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Comparative Evaluation of Cisatracurium and Atracurium for Neuromuscular Blockade During General Anesthesia: A Prospective Randomized Clinical Study

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ABSTRACT

Background: Neuromuscular blocking agents are essential components of general anesthesia, facilitating endotracheal intubation and providing optimal surgical conditions. Atracurium and Cisatracurium are commonly used intermediate-acting non-depolarizing neuromuscular blockers. Cisatracurium is associated with reduced histamine release and greater cardiovascular stability compared with Atracurium.

Aim and Objectives: To compare the efficacy of Cisatracurium and Atracurium in adult surgical patients with respect to onset of action, intubating conditions, hemodynamic profile, histamine release, anesthetic requirement, and recovery characteristics.

Methods: This prospective randomized comparative study included 60 adult patients of ASA physical status I and II undergoing elective surgical procedures under general anesthesia. Patients were randomly allocated into two groups of 30 each. Group C received Cisatracurium 0.15 mg/kg and Group A received Atracurium 0.5 mg/kg. Neuromuscular transmission was monitored using Train-of-Four stimulation. The primary outcomes assessed were onset time and recovery index, while secondary outcomes included intubating conditions, hemodynamic parameters, histamine release, FiSevo requirement, and adverse effects.

Results: The mean onset time was significantly shorter in the Cisatracurium group compared with the Atracurium group (188.30 ± 19.31 vs 221.17 ± 27.31 seconds; $p<0.001$). Excellent intubating conditions were observed in 80.0% and 83.33% of patients in the Cisatracurium and Atracurium groups, respectively ($p=0.739$). Histamine release was observed only in the Atracurium group (13.33%). Hemodynamic parameters remained comparable between groups during most observation periods. The recovery index was similar in both groups (632.97 ± 141.66 vs 592.90 ± 133.79 seconds; $p=0.265$).

Conclusion: Both Cisatracurium and Atracurium provided satisfactory neuromuscular blockade and comparable recovery characteristics. However, Cisatracurium demonstrated a significantly faster onset of action, lower incidence of histamine-related manifestations, and favorable hemodynamic stability, making it a preferable neuromuscular blocking agent in adult surgical patients.

Keywords: *Cisatracurium and Atracurium.*

INTRODUCTION

Neuromuscular blocking agents (NMBAs) are an integral component of modern general anesthesia, facilitating endotracheal intubation, controlled ventilation, and optimal surgical conditions. Adequate neuromuscular blockade contributes significantly to perioperative patient safety and surgical efficiency.[1]

Among the available non-depolarizing neuromuscular blocking agents, benzylisoquinolinium compounds such as Atracurium and Cisatracurium are widely used because of their intermediate duration of action and organ-independent elimination. These agents act by competitively inhibiting acetylcholine at nicotinic receptors located at the neuromuscular junction, thereby producing skeletal muscle relaxation.[1,2]

Atracurium has been extensively used in clinical anesthesia because it undergoes Hofmann elimination and ester hydrolysis, making its metabolism largely independent of hepatic and renal function.[2] However, Atracurium is associated with dose-dependent histamine release, which may result in flushing, hypotension, tachycardia, and bronchospasm.[3] Such adverse effects may be particularly important in patients with cardiovascular disease and in those undergoing major surgical procedures.

Cisatracurium, one of the ten stereoisomers of Atracurium, is approximately three to four times more potent than the parent compound and undergoes the same organ-independent Hofmann degradation.[4] Due to its lower propensity for histamine release, Cisatracurium has been shown to provide greater cardiovascular stability while maintaining effective neuromuscular blockade.[4,5] Consequently, it has become increasingly popular in operating rooms and intensive care units worldwide.

The ideal neuromuscular blocking agent should provide rapid onset of action, excellent intubating conditions, predictable duration of action, stable hemodynamics, minimal adverse effects, and smooth recovery from neuromuscular blockade.[6] Although both Atracurium and Cisatracurium satisfy many of these requirements, differences in onset time, intubating conditions, hemodynamic responses, recovery profile, and histamine release remain areas of ongoing clinical interest.[5,7]

Several comparative studies have demonstrated that Cisatracurium provides favorable intubating conditions with superior cardiovascular stability and a lower incidence of histamine-mediated adverse reactions when compared with Atracurium.[7–10] Furthermore, preservation of hemodynamic stability during anesthesia is particularly important because fluctuations in heart rate and blood pressure may contribute to perioperative morbidity and adverse outcomes.[3,7]

