Section: Anaesthesiology

Original Research Article

COMPARISON OF HAEMODYNAMIC EFFECTS OF CISATRACURIUM AND ROCURONIUM INTRAOPERATIVELY IN ELECTIVE SURGICAL CASES: RANDOMIZED CONTROLLED TRIAL

Iqbal Qasim[1], Sayeedurrehman[2], Sarfaraj Ahmad[3]

[1]*Junior Resident, Department of Anaesthesiology. Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India*
[2]*Assistant Professor, Department of Anaesthesiology. Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India*
[3]*Professor, Department of Anaesthesiology. Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India*

Received *: 10/04/2026*
Received in revised form *: 05/05/2026*
Accepted *: 08/05/2026*

Corresponding Author:
Dr. Iqbal Qasim,
Junior Resident, Department of Anaesthesiology. Rohilkhand Medical College and Hospital, Bareilly, Uttar Pradesh, India.
Email: id-iqbalqasim00@gmail.com

DOI: 10.70034/ijmedph.2026.2.337

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (2); 2014-2020

ABSTRACT

Background: Neuromuscular blocking agents form one of the cornerstones of contemporary anaesthetic practice and play a pivotal role in ensuring optimal conditions during general anaesthesia. Their use facilitates smooth endotracheal intubation, provides adequate skeletal muscle relaxation for surgical exposure, and helps optimize controlled mechanical ventilation intraoperatively. The objective is to compare the hemodynamic effects of these two agents during elective surgical procedures under general anaesthesia.

Materials and Methods: This prospective, randomized, double-blinded clinical study was carried out in the Department of Anaesthesiology, Rohilkhand Medical College and Hospital, Bareilly, over a period of one year.

Results: The demographic profiles of both groups were comparable with respect to age, gender, BMI, ASA status, and airway characteristics, eliminating confounding variables. The mean time from induction to intubation was significantly shorter in the Rocuronium group, averaging between 200 and 220 seconds, compared with 300 to 320 seconds in the Cisatracurium group, indicating a faster onset of neuromuscular block with Rocuronium ($p < 0.001$). The hemodynamic parameters remained stable in both groups at all time intervals. Differences in heart rate, systolic blood pressure, and mean arterial pressure were statistically insignificant, while a mild transient rise in diastolic blood pressure was observed in the Rocuronium group at nine and twelve minutes, which was statistically significant but clinically negligible. Oxygen saturation remained above 98% in all cases, and no adverse cardiovascular events or allergic reactions were reported.

Conclusion: Both Cisatracurium and Rocuronium are safe and effective non-depolarizing neuromuscular blocking agents for use in elective surgical patients. Rocuronium offers the advantage of a faster onset and superior intubating conditions, making it the agent of choice when rapid airway control is required. Cisatracurium provides highly stable hemodynamic and predictable recovery independent of organ function, making it preferable in patients with cardiovascular compromise or hepatic and renal impairment.

Keywords: Cisatracurium, Rocuronium, non-depolarizing neuromuscular blocking agents, elective surgical patients. hemodynamic.

INTRODUCTION

In modern anaesthesia, the selection of an NMBA is based not only on its efficacy in producing muscle relaxation but also on parameters such as onset of action, duration, ease of reversibility, metabolic pathways, and cardiovascular safety. These considerations are especially relevant as anaesthetic practice increasingly emphasizes individualized

drug selection to enhance both intraoperative stability and postoperative recovery.[1]

Among the non-depolarizing neuromuscular blockers, Cisatracurium and Rocuronium represent two widely used agents that differ significantly in their chemical structure, metabolism, and clinical behaviour. Cisatracurium, a benzylisoquinolinium derivative and it is a stereoisomer of atracurium, undergoes degradation primarily through Hofmann elimination and ester hydrolysis—pathways reliant on physiological pH and temperature rather than hepatic or renal clearance. This unique organ-independent metabolism provides remarkable predictability and makes Cisatracurium especially advantageous in patients with hepatic or renal impairment, critically ill individuals, or those requiring prolonged neuromuscular blockade. It was specifically developed to address the limitations of its parent compound atracurium, which is associated with dose-dependent histamine release leading to hypotension, tachycardia, and cutaneous flushing. By contrast, Cisatracurium demonstrates minimal histamine-releasing potential, thereby offering superior cardiovascular stability and making it particularly suitable for high-risk patients who cannot tolerate abrupt hemodynamic changes.[2,3]

