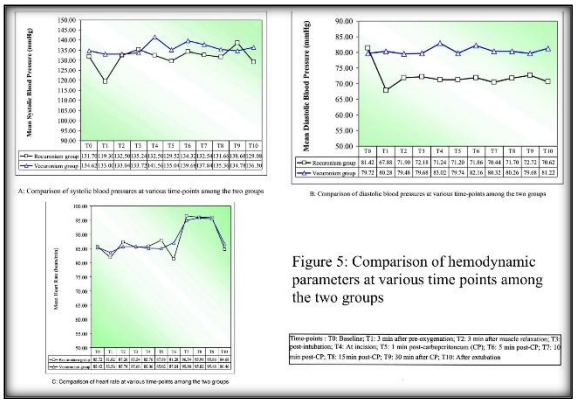


Figure 5: Comparison of hemodynamic parameters at various time points among the two groups

DISCUSSION

The primary aim of this study was to compare the intubating conditions and haemodynamic parameters linked with the use of rocuronium and vecuronium in patients undergoing laparoscopic surgeries. Statistical analysis demonstrated that rocuronium 0.6 mg/kg BW provided significantly better conditions for intubation compared to vecuronium 0.1 mg/kg in patients undergoing elective laparoscopic surgeries under general anesthesia. In addition, rocuronium was associated with more stable peri-intubation and intraoperative hemodynamics.

Rocuronium provided better jaw relaxation, with 98% of the patients having excellent relaxation (Score 3) compared to 74% in the vecuronium group. [Figure 2] Rocuronium group had a higher percentage of patients (76%) with optimal vocal cord positioning (score 3), compared to vecuronium (62%). [Figure 3] The rocuronium group showed a higher percentage of patients (94%) with minimal response to intubation (Score 3), compared to the vecuronium group (60%). [Figure 4]

The Cooper score was markedly higher in the rocuronium group, with excellent conditions observed in 72% of patients versus 20% in the vecuronium group. [Table 3]

These findings are consistent with the observations of Cooper et al., who first described the scoring system and also demonstrated superior and similar intubating conditions with rocuronium in 98% of the patients who received 0.6mg/kg of rocuronium at the end of 180s. The ease of intubation was measured by introducing the subjective scoring system called Cooper et al. scoring system which was also used in the current study.[1] The superior performance of rocuronium can be attributed to its pharmacodynamic profile. Being a less potent aminosteroid compound, rocuronium is administered in a higher molar concentration, allowing rapid saturation of nicotinic receptors at the neuromuscular junction and thereby producing faster onset of action.

The findings of our study are consistent with a study conducted by Juneja et al. who used the same dose of rocuronium in patients undergoing laparoscopic surgery and reported that 100% of the patients had a Cooper et al score of 8-9, compared to 69% of the patients in the vecuronium group.[4] Passavanti et al. conducted a similar study in adult and elderly patients comparing different doses of rocuronium. Among the patients who received a dose of 0.5 mg/kg BW, at the end of 3 minutes 40% of the patients had a Cooper et al score 8-9 compared to 60% of those who received 0.9 mg/kg BW of the drug with a significant p value.[5]

A study by Choudhari et al. also reported findings comparable to the current study. 72% patients administered with rocuronium achieved excellent conditions of intubation versus 56% of those given vecuronium. These findings have reinforced the reliability of rocuronium in achieving excellent intubation scores.[7] Parasa et al. who also used the Cooper et al scoring system to assess intubating conditions found that 100% of patients in the rocuronium group had excellent intubating conditions, compared to 70% in the vecuronium group (P<0.001).[10]

Although the studies discussed above showed evidence consistent with our study, in a study conducted by Yazed et al,[11] in 60 morbidly obese patients, the investigators found no difference between the intubation scores among rocuronium (0.9 mg/kg) and vecuronium (0.15 mg/kg) groups. Another study by Sahu et al. reported no significant difference between rocuronium and vecuronium in terms of intubation conditions (86% in rocuronium versus 80% in vecuronium groups had excellent conditions).[12]

Hemodynamic stability is especially relevant in laparoscopic surgery due to the physiological effects of carbon dioxide pneumoperitoneum. Increased intra-abdominal pressure leads to elevated systemic vascular resistance and sympathetic stimulation, which may exaggerate fluctuations in HR and blood pressure.[5]

HR trends were comparable between the groups at baseline, post-induction, and immediately after intubation. A significant reduction in HR was observed with vecuronium at five minutes following creation of pneumoperitoneum (p = 0.0024), though this difference was transient and not clinically significant. [Figure 5, C]

