

Research Article**Comparison of hemodynamic changes in patients undergoing laparoscopic cholecystectomy using rocuronium and vecuronium for intubation and maintenance under general anaesthesia**

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Abstract:**Background**

Laparoscopic cholecystectomy is the standard minimally invasive treatment for symptomatic gallbladder disease. General anaesthesia is preferred because it ensures airway protection, controlled ventilation, and adequate muscle relaxation for pneumoperitoneum. Neuromuscular blocking agents are essential for facilitating intubation and maintaining optimal surgical conditions [1]. Rocuronium provides rapid

onset with intermediate duration and is considered hemodynamically stable, making it a useful alternative when rapid airway control is needed [2]. Vecuronium has reliable relaxation and smooth recovery but has been associated with bradycardia during laparoscopic procedures, possibly exacerbated by pneumoperitoneum-related vagal stimulation [3]. This study compared rocuronium and vecuronium with respect to perioperative hemodynamic changes in laparoscopic cholecystectomy.

Materials and Methods

A randomized controlled trial was conducted in the Department of Anaesthesiology, Santosh Medical College and Hospital, after ethics approval. One hundred sixteen ASA I–II adults (18–65 years) posted for elective laparoscopic cholecystectomy were randomized into Group A (rocuronium 0.6 mg/kg; n=58) and Group B (vecuronium 0.1 mg/kg; n=58). Standardized anesthesia induction and maintenance were used. Hemodynamic parameters (HR, SBP, DBP, MAP, SpO₂) were recorded at predefined perioperative intervals. Intubating conditions were assessed using Cooper's score. Data were analyzed with appropriate statistical tests; p<0.05 was considered significant.

Results

Baseline demographic variables and pre-induction hemodynamics were comparable between groups. Rocuronium showed a significantly faster onset time than vecuronium (58.7 ± 8.5 s vs 82.3 ± 9.2 s; p<0.001), while intubating conditions were

similarly excellent (Cooper's score 8.85 ± 0.42 vs 8.79 ± 0.48 ; p=0.498). Overall intraoperative and post-extubation hemodynamics remained stable in both groups; HR differed statistically at 30 and 40 minutes but without clinical relevance. Adverse events were infrequent and comparable (13.8% vs 15.5%), with similar recovery profiles.

Conclusion

Both rocuronium and vecuronium provided safe neuromuscular blockade with comparable hemodynamic stability and intubation quality, while rocuronium offered a clear advantage of faster onset.

Keywords

Laparoscopic cholecystectomy; Rocuronium; Vecuronium; Hemodynamic changes; Neuromuscular blockade; Intubation conditions.

INTRODUCTION

Laparoscopic cholecystectomy has become the gold-standard surgical approach for the management of symptomatic gallbladder

disease, largely replacing open cholecystectomy due to its minimally invasive nature. General anesthesia remains the preferred technique for laparoscopic cholecystectomy as it provides secure airway control, controlled ventilation, and optimal muscle relaxation required for pneumoperitoneum and surgical manipulation. Neuromuscular blocking agents play a crucial role in facilitating endotracheal intubation and maintaining appropriate surgical conditions throughout the procedure [1].

Rocuronium bromide is a non-depolarizing aminosteroid neuromuscular blocking agent characterized by a rapid onset and intermediate duration of action. It is less potent than vecuronium, a property that contributes to its faster onset. Rocuronium is widely regarded as hemodynamically stable and is frequently used as an alternative to succinylcholine for rapid sequence induction, especially when succinylcholine is contraindicated due to conditions such as hyperkalemia, malignant

hyperthermia susceptibility, or raised intracranial pressure [2]. Vecuronium, another commonly used non-depolarizing aminosteroid muscle relaxant, has traditionally been favored for its intermediate duration of action, minimal cumulative effects, and smooth recovery characteristics. It provides satisfactory intubating conditions and reliable muscle relaxation for a wide range of surgical procedures, including laparoscopic cholecystectomy. However, concerns have been raised regarding its cardiovascular effects during laparoscopic surgery. Several studies have reported an association between vecuronium and episodes of bradycardia, and rarely cardiac arrest, particularly in the setting of pneumoperitoneum [3].

