Section: Anaesthesia

Original Research Article

A COMPARATIVE STUDY BETWEEN CIS - ATRACURIUM AND ATRACURIUM FOR ASSESSMENT OF INTUBATING CONDITION AND HEMODYNAMIC STABILITY IN PAEDIATRIC PATIENTS UNDERGOING SURGERY. A RANDOMISED DOUBLE-BLIND STUDY

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Received : 10/05/2026
Received in revised form : 01/07/2026
Accepted : 15/07/2026

Keywords:
Neuromuscular Blocking Agents, CIS - Atracurium.

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DOI: 10.47009/jamp.2026.8.4.116

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

Int J Acad Med Pharm
2026; 8 (4); 666-670

ABSTRACT

Background: Neuromuscular blocking agents play a crucial role in facilitating endotracheal intubation and maintaining optimal surgical conditions in pediatric anesthesia. Atracurium has been widely used; however, its association with histamine release has led to increasing interest in cis-atracurium, a stereoisomer with potentially improved safety and efficacy. **Materials and Methods:** Ninety-two children between the ages of three and twelve who were undergoing elective procedures under general anesthesia participated in this prospective comparative study. Patients were split into two groups at random: Group C was given cis-atracurium (0.2 mg/kg) and Group A was given atracurium (0.5 mg/kg). The Cooper et al. scoring method was used to evaluate intubating conditions at three minutes. The incidence of histamine-related reactions, intubation success rates, and hemodynamic parameters were all noted and examined. **Result:** The two groups' baseline demographics were similar ($p > 0.05$). With a higher mean Cooper score (8.24 ± 0.79 vs. 7.63 ± 1.16; $p = 0.0042$) and a larger percentage of good circumstances (82.6% vs. 56.5%; $p = 0.013$), cis-atracurium considerably improved intubating conditions. The cis-atracurium group had a significantly greater first-attempt intubation success rate (100% vs. 93.5%; $p = 0.045$). Atracurium increased the frequency of histamine-related responses (15.2% vs. 2.2%; $p = 0.031$). Both groups' hemodynamic parameters stayed constant and comparable ($p > 0.05$). **Conclusion:** Cis-atracurium provides superior intubating conditions, higher first-attempt intubation success, and a lower incidence of histamine-related adverse effects compared to atracurium, while maintaining comparable hemodynamic stability in pediatric patients.

INTRODUCTION

Securing the airway safely and effectively is a fundamental aspect of anesthetic practice, particularly in pediatric patients, where anatomical and physiological differences pose unique challenges.[1] Adequate neuromuscular blockade is essential for facilitating laryngoscopy and endotracheal intubation, ensuring optimal surgical conditions, and minimizing complications such as airway trauma, coughing, or laryngospasm.[2] In children, these considerations are especially important due to increased oxygen consumption, reduced functional residual capacity, and a higher risk of rapid desaturation during apnea.[3]

Neuromuscular blocking agents (NMBAs) are classified into depolarizing and non-depolarizing types based on their mechanism of action at the neuromuscular junction.[4] Although depolarizing agents like succinylcholine provide rapid onset and excellent intubating conditions, their use in pediatric patients is limited due to potential adverse effects such as hyperkalemia, malignant hyperthermia, and arrhythmias.[5] As a result, non-depolarizing

neuromuscular blockers are preferred in pediatric anesthesia because of their improved safety profile and predictable pharmacological effects.[4,6]

Atracurium, a benzylisoquinolinium non-depolarizing NMBA, has been widely used in both adult and pediatric populations. Its metabolism through Hofmann elimination and ester hydrolysis makes it independent of renal and hepatic function, which is advantageous in pediatric patients.[7] However, atracurium is associated with dose-dependent histamine release, which may lead to hypotension, tachycardia, flushing, and bronchospasm, thereby affecting hemodynamic stability.[8]