Despite its rapid pharmacodynamic profile, Rocuronium is widely regarded as a hemodynamically stable agent. Extensive clinical experience and comparative studies have shown that it generally produces minimal cardiovascular perturbation, with only transient, mild fluctuations in heart rate or blood pressure reported in some cases. These changes are typically short-lived, dose-dependent, and rarely of clinical concern, especially when standard induction agents and opioids are used concurrently. Overall, Rocuronium's combination of rapid onset, favourable safety profile, ease of titration, and compatibility with Sugammadex reversal has firmly established its role as a versatile and reliable agent in routine as well as emergency airway management.

Cisatracurium demonstrates a markedly improved hemodynamic profile, with minimal fluctuations in blood pressure or heart rate, even at higher doses or in hemodynamically fragile patients.

In summary, Cisatracurium and Rocuronium both represent significant milestones in the evolution of neuromuscular pharmacology, each offering distinct advantages that guide their use in contemporary anaesthetic practice. Cisatracurium, through its organ-independent Hofmann elimination and negligible histamine-releasing potential, provides exceptional hemodynamic stability even in physiologically fragile or critically ill patients. Its predictable pharmacokinetics allow for safe use in individuals with either renal or hepatic impairment, multi-organ dysfunction, or limited cardiovascular reserve, making it a highly reliable agent across diverse clinical scenarios.

In summary, Cisatracurium and Rocuronium both represent significant advancements in the field of neuromuscular pharmacology. Cisatracurium, with its organ-independent metabolism and minimal histamine release, ensures stable hemodynamic even in fragile patients, while Rocuronium's rapid onset and excellent intubating conditions make it invaluable in situations demanding immediate airway control. Existing literature and randomized studies largely confirm that both agents maintain comparable cardiovascular stability under standardized anaesthetic conditions, though isolated variations may occur at specific time points. These observations form the basis and rationale for the present study, which aims to systematically compare the intraoperative hemodynamic effects of Cisatracurium and Rocuronium in elective surgical patients, using standardized protocols, objective neuromuscular monitoring, and uniform anaesthetic regimens to ensure reliable and clinically meaningful outcomes.

MATERIALS AND METHODS

This study was conducted among the patient who was scheduled for elective surgery under General Anaesthesia in Department of Anaesthesia, Rohilkhand Medical College and hospital, Bareilly. The duration of study was one year. The study was done after approval from Institutional Ethics Committee (IEC).

Sample Size: The sample size was calculated using G*Power 3.1 software. With an α error probability of 0.05, a power of 80%, and based on the effect size from Maybauer et al. (2007), the minimum required sample size was 37 patients per group, resulting in a total of 74 patients. 3

Inclusion Criteria:

1. Patients aged between 18 and 65 years of either gender.
2. ASA physical status I or II.
3. BMI < 30 kg/m².
4. Modified Mallampati class I-II.

Exclusion Criteria:

- Emergency or urgent surgical procedures.
- Full stomach cases.
- Pregnancy.
- Anticipated difficult airway.
- Patients with cardiovascular diseases such as ischemic heart disease (IHD), hypertension (HTN), or coronary artery disease (CAD).
- Patients on antihypertensive or rate-modifying drugs such as beta-blockers, calcium channel blockers, or adrenergic agents.
- Neuromuscular transmission disorders (e.g., myopathies).
- Family history of neuromuscular disorders (NMD).