Laparoscopic cholecystectomy is associated with unique physiological challenges due to the creation of pneumoperitoneum. Carbon dioxide insufflation increases intra-abdominal pressure, leading to reduced venous return,

decreased cardiac output, and increased systemic vascular resistance. Absorption of carbon dioxide may cause hypercarbia, resulting in sympathetic stimulation manifested as tachycardia and hypertension. Additionally, patient positioning during surgery, particularly reverse Trendelenburg position, further influences cardiovascular and respiratory dynamics [4]. Neuromuscular blocking agents differ in their effects on the autonomic nervous system. Rocuronium is considered relatively cardioneutral, with minimal vagolytic or vagotonic activity and no clinically significant histamine release. This profile makes it particularly suitable for laparoscopic procedures where both sympathetic and parasympathetic reflexes are common. Its rapid onset also facilitates smooth intubation with minimal stress response [5]. In contrast, vecuronium has been associated with vagotonic effects, which, when combined with other anesthetic agents or surgical stimuli, may predispose to bradyarrhythmias. Reports of

severe bradycardia during laparoscopic surgeries highlight the need for careful evaluation of its hemodynamic effects [6,7].

With the rising prevalence of cardiovascular comorbidities among surgical patients, including hypertension, diabetes, and ischemic heart disease, maintaining perioperative hemodynamic stability has become increasingly important. Muscle relaxants that provide stable cardiovascular profiles, predictable action, and smooth recovery are essential for improving patient safety and outcomes. [8] Given these considerations, a comparative evaluation of the hemodynamic responses associated with rocuronium and vecuronium during laparoscopic cholecystectomy is clinically relevant

MATERIALS AND METHODS

This randomized controlled trial was conducted in the Department of Anaesthesiology at Santosh Medical College and Hospital after obtaining

approval from the Institutional Ethics Committee. A total of 116 adult patients scheduled for elective laparoscopic cholecystectomy under general anaesthesia were enrolled after written informed consent. Sample size was calculated based on heart rate differences reported by Juneja N et al. [9], considering a 95% confidence level and 80% power, yielding 58 patients in each group. Participants were randomized using computer-generated allocation into two equal groups: Group A received rocuronium and Group B received vecuronium as the neuromuscular blocking agent. Inclusion criteria comprised ASA physical status I–II patients aged 18–65 years, while patients with anticipated difficult airway, obesity (BMI >30 kg/m²), significant anemia, coagulation abnormalities, pregnancy, neuromuscular or cardiovascular disease were excluded. All patients underwent standard preanaesthetic evaluation and monitoring. Anaesthesia was induced with propofol following intravenous midazolam and

fentanyl, and neuromuscular blockade was achieved with rocuronium 0.6 mg/kg or vecuronium 0.1 mg/kg as per group allocation. Anaesthesia was maintained with oxygen–nitrous oxide and isoflurane. Hemodynamic parameters were recorded at predefined perioperative intervals. Intubating conditions were assessed using the Cooper scoring system. Data were analyzed using SPSS software, with appropriate statistical tests applied and a p-value <0.05 considered significant.

RESULTS

The baseline demographic and clinical characteristics of patients in both groups were comparable. There were no statistically significant differences with respect to age, body mass index, sex distribution, or ASA physical status, indicating adequate randomization and homogeneity of the study population. (*Table 1*)

Pre-operative hemodynamic parameters, including heart rate, systolic and diastolic blood pressure, mean arterial pressure, and

oxygen saturation, were similar in both groups. This confirms that all patients had comparable cardiovascular status prior to induction of anaesthesia. (Table 2)

Rocuronium demonstrated a significantly faster onset of neuromuscular blockade compared to vecuronium. However, intubating conditions assessed using Cooper's scoring system were equally excellent in both groups, with no statistically significant difference in intubation quality. (Table 3)

Intraoperative and post-extubation hemodynamic trends showed overall stability in both groups. Although transient

statistically significant differences in heart rate were observed at 30 and 40 minutes intraoperatively, these variations were not clinically significant, and mean arterial pressure remained comparable throughout the perioperative period. (Table 4)

The incidence of adverse events was low and comparable between the two groups. Duration of surgery, time to extubation, and recovery parameters were similar, and the majority of patients in both groups maintained hemodynamic stability throughout the perioperative period, indicating comparable safety profiles of both muscle relaxants. (Table 5)