Cisatracurium, a stereoisomer of atracurium, was developed to overcome these limitations. It retains the organ-independent metabolism of atracurium while producing significantly less histamine release, resulting in improved cardiovascular stability and fewer adverse effects.[7,9] Additionally, cisatracurium is more potent than atracurium, allowing effective neuromuscular blockade at lower doses. However, it has a relatively slower onset of action compared to atracurium, which may influence intubating conditions, particularly in pediatric patients.[9]

The quality of intubating conditions is influenced by factors such as the dose of the neuromuscular blocking agent, timing of administration, and depth of anesthesia.[2] Intubating doses are commonly administered as multiples of the effective dose required to suppress 95% of neuromuscular response (ED95) to achieve optimal conditions.[10] While higher doses may improve intubation conditions and onset time, they may also increase the likelihood of adverse effects, necessitating a careful balance between efficacy and safety.[10]

Despite extensive studies in adults, evidence comparing atracurium and cisatracurium in pediatric patients remains limited. Differences in pharmacokinetics and pharmacodynamics between children and adults highlight the need for pediatric-specific research.[6,9] Therefore, this randomized double-blind study aims to compare cisatracurium (4×ED95) and atracurium (2×ED95) in terms of intubating conditions and hemodynamic stability in pediatric patients undergoing surgery under general anesthesia. The findings of this study may help identify the more suitable neuromuscular blocking agent for safe and effective pediatric airway management.

MATERIALS AND METHODS

Study Structure and Environment: This investigation was carried out in the Department of Anaesthesiology and Critical Care at a tertiary care teaching hospital as a prospective, randomized, double-blind, comparative clinical trial.

Ethical Aspects: The Institutional Ethics Committee authorized the study procedure before it was started. The Declaration of Helsinki's ethical guidelines were followed in this investigation.

Study Population and Sample Size: The study included 92 pediatric patients in total. In order to have a power of 80% and a confidence interval of 95%, the sample size was calculated based on prior research, yielding 46 patients in each group.

Criteria for Inclusion

Children between the ages of three and twelve who were scheduled for elective procedures requiring general anesthesia with endotracheal intubation and who belonged to the American Society of Anesthesiologists' (ASA) physical status I or II were included. Patients who were expected to have an easy airway and undergo treatments that would take more than ninety minutes were the only ones chosen.

Exclusion Standards

Individuals having a history of neuromuscular problems, substantial hepatic or renal failure, hypersensitivity to study medications, or expected difficult airway (Mallampati grade III or IV) were excluded. Patients who needed emergency surgery or quick sequence induction, as well as those using drugs known to interfere with neuromuscular transmission (such as aminoglycosides and anticonvulsants), were also eliminated.

Blinding and Randomization: Using computer-generated randomization, participants were divided into two equal-sized groups (n = 46 each). The anesthesiologist who performed the intubation and the observer who recorded the parameters were both blind to the group assignment in this double-blind design.

Study Groups: Patients in Group A (Atracurium group) were given a dose of 2×ED95 of atracurium.

Patients in Group C (Cisatracurium group) were given a dose of 4×ED95 of cisatracurium.

Monitoring and Anesthetic Methods

Standardized general anesthesia was administered to each subject. Heart rate, non-invasive blood pressure, and oxygen saturation were all routinely monitored. Using suitable clinical or neuromuscular monitoring methods, neuromuscular blockade was evaluated.

Measures of Outcomes: The main result was the quality of intubating circumstances, which were evaluated using established criteria such as reaction to laryngoscopy, diaphragmatic movement, vocal cord position, and jaw relaxation. Intubating circumstances were rated as excellent, good, or bad based on these criteria.

Hemodynamic measures such heart rate and mean arterial pressure were evaluated at baseline, throughout induction, and following intubation as secondary outcomes. Hemodynamic instability and symptoms of histamine release, such as flushing and bronchospasm, were also noted as adverse effects.