Methodology: All patients underwent a standard pre-anaesthetic check-up that included history, general and systemic examination, airway assessment, and laboratory investigations such as haemoglobin (Hb), total leukocyte count (TLC),

differential count (DC), platelet count, random blood sugar (RBS), bleeding time (BT), clotting time (CT), chest X-ray, 12-lead ECG, and respiratory function tests (RFT). Eligible patients were randomly allocated into two groups using computer-generated random numbers:

1. Group C: Intubation dose inj. cisatracurium (0.15 mg/kg) & maintenance with 0.02mg/kg.
2. Group R: Intubation dose inj. rocuronium (0.6 mg/kg) & maintenance with 0.12mg/kg.
3. On arrival in the operating room, patients were connected to routine monitors including ECG, non-invasive blood pressure (NIBP), and pulse oximetry. An 18G intravenous cannula was secured and ringer lactate infusion was initiated. Premedication was given intravenously: glycopyrrolate 0.005 mg/kg, midazolam 0.02 mg/kg, and fentanyl 2 µg/kg, administered 5 minutes prior to induction. Pre-oxygenation with 100% oxygen was carried out. Neuromuscular monitoring was performed using Stimpod NMS 450. Two surface electrodes were applied to stimulate the ulnar nerve at the wrist. Supramaximal current was determined for each patient. Train-of-four (TOF) monitoring was used at 15-second intervals. Anaesthesia was induced with intravenous propofol 2 mg/kg. Depending on the group allocation, patients received either rocuronium 0.6 mg/kg or cisatracurium 0.2 mg/kg for neuromuscular blockade. Once TOF count reached 0, patients were intubated with an appropriately sized cuffed endotracheal tube, and correct placement was confirmed by capnography and bilateral auscultation. Anaesthesia was maintained with nitrous oxide and oxygen (2:1 ratio) with 1% sevoflurane in a closed-circuit circle absorber system. Ventilation was controlled, and additional doses of muscle relaxant were administered when the T1 response on TOF returned to 25% of baseline. Additional fentanyl (25% of initial dose) was administered hourly as required. Hemodynamic parameters-heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP)-were recorded at baseline, post-induction, during intubation, and at defined intervals intraoperatively.

Statistical Analysis: The data was coded and entered, its clearing and compiling was done on a Microsoft Excel spread sheet and then it was imported into Statistical Package for Social Sciences (SPSS) version 23 for Statistical analysis. Data was analysed by applying frequency, percentage, mean, standard deviation. Appropriate statistical tests were applied based on distribution and type of data. The quantitative data, expressed in means were analysed by paired t-test. A p value of <0.05 was concluded statistically significant.

RESULTS

Table 1: Distribution of Gender Between Rocuronium and Cisatracurium Groups

Gender	Rocuronium		Cisatracurium		p-value
	Frequency	Percent	Frequency	Percent	
Male	17	45.9	12	32.4	0.23#
Female	20	54.1	25	67.6	
Total	37	100.0	37	100.0	

In the present study, the Rocuronium group consisted of 17 males (45.9%) and 20 females (54.1%), whereas the Cisatracurium group included 12 males (32.4%) and 25 females (67.6%). The difference in gender distribution between the two groups was statistically insignificant (p = 0.23). This indicates that both groups were comparable in terms of gender composition and therefore gender was not a confounding variable in the study.

Table 2: Comparison of Body Mass Index (BMI) Between Study Groups

BMI	Rocuronium		Cisatracurium		p-value
	Frequency	Percent	Frequency	Percent	
Normal weight	18	48.6	19	51.4	0.08#
Overweight	19	51.4	18	48.6	
Total	37	100.0	37	100.0	

In the Rocuronium group, 48.6% of patients had normal BMI and 51.4% were overweight, while in the Cisatracurium group, 51.4% were of normal BMI and 48.6% were overweight. The observed difference was statistically non-significant (p = 0.08). Hence, both groups were comparable with respect to BMI, minimizing potential bias related to body habitus.