Recovery characteristics are equally important in determining the overall effectiveness of a neuromuscular blocking agent. Delayed recovery may predispose patients to residual neuromuscular blockade, postoperative respiratory complications, prolonged post-anesthesia care unit stay, and increased healthcare costs. Therefore, evaluation of recovery indices and neuromuscular recovery profiles remains an essential component of comparative studies involving muscle relaxants.[1,4]

Considering the pharmacological advantages of Cisatracurium and the continued widespread use of Atracurium, a direct comparison of these two agents is clinically relevant. The present study was therefore undertaken to compare Cisatracurium and Atracurium with respect to onset of action, intubating conditions, hemodynamic stability, histamine release, anesthetic requirements, and recovery characteristics in patients undergoing surgery under general anesthesia

MATERIALS AND METHODS

This prospective randomized comparative study was conducted in 60 adult patients (ASA I–II) undergoing elective surgery under general anesthesia. Patients were randomly allocated into two groups of 30 each. Group C received intravenous Cisatracurium 0.15 mg/kg, while Group A received intravenous Atracurium 0.5 mg/kg for neuromuscular blockade. Standard anesthetic monitoring including ECG, non-invasive blood pressure, pulse oximetry, and capnography was instituted. Neuromuscular transmission was assessed using Train-of-Four (TOF) monitoring at the adductor pollicis muscle. The primary outcomes assessed were onset time, duration of action, and recovery index. Secondary outcomes included intubating conditions, hemodynamic parameters (heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure), signs of histamine release, anesthetic requirement (FiSevo), and adverse effects. Hemodynamic variables were recorded at predefined intervals from baseline until recovery. Intubating conditions were graded as excellent, good, or poor.

Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation and compared using the unpaired Student's t-test, while categorical variables were analyzed using the Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

RESULT

Table 1. Comparison of Onset Time

Parameter	Cisatracurium (Mean ± SD)	Atracurium (Mean ± SD)	P value
Onset time (sec)	188.30 ± 19.31	221.17 ± 27.31	<0.001

Table 2. Intubating Conditions

Condition	Cisatracurium n (%)	Atracurium n (%)	P value
Excellent	24 (80.0)	25 (83.33)	0.739

Good	6 (20.0)	5 (16.67)

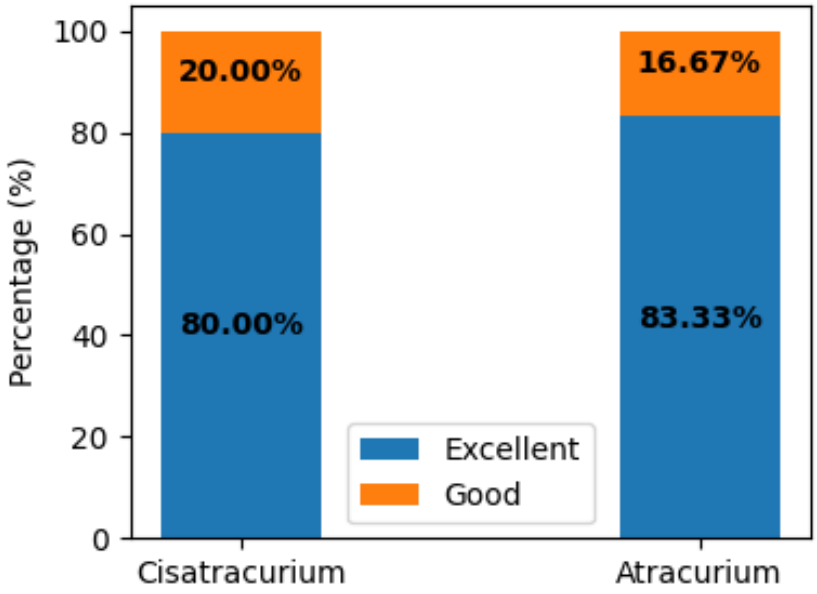


Table 3. Histamine Release

Histamine Release	Cisatracurium n (%)	Atracurium n (%)	P value
Yes	0 (0%)	4 (13.33%)	0.112
No	30 (100%)	26 (86.67%)	

Table 4. Heart Rate Comparison

Time Point	P value
Baseline	0.636
Loss of eyelash reflex	0.699
First dose	0.908
T1=0	0.952
T1=25%	0.955
T1=25–75%	0.232