SBP values showed greater decline in the vecuronium group at several measured intervals. Statistically significant lower systolic pressures were recorded at three minutes after oxygenation, at surgical incision,

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and at one, five-, and ten-minutes following pneumoperitoneum ($p < 0.05$). In contrast, patients receiving rocuronium maintained relatively stable systolic pressures throughout the observation period. [Figure 5, A]

DBP demonstrated a similar pattern. The vecuronium group exhibited significantly lower DBP following administration of the neuromuscular blocker, immediately after intubation, and throughout pneumoperitoneum, extending up to the extubation period ($p < 0.0001$). Rocuronium, on the other hand, was associated with comparatively stable DBP values. [Figure 5, B] While these changes were not clinically detrimental in the patients, they suggest relatively greater cardiovascular depression with vecuronium compared to rocuronium.

This was in accordance with the findings of Savargaonkar et al,[18] The decline in average heart rate in the vecuronium group was significant at the 2nd minute post-administration of the muscle relaxant when compared with the rocuronium group, (77.12±9.96bpm) versus (85.04±12.82bpm, respectively) ($p<0.05$). Notably, this difference in heart rate was even more pronounced at three-minute following drug administration (76.12±9.67bpm) compared to rocuronium at clinical doses.[18] Juneja et al,[4] noted a comparable outcome to that of the present study, where there was a significant reduction in mean heart rate in the vecuronium group compared to rocuronium.

Vecuronium, while providing moderately adequate muscle relaxation, was associated with a more pronounced decrease in heart rate post-intubation. This bradycardia response could be due to its vagotonic effects, as noted in a study by McCarthy et al. who reported a mean of 69±19.2bpm, following the dose of 0.12 mg/kg BW in the vecuronium group.[13]

The findings from this study are in line with the work of Tabdar et al. in which on using vecuronium for laparoscopic cholecystectomy resulted in haemodynamic alterations intra-operatively by a significant fall in the HR at 1st minute after carboperitoneum compared to rocuronium group (62.80±11.25bpm versus 87.23±14.35 bpm respectively, $p<0.05$). Bradycardia requiring atropine was significant in vecuronium group.[14] This emphasized the importance of maintaining haemodynamic stability during laparoscopic surgeries and recommended rocuronium as a suitable muscle relaxant for such procedures.

In contrast to the findings in our study, Telkar et al. reported that rocuronium was associated with increases in HR and MAP which was statistically significant (13% from baseline, $P < 0.001$), although the authors considered it clinically insignificant. They reported a decrease in HR and MAP (4% from baseline, $p>0.05$) following vecuronium similar to the present study. However, they concluded that vecuronium had more cardiostability compared to vecuronium.[3] Kale et al. and Nitschmann et al. also found rocuronium to be devoid of any significant cardiovascular changes when compared with vecuronium, with better hemodynamic stability.[15,16] No adverse events such as arrhythmias, bronchospasm, or prolonged neuromuscular blockade were observed in either group, indicating that both agents are safe when used in appropriate doses. However, when superior conditions for intubation are required, rocuronium appears to offer an advantage.

The findings of this study are clinically relevant in the current era of minimally invasive surgery, where rapid airway control and hemodynamic stability are critical for optimal perioperative outcomes. By demonstrating both improved intubation conditions and stable cardiovascular profile, rocuronium may be considered a preferable alternative to vecuronium in routine practice during laparoscopic surgeries.

The study had certain limitations. The study was conducted at a single center limiting the generalization of the results. There was a significant difference observed in gender distribition during analysis of demographic profile. It cannot be said with certainty, that there is no difference in the effects of the study drugs based on gender. The onset and the duration of action of the drug were not studied in the current study and the use of neuromuscular transmission monitoring would have added more significance to the study. Future research with larger, multi-center trials could provide more comprehensive insights. Future research could focus on further elucidating the comparative benefits of these muscle relaxants in various surgical contexts to optimize anaesthetic practices.

CONCLUSION

Better conditions for endotracheal intubation were provided by rocuronium at a dose of 0.6 mg/kg BW with stable hemodynamics throughout the procedure compared to vecuronium 0.1 mg/kg BW in patients undergoing laparoscopic surgeries under general anesthesia. Based on these findings, rocuronium may be considered a preferable neuromuscular blocking agent when rapid, smooth intubation and cardiovascular stability are desired during laparoscopic procedures.

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