Table 3: Comparison of ASA Physical Status Classification Between Study Groups

ASA	Rocuronium		Cisatracurium		p-value
	Frequency	Percent	Frequency	Percent	
I	18	48.6	17	45.9	0.71#
II	19	51.4	20	54.1	
Total	37	100.0	37	100.0	

ASA Grade I and II were evenly distributed between Rocuronium and Cisatracurium groups (p = 0.71). This indicates that the preoperative physical fitness of patients was comparable between the two groups, ensuring equivalence in baseline anaesthetic risk profiles.

Table 4: Comparison of Modified Mallampati Grading Between Study Groups

Modified mallampati grading	Rocuronium		Cisatracurium		p-value
	Frequency	Percent	Frequency	Percent	
I	9	24.3	10	27.0	0.42#
II	28	75.67	27	72.97	
Total	37	100.0	37	100.0	

The majority of patients in both groups were classified as Mallampati Grade II (75.67 % in Rocuronium and 72.97 % in Cisatracurium groups). No significant difference was observed (p = 0.42), demonstrating comparable airway characteristics across groups.

Table 5: Comparison of time taken from induction to intubation while TOF "0" Between Study Groups

Time (SEC) taken from induction to intubation while TOF "0"	Rocuronium		Cisatracurium		p-value
	Frequency	Percent	Frequency	Percent	
191-200	3	8.1	0	0.0	0.001*
201-210	16	43.2	0	0.0	
211-220	7	18.9	0	0.0	
221-230	7	18.9	0	0.0	
231-240	2	5.4	0	0.0	
241-250	2	5.4	0	0.0	
251-260	0	0.0	0	0.0	
261-270	0	0.0	0	0.0	
271-280	0	0.0	0	0.0	
281-290	0	0.0	0	0.0	
291-300	0	0.0	8	21.6	
301-310	0	0.0	16	43.2	
311-320	0	0.0	10	27.0	
321-330	0	0.0	3	8.1	
Total	37	100.00	37	100.00	

The above table demonstrates the distribution of time (in seconds) taken from induction to intubation among patients administered Rocuronium and Cisatracurium. It is observed that the majority of patients in the Rocuronium group (43.2%) achieved successful intubation between 201-210 seconds, followed by 18.9% each in the 211-220 seconds and 221-230 seconds intervals, 5.4% each in the 231-240 and 241-250 seconds, 8.1% in 191-200 seconds. In contrast, none of the patients in the Cisatracurium group were intubated within these time period. For the Cisatracurium group, the majority of patients (43.2%) achieved intubation between 301-310 seconds, followed by 27% between 311-320 seconds, 21.6% between 291-300 seconds and 8.1% between 321-330 seconds. No patients in this group achieved intubation before 290 seconds. This clearly indicates that Rocuronium produced a significantly faster onset of intubating conditions as compared to Cisatracurium, with the difference being statistically significant (p = 0.001).

Heart rate values were comparable across all time intervals between both study group (p > 0.05), indicating stable intraoperative haemodynamic.

Systolic blood pressure showed no significant difference between both study group (p > 0.05), confirming cardiovascular stability in both treatment arms.