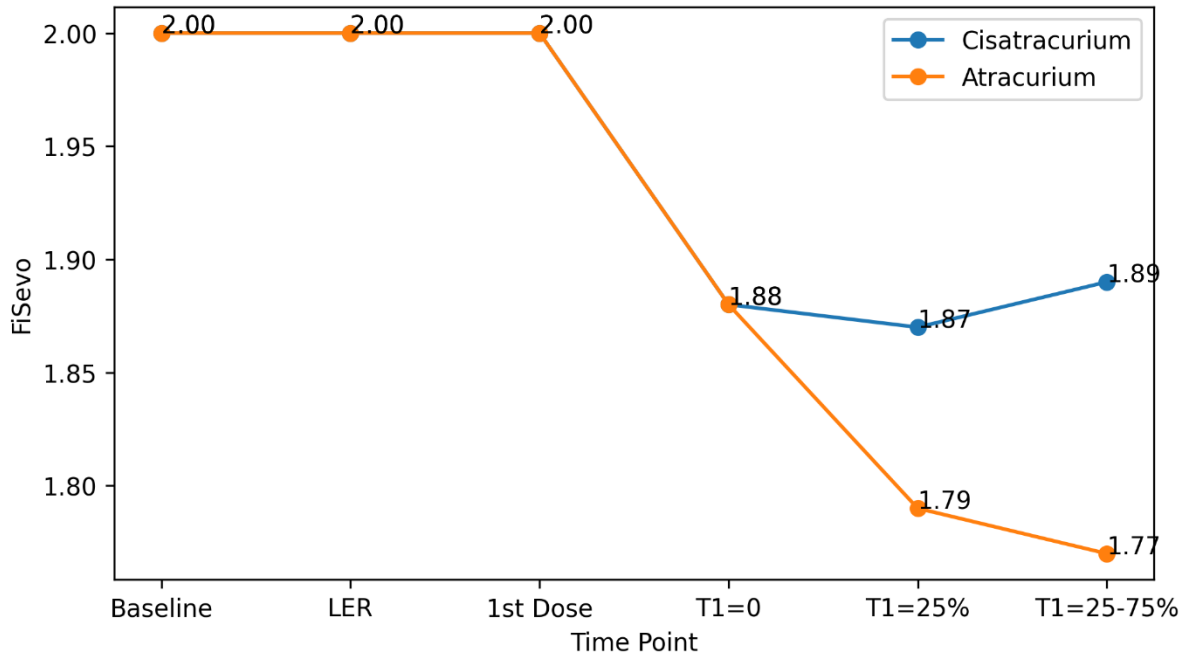
Table 5. Systolic Blood Pressure Comparison

Time Point	P value
Baseline	0.990
Loss of eyelash reflex	0.378
First dose	0.299
T1=0	0.277
T1=25%	0.303
T1=25–75%	0.026

Table 6. Mean Arterial Pressure Comparison

Time Point	P value
Baseline	0.458
Loss of eyelash reflex	0.156
First dose	0.691
T1=0	0.815
T1=25%	0.911
T1=25–75%	<0.001

Chart 2. Comparison of FiSevo Requirement Between Cisatracurium and Atracurium Groups



*Statistically significant ($p<0.05$).

Table 7. Recovery Index

Parameter	Cisatracurium (Mean ± SD)	Atracurium (Mean ± SD)	P value
Recovery Index (sec)	632.97 ± 141.66	592.90 ± 133.79	0.265

The mean onset time was significantly shorter in the Cisatracurium group (188.30 ± 19.31 seconds) compared to the Atracurium group (221.17 ± 27.31 seconds). The difference was statistically highly significant ($p<0.001$), indicating that Cisatracurium produced a faster onset of neuromuscular blockade than Atracurium.

The quality of intubating conditions was comparable between the two groups. Excellent intubating conditions were achieved in 80.0% of patients receiving Cisatracurium and 83.33% of patients receiving Atracurium, while the remaining patients demonstrated good intubating conditions. The difference was not statistically significant ($p=0.739$), suggesting similar efficacy of both drugs in facilitating endotracheal intubation.

No patient in the Cisatracurium group exhibited signs of histamine release, whereas histamine-related manifestations were observed in 13.33% of patients receiving Atracurium. Although the incidence was higher in the Atracurium group, the difference was not statistically significant ($p=0.112$).

Heart rate remained comparable between the two groups throughout the study period. No statistically significant differences were observed at baseline, loss of eyelash reflex, first dose, T1=0, T1=25%, or during recovery from T1=25% to 75% (all $p>0.05$), indicating similar cardiovascular stability with both agents.