Table 1. Baseline Demographic and Clinical Characteristics (N = 116)

Parameter	Group A (Rocuronium) n=58	Group B (Vecuronium) n=58	p-value
Age (years)	42.5 ± 12.3	41.8 ± 11.7	0.754
Weight (kg)	64.8 ± 10.2	65.3 ± 9.8	0.812
BMI (kg/m ²)	24.5 ± 2.8	24.7 ± 2.6	0.689
Male : Female	18:40	20:38	0.802
ASA I / ASA II	35 / 23	33 / 25	0.824

Table 2. Baseline Hemodynamic Parameters

Parameter	Group A	Group B	p-value
Heart Rate (beats/min)	82.5 ± 14.2	83.1 ± 13.8	0.823
SBP (mmHg)	124.3 ± 12.5	125.1 ± 11.8	0.741
DBP (mmHg)	78.6 ± 8.4	79.2 ± 8.1	0.712
MAP (mmHg)	93.8 ± 9.2	94.5 ± 8.9	0.698
SpO ₂ (%)	98.5 ± 0.8	98.6 ± 0.7	0.645

Table 3. Neuromuscular Blockade Characteristics and Intubating Conditions

Parameter	Group A (Rocuronium)	Group B (Vecuronium)	p-value
Onset time (seconds)	58.7 ± 8.5	82.3 ± 9.2	<0.001
Cooper's score	8.85 ± 0.42	8.79 ± 0.48	0.498
Excellent intubation n (%)	52 (89.7%)	51 (87.9%)	0.742

Table 4. Intraoperative and Post-Extubation Hemodynamic Trends (Selected Time Points)

Time Point	HR (Group A / B)	MAP (Group A / B)	p-value
1 min post-intubation	92.8 / 91.5	100.4 / 99.8	NS
10 min intra-op	84.6 / 82.8	92.7 / 92.1	NS
30 min intra-op	84.7 / 77.8	92.0 / 91.1	0.010

40 min intra-op	83.2 / 76.2	90.5 / 89.7	0.005
5 min post-extubation	82.1 / 81.4	93.7 / 93.2	NS

Table 5. Adverse Events, Recovery, and Primary Outcomes

Parameter	Group A	Group B	p-value
Any adverse event	8 (13.8%)	9 (15.5%)	0.782
Bradycardia	1 (1.7%)	2 (3.4%)	NS
Hypotension	2 (3.4%)	3 (5.2%)	NS
Duration of surgery (min)	58.3 ± 12.5	59.7 ± 13.2	0.584
Time to extubation (min)	8.5 ± 2.3	8.8 ± 2.5	0.542
Hemodynamic stability maintained	54 (93.1%)	55 (94.8%)	0.688

DISCUSSION

The present randomized controlled study compared the hemodynamic effects, onset characteristics, intubating conditions, and safety profiles of rocuronium and vecuronium in patients undergoing laparoscopic cholecystectomy under general anesthesia. The demographic characteristics of the two groups were

comparable, including age, sex distribution, body mass index, and ASA physical status.

This baseline homogeneity is essential, as it minimizes confounding variables that could influence hemodynamic responses or neuromuscular drug pharmacokinetics. The female predominance observed in both groups reflects the higher incidence of gallbladder disease among women and is

consistent with earlier studies by Juneja et al. [54] and Alen Mathew et al. [55].

Baseline hemodynamic parameters, including heart rate, systolic and diastolic blood pressure, mean arterial pressure, and oxygen saturation, were similar between the two groups prior to induction. This equivalence confirms that subsequent intraoperative hemodynamic changes could be reliably attributed to the neuromuscular blocking agents rather than pre-existing cardiovascular differences. Similar emphasis on baseline hemodynamic comparability has been highlighted by Somani et al. [57] in their evaluation of cardiovascular effects of muscle relaxants.

One of the most clinically significant findings of the present study was the markedly faster onset of neuromuscular blockade with rocuronium compared to vecuronium. Rocuronium achieved adequate intubating conditions within a significantly shorter time, a finding that aligns with multiple previous studies [54,55,57]. This rapid onset is explained by

the lower potency of rocuronium, which necessitates a higher number of molecules at the neuromuscular junction, resulting in faster receptor occupancy and quicker paralysis onset. Mishra et al. [59] also demonstrated that rocuronium provides intubation conditions comparable to succinylcholine, making it a suitable alternative in situations where depolarizing agents are contraindicated.