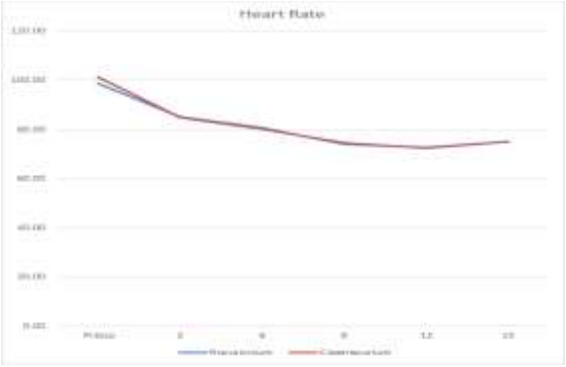

Figure 1: Comparison of Heart Rate (bpm) at Various Time Intervals

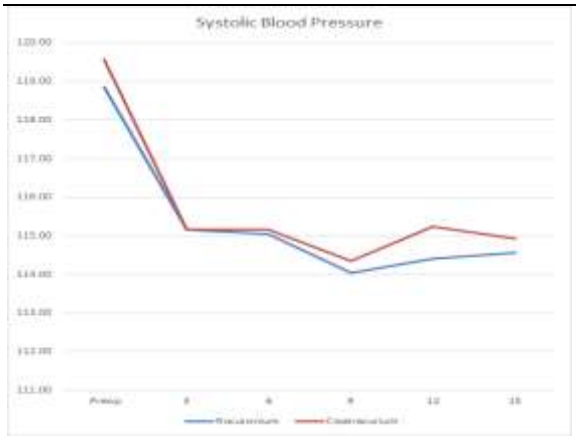

Figure 2: Comparison of Systolic Blood Pressure (mmHg) between Groups

Diastolic blood pressure did not differ significantly between groups ($p > 0.05$), suggesting similar haemodynamic responses.

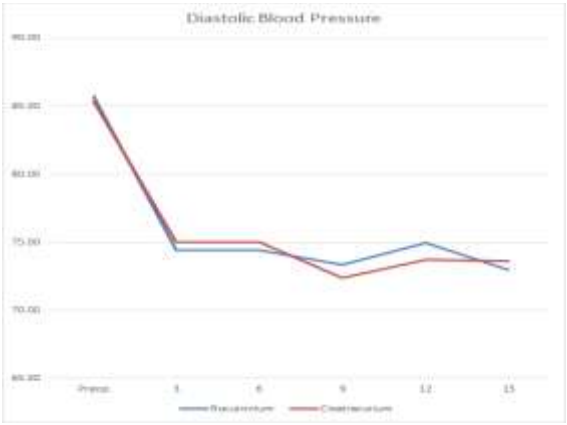

Figure 3: Comparison of Diastolic Blood Pressure (mmHg) between Groups

Mean arterial pressure was significantly higher at Pre-operative in the Both group ($p = 0.931$), but otherwise comparable at other intervals.

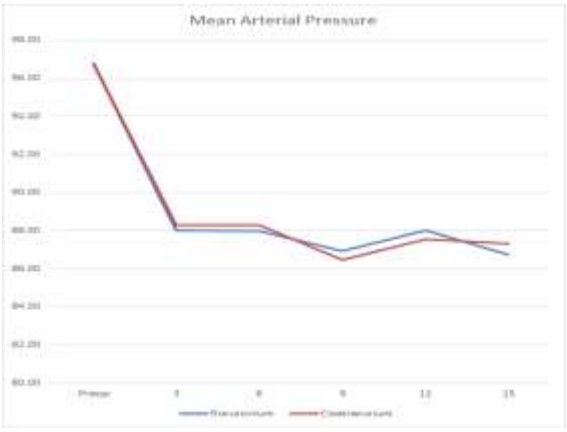

Figure 4: Comparison of Mean Arterial Pressure (mmHg) between Groups

Oxygen saturation remained comparable between both groups across all time intervals.

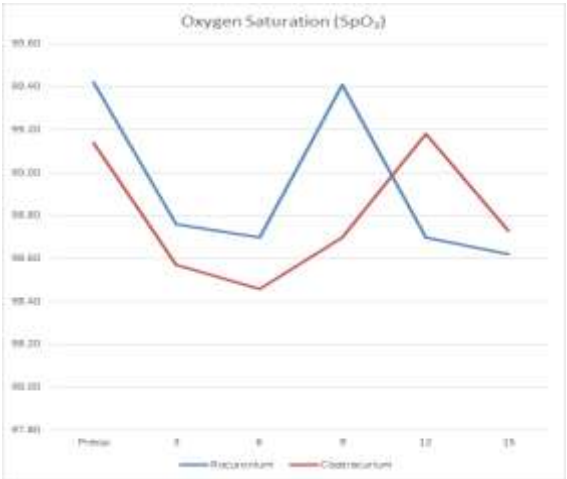

Figure 5: Comparison of Oxygen Saturation (SpO_2) between Groups

DISCUSSION

This randomized, double-blinded prospective clinical study comparing the hemodynamic effects of Cisatracurium and Rocuronium during elective surgeries under general anaesthesia demonstrated two consistent findings. First, Rocuronium provided a significantly faster onset of neuromuscular block and superior intubating conditions, and second, both agents maintained comparable intraoperative hemodynamic stability, with only minimal transient variations in diastolic blood pressure. These findings align with most contemporary randomized controlled trials evaluating the two agents in elective surgical settings.