Systolic blood pressure was comparable between the two groups from baseline until T1=25% recovery. However, during the recovery phase (T1=25% to 75%), the Atracurium group demonstrated significantly higher systolic blood pressure values compared with the Cisatracurium group ($p=0.026$).

Similarly, mean arterial pressure remained comparable between the groups during the initial stages of neuromuscular blockade and recovery. During the recovery period from T1=25% to 75%, the Atracurium group showed significantly higher mean arterial pressure values than the Cisatracurium group ($p<0.001$).

The inspired fraction of sevoflurane (FiSevo) requirement was similar between the two groups until T1=25% recovery. However, during the recovery phase, FiSevo was significantly lower in the Atracurium group compared with the Cisatracurium group ($p=0.021$).

The recovery index was 632.97 ± 141.66 seconds in the Cisatracurium group and 592.90 ± 133.79 seconds in the Atracurium group. The difference was not statistically significant ($p=0.265$), indicating comparable recovery characteristics between the two neuromuscular blocking agents.

Overall, Cisatracurium demonstrated a significantly faster onset of action while providing intubating conditions, recovery profile, and overall hemodynamic stability comparable to Atracurium. In addition, Cisatracurium was associated with a lower incidence of histamine-release manifestations and more stable blood pressure values during recovery, suggesting a favorable efficacy and safety profile in adult surgical patients undergoing general anesthesia.

DISCUSSION

The present study compared Cisatracurium and Atracurium with respect to onset characteristics, intubating conditions, hemodynamic profile, histamine release, anesthetic requirement, and recovery characteristics in adult surgical patients undergoing general anesthesia. The findings demonstrated that Cisatracurium produced a significantly faster onset of neuromuscular blockade than Atracurium while maintaining comparable intubating conditions and recovery characteristics. The mean onset time was significantly shorter in the Cisatracurium group compared with the Atracurium group. This finding is in agreement with previous studies that reported rapid and effective neuromuscular blockade with Cisatracurium at clinically recommended intubating doses.[7–10] The faster onset observed in the present study may be attributed to the pharmacodynamic properties of Cisatracurium, which provide effective neuromuscular blockade with favorable onset characteristics.[4,5]

The quality of intubating conditions was comparable between the two groups, with a majority of patients demonstrating excellent conditions for tracheal intubation. Similar findings have been reported in previous comparative studies, which observed that both Cisatracurium and Atracurium provide satisfactory intubating conditions suitable for routine clinical practice.[7,9,10]

Histamine release was observed only in patients receiving Atracurium, whereas no patient in the Cisatracurium group demonstrated histamine-related manifestations. Although the difference did not achieve statistical significance, this observation supports the established pharmacological profile of Cisatracurium, which is associated with minimal histamine release and greater cardiovascular stability compared with Atracurium.[3–5] This characteristic may be particularly beneficial in patients where hemodynamic stability is a major concern.

Heart rate remained comparable between the two groups throughout the study period. Similarly, systolic blood pressure and mean arterial pressure showed no significant differences during most observation periods, although higher values were observed in the Atracurium group during recovery. These findings are consistent with previous reports suggesting superior hemodynamic stability with Cisatracurium due to its lower tendency to induce histamine release.[5,7,10]

The anesthetic requirement, assessed using FiSevo concentration, was largely comparable between the two groups. A significant difference was observed only during the recovery phase, suggesting that both neuromuscular blocking agents have a similar influence on anesthetic maintenance during most of the intraoperative period.

Recovery characteristics constitute an important determinant of the overall effectiveness of a neuromuscular blocking agent. In the present study, the recovery index was comparable between the two groups, indicating similar recovery profiles. These findings are in accordance with previous investigations demonstrating that Cisatracurium and Atracurium exhibit comparable recovery characteristics despite differences in onset and histamine release profiles.[5,7,9]

Overall, the findings of the present study suggest that both agents are effective intermediate-acting neuromuscular blockers; however, Cisatracurium offers the additional advantages of faster onset, lower incidence of histamine-related effects, and favorable hemodynamic stability.

CONCLUSION

Both Cisatracurium and Atracurium provided satisfactory neuromuscular blockade, excellent intubating conditions, and comparable recovery characteristics in adult patients undergoing surgery under general anesthesia. However, Cisatracurium demonstrated a significantly faster onset of action and a lower incidence of histamine-release manifestations while maintaining stable hemodynamic parameters. Based on these findings, Cisatracurium may be considered a preferable neuromuscular blocking agent for routine anesthetic practice, particularly in patients where cardiovascular stability and minimal adverse effects are desired.

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