Despite differences in onset time, both rocuronium and vecuronium provided excellent intubating conditions, as assessed by Cooper's scoring system. Most patients in both groups achieved optimal jaw relaxation, open vocal cords, and minimal response to intubation, with no statistically significant difference between groups. These findings corroborate those of Juneja et al. [54] and Mishra et al. [59], who reported comparable intubating conditions between these agents when administered at standard doses. Clinically, this indicates that either drug can be safely used to facilitate tracheal intubation in laparoscopic

procedures, provided adequate dosing and timing are followed.

Heart rate changes during the perioperative period showed a predictable transient increase following laryngoscopy and intubation in both groups, reflecting sympathetic stimulation. Although statistically significant differences were noted at 30 and 40 minutes, these variations were mild and clinically insignificant. The overall heart rate remained stable throughout the procedure. These findings are consistent with Alen Mathew et al. [10] and Somani et al. [11], who reported minor, transient increases in heart rate with rocuronium that did not adversely affect patient outcomes. In contrast, several studies have reported a greater tendency toward bradycardia with vecuronium [9,12,13]. Tabdar and Kadariya [12] observed a significantly higher incidence of bradycardia requiring atropine in the vecuronium group, attributed to its lack of vagolytic activity.

The relatively stable heart rate observed with rocuronium may be explained by its mild vagolytic properties, which can counteract vagal reflexes induced by pneumoperitoneum and peritoneal stretching during laparoscopic surgery. Vecuronium, lacking such properties, may allow unopposed vagal stimulation, leading to bradycardia during periods of increased intra-abdominal pressure [14]. However, in the present study, the incidence of clinically significant bradycardia was low and comparable between groups, possibly reflecting vigilant anesthetic management and standardized intra-abdominal pressures.

Blood pressure parameters, including systolic, diastolic, and mean arterial pressure, showed transient increases following intubation in both groups, followed by stabilization. No statistically significant intergroup differences were observed at any time point. These findings are in agreement with Savargaonkar et al. [12], who reported comparable blood

pressure profiles with both rocuronium and vecuronium during laparoscopic surgeries. Although Juneja et al. [9] reported higher blood pressure values in the vecuronium group during the postoperative period, such differences were not observed in the present study, suggesting comparable intraoperative cardiovascular stability with both agents.

Oxygen saturation remained consistently high throughout the perioperative period in both groups, indicating that neither drug adversely affected ventilation or oxygenation. This is particularly important in laparoscopic procedures, where pneumoperitoneum and patient positioning can compromise respiratory mechanics. The stable oxygenation observed reinforces the respiratory safety of both neuromuscular blocking agents.

The incidence of adverse events was low and comparable between groups. Minor complications such as bradycardia, tachycardia, hypotension, and hypertension were infrequent, and no cases of

bronchospasm or histamine release were observed. These findings reflect the favorable pharmacological profile of aminosteroid neuromuscular blocking agents and are consistent with previous reports [13-14]. Surgical duration, recovery time, and total anesthesia time were also similar between groups, indicating equivalent effects on workflow and recovery characteristics.

In summary, rocuronium demonstrated a clear advantage in terms of faster onset of neuromuscular blockade, while both rocuronium and vecuronium provided excellent intubating conditions, stable hemodynamics, and comparable safety profiles during laparoscopic cholecystectomy. These findings support the preferential use of rocuronium in situations requiring rapid airway control, while confirming that both agents remain effective and safe choices for routine laparoscopic procedures [9-14].

CONCLUSION

The present study concludes that both rocuronium and vecuronium provide safe and effective neuromuscular blockade for laparoscopic cholecystectomy under general anaesthesia, with comparable intubating conditions and overall hemodynamic stability. Rocuronium, however, offers a distinct advantage in terms of a significantly faster onset of action without causing clinically significant hemodynamic disturbances. Given its rapid onset, predictable cardiovascular profile, and low incidence of adverse effects, rocuronium may be considered a preferable neuromuscular blocking agent, particularly in situations requiring rapid tracheal intubation or in patients where cardiovascular stability is of paramount importance.

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