In our study, Rocuronium achieved peak neuromuscular block faster than Cisatracurium, consistent with previous studies. Parvati et al. (2024) observed that Rocuronium produced excellent intubating conditions within 90 seconds, compared to 200-240 seconds for Cisatracurium.[2] Similarly, Meena et al. (2019) demonstrated that Rocuronium achieved rapid onset (86.6 ± 28.6 seconds) with a shorter clinical duration compared to Cisatracurium (233.3 ± 62.3 seconds).[4] Adamus et al. (2006) also reported similar findings, noting Rocuronium's faster onset but comparable overall recovery times.[5] These cumulative results reinforce that Rocuronium is advantageous when rapid airway control is required, such as during rapid sequence induction or in situations where succinylcholine is contraindicated.

Despite these onset differences, our study found no significant differences in heart rate, systolic blood pressure, diastolic blood pressure, or mean arterial pressure between groups during induction and intubation. Slight variations in diastolic pressure at isolated time points were statistically significant but clinically irrelevant. This hemodynamic stability is consistent with Sagir et al. (2013), who found that both Cisatracurium and Rocuronium caused minimal hemodynamic fluctuations in elderly patients.[6] Ghorbanlo et al. (2016) similarly observed that Cisatracurium produced negligible cardiovascular changes even in patients with markedly reduced left ventricular ejection fraction.[7] Badole et al. (2021) also demonstrated stable intraoperative hemodynamic with both agents, although Rocuronium retained its advantage of faster onset.[8] These consistent findings indicate that under standardized induction conditions using agents such as propofol and fentanyl-both of which blunt sympathetic surges-the direct hemodynamic influence of either NMBA is minimal.

Mechanistically, Cisatracurium's hemodynamic stability is attributed to its virtually absent histamine release, in contrast to its parent compound atracurium. Rocuronium, while not promoting histamine release, may exert weak vagolytic activity resulting in occasional mild tachycardia. These pharmacodynamic characteristics explain the slight

transient variations in blood pressure sometimes observed clinically. The use of opioids and propofol likely further obscures subtle sympathetic activation during laryngoscopy and intubation, thereby homogenizing the hemodynamic responses between agents.

Reversal and recovery considerations also influence agent selection. Rocuronium benefits from the availability of Sugammadex, which allows near-instant reversal even from deep neuromuscular block. Ji et al. (2023) demonstrated that Sugammadex achieved rapid recovery in paediatric patients with minimal cardiovascular risk.[9] Szewczyk et al. (2025) confirmed its utility in ICU patients, although rare cardiovascular effects such as bradycardia or coronary spasm have been reported.[10] In contrast, Cisatracurium metabolism via Hofmann elimination ensures highly predictable spontaneous recovery even without pharmacologic reversal, making it ideal for patients with renal or hepatic impairment or in prolonged ICU sedation where drug accumulation must be avoided.

Regarding safety, Cisatracurium is well known for its excellent cardiovascular tolerance, purposefully designed to eliminate the histamine release seen with atracurium. This was validated by Ghorbanlo et al. (2016) and Karimi et al. (2024), both of whom confirmed Cisatracurium minimal cardiovascular impact.[7,11] Rocuronium, while generally safe, has been associated with a higher incidence of hypersensitivity reactions compared with benzylisoquinolinium agents. Li et al. (2024), through FAERS pharmacovigilance analysis, found Rocuronium to have a disproportionately higher rate of anaphylaxis and hypersensitivity reports.[12] Although rare, such reactions underscore the importance of preparedness for perioperative anaphylaxis, especially in patients with prior drug allergy.