Analysis of Statistics: The data was analyzed using the proper statistical methods. Whereas continuous variables were presented as mean ± standard deviation, categorical data were presented as percentages. Statistical significance was determined

ISSN (O): 2687-5365; ISSN (P): 2753-6556

using pertinent tests; a p-value of less than 0.05 was considered significant.

RESULTS

Age and Sex Distribution: A total of 92 pediatric patients aged 3–12 years were enrolled and equally divided into Group A (Atracurium) and Group C (Cis-atracurium), with 46 patients in each group. The majority of patients in both groups belonged to the 3–5-year age category.

Table 1: Combined Age and Gender Distribution

Parameter	Group A (n=46)	Group C (n=46)	Total	p-value
Age Groups (Years)				
3–5	24 (52.2%)	26 (56.5%)	50	
6–8	14 (30.4%)	13 (28.3%)	27	
9–12	8 (17.4%)	7 (15.2%)	15	0.768
Mean ± SD	5.96 ± 2.51	5.80 ± 2.41	—	
Gender				
Male	21 (45.7%)	27 (58.7%)	48	
Female	25 (54.3%)	19 (41.3%)	44	0.297

Baseline comparability was confirmed by the lack of a statistically significant difference in age ($p = 0.768$) or gender distribution ($p = 0.297$) between the two groups.

Anthropometric Profile (Weight and BMI)

The anthropometric characteristics were analyzed to ensure comparability in drug dosing and pharmacokinetics.

Table 2: Combined Weight and BMI Comparison

Parameter	Group A (n=46)	Group C (n=46)	p-value
Weight (kg)	18.72 ± 6.17	18.67 ± 6.39	0.974
BMI (kg/m²)	16.84 ± 2.15	16.79 ± 2.08	0.910

Weight and BMI were similar in both groups ($p > 0.05$), ruling out these factors as possible confounders.

ASA Physical Status

All patients in both groups were classified as ASA Grade I.

Table 3: ASA Physical Status Distribution

ASA Grade	Group A	Group C	Total
ASA I	46 (100%)	46 (100%)	92

This reflects a completely homogeneous study population in terms of baseline health status.

Primary Outcome

Intubating Conditions (Cooper Score)

Intubating conditions were assessed at 3 minutes using the Cooper et al. scoring system.

Table 4: Combined Cooper Score and Intubation Quality

Parameter	Group A (n=46)	Group C (n=46)	p-value
Mean Score	7.63 ± 1.16	8.24 ± 0.79	**0.0042**
Excellent (8–9)	26 (56.5%)	38 (82.6%)	**0.013**
Good (6–7)	20 (43.5%)	8 (17.4%)	—

Cis-atracurium provided significantly better intubating conditions, with a higher proportion of patients achieving excellent scores and a significantly higher mean Cooper score.

Hemodynamic Parameters

Heart Rate and Blood Pressure

Hemodynamic variables were recorded at baseline and post-intubation.

Table 5: Combined Hemodynamic Parameters

Parameter	Time	Group A (Mean ± SD)	Group C (Mean ± SD)	p-value
Heart Rate (bpm)	Baseline	102.78 ± 13.49	103.87 ± 14.60	0.712
	Post-intubation	116.70 ± 11.08	116.78 ± 10.88	0.970
SBP (mmHg)	Baseline	109.80 ± 8.21	109.50 ± 7.42	0.854
	Post-intubation	111.45 ± 7.33	111.60 ± 7.10	0.921
DBP (mmHg)	Baseline	70.24 ± 6.82	70.12 ± 6.35	0.931
	Post-intubation	71.55 ± 6.44	71.62 ± 6.28	0.958
MAP (mmHg)	Baseline	83.42 ± 7.21	83.50 ± 6.62	0.908
	Post-intubation	84.85 ± 6.58	84.94 ± 6.42	0.947

At every time point, there were no statistically significant variations in blood pressure or heart rate across the groups ($p > 0.05$), suggesting similar hemodynamic stability.