Clinical implications extend to special populations. Although our study involved ASA I-II patients, evidence from Hudson et al. (1998) demonstrates that Rocuronium is hemodynamically well tolerated even in cardiac surgical patients.[13] However, Cisatracurium remains favoured in individuals with compromised cardiovascular or organ function due to predictable metabolism and minimal sympathetic or vagolytic effects. Georgakis et al. (2025), in a propensity-matched study, reported lower rates of acute complications with Cisatracurium compared to Rocuronium in patients with chronic kidney disease.[14] Such findings highlight the importance of tailoring NMBA selection to patient comorbidities, anticipated physiological stress, and the availability of monitoring systems.

Our findings also echo several other comparative studies. Omera et al. (2005) demonstrated faster onset with Rocuronium but stable hemodynamic with both agents.[15] Bonala et al. (2022) further confirmed Cisatracurium hemodynamic safety across dosing regimens.[16] Bansal et al. (2023) reported that Rocuronium achieved superior intubating conditions and maintained cardiovascular stability in paediatric patients.[17] Taken together, these findings reinforce that both NMBAs are suitable for elective surgical patients and may be selected based on onset needs, comorbidity profiles, and anticipated recovery considerations rather than concerns regarding major cardiovascular instability.

Future research would benefit from large, multicentric trials including elderly, cardiac, renal, and hepatic impairment populations, as well as more standardized neuromuscular monitoring using quantitative train-of-four systems. Additionally, studies incorporating modern reversal strategies particularly the Sugammadex versus neostigmine paradigm would help further define optimal practice guidelines across diverse clinical situations.

In conclusion, this study confirms that both Rocuronium and Cisatracurium are safe, effective, and hemodynamically stable neuromuscular blocking agents in healthy elective surgical patients. Rocuronium offers clear superiority in terms of faster onset and better intubation conditions, while Cisatracurium provides unmatched predictability, cardiovascular neutrality, and safety in patients with organ dysfunction. Differences in hemodynamic values, though statistically significant at isolated time points, remain clinically inconsequential. The choice of neuromuscular blocker should therefore be individualized based on clinical urgency, patient comorbidities, desired onset time, and the availability of reversal agents to ensure optimal perioperative outcomes.

CONCLUSION

This randomized, double-blinded clinical study compared the hemodynamic effects of Cisatracurium and Rocuronium during elective surgeries under general anaesthesia in ASA I-II patients. Both agents provided effective neuromuscular blockade and maintained excellent cardiovascular stability throughout the intraoperative period.

Rocuronium demonstrated a significantly faster onset of action, achieving complete intubating conditions approximately one hundred seconds earlier than Cisatracurium. Despite this rapid onset, it did not produce clinically relevant hemodynamic disturbances. Cisatracurium, metabolized via organ-independent Hofmann elimination, showed exceptional cardiovascular stability and predictable recovery, with only minimal variations in blood pressure that were statistically but not clinically significant.

No episodes of hypotension, bradycardia, arrhythmia, or desaturation occurred in either group, and oxygen saturation remained consistently above 98%. The study thus confirms that both Cisatracurium and Rocuronium are safe, effective, and hemodynamically stable when used under standardized anaesthetic conditions.

Clinically, Rocuronium is preferable when rapid airway control or short induction-to-intubation interval is required, whereas Cisatracurium is advantageous in patients with hepatic or renal impairment or those requiring tight hemodynamic control. The choice between the two should therefore be individualized based on patient comorbidities, surgical needs, and available reversal agents.

Thus, both agents can be confidently used in routine anaesthetic practice. Rocuronium offers the benefit of speed; Cisatracurium provides unmatched stability. With vigilant monitoring and appropriate dosing, either drug ensures safe anaesthesia with minimal cardiovascular variation.