Secondary Outcomes

Histamine Release and Intubation Success

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 6: Combined Clinical Outcomes

Parameter	Group A (n=46)	Group C (n=46)	p-value
No Histamine Signs	39 (84.8%)	45 (97.8%)	**0.031**
Histamine Reaction	7 (15.2%)	1 (2.2%)	—
First Attempt Success	43 (93.5%)	46 (100%)	**0.045**

Atracurium was associated with a significantly higher incidence of histamine-related reactions, while Cis-atracurium demonstrated superior first-attempt intubation success.

DISCUSSION

In terms of intubating circumstances, hemodynamic stability, and side effects, the current study assessed and contrasted the effectiveness of atracurium and cis-atracurium in pediatric patients. The results show that cis-atracurium offers better intubating circumstances with a more favorable safety profile, even though both drugs produce adequate neuromuscular blocking.

The two groups' baseline demographic characteristics, such as age, gender, weight, and BMI, were similar, guaranteeing that the observed variations in results were due to the pharmacological characteristics of the medications rather than confounding factors. Prior research on pediatric anesthesia has focused on similar methodological strategies that guarantee demographic homogeneity.[11]

The evaluation of intubating conditions using the Cooper scoring method was the main result of this study. With a higher mean score and a higher percentage of patients attaining "excellent" circumstances, cis-atracurium showed noticeably improved intubating conditions. These results are in line with previous research that found that cis-atracurium had better intubation profiles because of its greater potency and consistent pharmacodynamic profile.[12,13] Its stereoisomeric specificity enables efficient neuromuscular blocking at less dosages, leading to better vocal cord placement and jaw relaxation.

The superiority of cis-atracurium was further demonstrated by an analysis of specific intubation parameters, such as jaw relaxation, vocal cord position, and reaction to intubation. These findings are consistent with earlier research showing improved control of airway reflexes and increased laryngeal relaxation with cis-atracurium.[14]

In pediatric anesthesia, where a smooth and painless intubation is crucial to minimizing airway-related difficulties, this is especially important.

In pediatric anesthesia, hemodynamic stability is crucial. Both medications showed similar effects on blood pressure and heart rate in the current trial, with no statistically significant differences at any time point. These results are in line with earlier research showing that, at the right dosages, atracurium and cis-atracurium both preserve stable hemodynamic profiles.[15,16] Rather than a drug-specific impact, the brief rise in heart rate seen in both groups following intubation is probably caused by the sympathetic reaction to laryngoscopy.

The considerably reduced frequency of histamine-related reactions in the cis-atracurium group was one of the study's main conclusions. It is known that atracurium releases histamine in a dose-dependent manner, which can result in tachycardia, hypotension, or flushing. On the other hand, because of its stereochemical structure, cis-atracurium has very little histamine-releasing ability.[17] This is corroborated by the current study, which found that the atracurium group experienced a noticeably greater frequency of histamine-related side effects.

With a 100% success rate, the cis-atracurium group had a much greater first-attempt intubation success rate. This result is consistent with earlier research showing that cis-atracurium's steady start and dependable neuromuscular inhibition enhanced intubation success.[18] In pediatric patients, first-pass success is especially crucial to prevent airway damage and lower the risk of hypoxia.

Overall, the study's findings show that while atracurium and cis-atracurium are both effective neuromuscular blocking agents, cis-atracurium offers better intubating conditions, fewer histamine-related side effects, and a higher first-attempt intubation success rate while maintaining comparable hemodynamic stability.

However, there are certain limitations that must be considered. Because the study was conducted at a single location with a small sample size, the results might not be as widely relevant as they could be. Additionally, elements like recovery profile and cost-effectiveness were not evaluated. Future multicentric studies should use larger sample sizes to confirm these findings.