REFERENCES

1. Strawbridge AD, Khanna NR, Patel P, Sadler C, Alston TA, Werth VP, et al. Cisatracurium. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2025.
2. Parvati S, Sen J. Comparison of the effects of rocuronium bromide and cisatracurium besylate on intubating conditions and haemodynamic response. Cureus. 2024;16(4):e57878.
3. Dong YJ, Li X. Comparative study on the pharmacodynamics of cisatracurium: Continuous infusion or intermittent bolus injection. Contemporary clinical trials. 2012 May 1;33(3):482-5.
4. Magorian T, Flannery KB, Miller RD. Comparison of rocuronium, succinylcholine, and vecuronium for rapid-sequence induction of anesthesia in adult patients. Anesthesiology. 1993 Nov;79(5):913-8.
5. Schramm WM, Jesenko R, Bartunek A, Gilly H. Effects of cisatracurium on cerebral and cardiovascular hemodynamics in patients with severe brain injury. Acta anaesthesiologica scandinavica. 1997 Nov;41(10):1319-23.
6. Sagir O, Yucesoy Noyan F, Koroglu A, Cicek M, Toprak HI. Comparison between rocuronium, vecuronium, and cisatracurium using TOF and clinical tests in elderly. Anesth Pain Med. 2013;2(4):142-48.
7. Ghorbanlo M, Mohaghegh MR, Yazdanian F, Mesbah M, Totonchi Z. A comparison between the hemodynamic effects of cisatracurium and atracurium in patients with low ejection fraction undergoing cardiac surgery. Med Arch. 2016;70(4):265-68.
8. Jellish WS, Brody M, Sawicki K, Slogoff S. Recovery from neuromuscular blockade after either bolus and prolonged infusions of cisatracurium or rocuronium using either isoflurane or propofol-based anesthetics. Anesthesia & Analgesia. 2000 Nov 1;91(5):1250-5.
9. Schultz P, Ibsen M, Østergaard D, Skovgaard LT. Onset and duration of action of rocuronium–from tracheal intubation, through intense block to complete recovery. Acta anaesthesiologica scandinavica. 2001 May;45(5):612-7.
10. Kirov K, Motamed C, Decailliot F, Behforouz N, Duvaldestin P. Comparison of the neuromuscular blocking effect of cisatracurium and atracurium on the larynx and the adductor pollicis. Acta anaesthesiologica scandinavica. 2004 May; 48(5):577-81.
11. Karimi M, Ghaheri A, Saleh K, Ghadri N, Mohammadi M, Arjmand B, et al. Effect of atracurium versus cisatracurium on QT interval changes in cataract surgery: a randomized clinical trial. BMC Anesthesiol. 2024;24:431.
12. Karanovic N, Jukic M, Carev M, Kardum G, Dogas Z. Rocuronium attenuates oculocardiac reflex during squint surgery in children anesthetized with halothane and nitrous oxide. Acta anaesthesiologica scandinavica. 2004 Nov;48(10):1301-5.
13. Hudson ME, Rothfield KP, Tullock WC, Firestone LL. Hemodynamic effects of rocuronium bromide in adult cardiac surgical patients. Can J Anaesth. 1998;45(2):139-43.
14. Georgakis NA, DeShazo SJ, Gomez JI, Kinsky MP, Arango D. Risk of acute complications with rocuronium versus cisatracurium in patients with chronic kidney disease: a propensity-matched study. Anesth Analg. 2025;140(5):1004-11.
15. Kisor DF, Schmith VD, Wargin WA, Lien CA, Ornstein E, Cook DR. Importance of the organ-independent elimination of cisatracurium. Anesthesia & Analgesia. 1996 Nov 1;83(5):1065-71.
16. Naguib M, el Dawlatly AA, Ashour M, Khidr A, Abdulatif M, al Harbi M. Pharmacodynamics of cisatracurium, rocuronium, and their combination in humans. Br J Anaesth. 1998;80(5):617-24.
17. Lighthall GK, Jalali A, Smith DS, Civetta JM, Engwall MJ, Sukiennik A. Comparison of the onset and duration of neuromuscular blockade from large doses of cisatracurium and rocuronium. J Clin Anesth. 1999;11(3):208-13.