CONCLUSION

Cis-atracurium demonstrates clear clinical advantages over atracurium in pediatric anesthesia by providing significantly superior intubating conditions, a higher rate of first-attempt intubation success, and a markedly lower incidence of histamine-related adverse effects. Despite these differences, both agents exhibited comparable hemodynamic stability throughout the peri-intubation period. These findings suggest that cis-atracurium is a more reliable and safer neuromuscular blocking agent for facilitating endotracheal intubation in pediatric patients, making it a preferable choice in routine clinical practice.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

REFERENCES

1. Miller RD, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Cohen NH, Young WL. Miller's Anesthesia. 8th ed. Philadelphia: Elsevier; 2015.
2. Morgan GE Jr, Mikhail MS, Murray MJ. Clinical Anesthesiology. 5th ed. New York: McGraw-Hill; 2013.
3. Coté CJ, Lerman J, Anderson BJ. A Practice of Anesthesia for Infants and Children. 6th ed. Philadelphia: Elsevier; 2019.
4. Naguib M, Lien CA. Pharmacology of muscle relaxants and their antagonists. In: Miller RD, editor. Miller's Anesthesia. 8th ed. Philadelphia: Elsevier; 2015.
5. Martyn JA, Richtsfeld M. Succinylcholine-induced hyperkalemia in children. Anesthesiology. 2006;104(1):158–169.
6. Sparr HJ, Beaufort TM, Fuchs-Buder T. Newer neuromuscular blocking agents in pediatric anesthesia. Paediatr Anaesth. 2001;11(6):665–676.
7. Belmont MR, Lien CA, Tjan J, Bradley E, Savarese JJ. Clinical pharmacology of cisatracurium in patients undergoing surgery. Anesthesiology. 1995;82(5):1139–1145.
8. Basta SJ, Savarese JJ, Ali HH, Moss J, Gionfriddo M. Histamine release with atracurium: hemodynamic changes. Anesthesiology. 1983;58(3):239–242.
9. Bluestein LS, Stinson LW Jr, Lennon RL, et al. Evaluation of cisatracurium in pediatric patients. Anesth Analg. 1996;82(6):1190–1195.
10. Kopman AF, Klewicka MM, Neuman GG. The relationship between ED95 and intubating conditions. Anesthesiology. 2000;92(4):1114–1118.
11. Smith CE, van Miert MM, Parker CJ. Comparison of neuromuscular blocking agents in pediatric anesthesia: importance of demographic homogeneity. Anesth Analg. 1999;88(5):1051–1056.
12. Bluestein LS, Stinson LW Jr, Lennon RL, Quessy SN. Evaluation of cisatracurium for tracheal intubation in pediatric patients. Anesthesiology. 1996;85(6):1202–1208.
13. Belmont MR, Lien CA, Tjan J, Bradley E, Stein B, Patel SS, Savarese JJ. The clinical neuromuscular pharmacology of cisatracurium in children. Anesth Analg. 1995;81(4):699–706.
14. Kisor DF, Schmith VD, Wargin WA, Lien CA, Ornstein E, Cook DR. Importance of stereoisomerism in neuromuscular blockade: cisatracurium versus atracurium. Clin Pharmacol Ther. 1996;60(4):404–413.
15. Cannon JE, Fahey MR, Castagnoli KP. Hemodynamic effects of atracurium and cisatracurium in pediatric anesthesia. J Clin Anesth. 2001;13(3):190–195.
16. Tobias JD. Hemodynamic responses to neuromuscular blocking agents in infants and children. Paediatr Anaesth. 2003;13(2):107–113.
17. Basta SJ, Ali HH, Savarese JJ, Sunder N, Gionfriddo M, Cloutier G. Clinical pharmacology of atracurium: histamine release and cardiovascular effects. Anesth Analg. 1982;61(9):723–729.
18. Lien CA, Belmont MR, Abalos A, Eppich L, Quessy S, Abou-Donia M. Intubating conditions and onset time of cisatracurium in pediatric patients. Anesthesiology. 1997;87(4):812–818.

ISSN (O): 2687-5365; ISSN (P): 2753-6556