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A COMPARATIVE EVALUATION OF EQUIPOTENT DOSES OF CISATRACURIUM AND ATRACURIUM FOR NEUROMUSCULAR BLOCKADE AND HEMODYNAMIC STABILITY IN LAPAROSCOPIC ABDOMINAL SURGERIES

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ABSTRACT **Introduction:** Neuromuscular blocking agents (NMBAs) are an essential component of general anesthesia to facilitate tracheal intubation and provide optimal muscle relaxation for surgical access. Cisatracurium and atracurium are benzylisoquinolinium compounds widely used for this purpose. Cisatracurium, a stereoisomer of atracurium, offers hemodynamic stability and predictable pharmacokinetics due to its organ-independent Hofmann elimination. This study compares equipotent doses of cisatracurium and atracurium in patients undergoing elective laparoscopic abdominal surgeries. **Material And Methods:** A randomized, prospective, double-blind clinical study was conducted on 60 ASA I–II patients aged 18–60 years undergoing elective laparoscopic cholecystectomy or appendectomy. Group A (n=30) received atracurium 0.5 mg/kg, and Group C (n=30) received cisatracurium 0.1 mg/kg. Onset time, duration of action, recovery index, and hemodynamic parameters were recorded using neuromuscular monitoring with a TOF-Watch®. Statistical analysis was performed using Student's *t*-test and Chi-square test ($p < 0.05$ significant). **Results:** The mean onset of action was significantly faster with atracurium (2.5 ± 0.4 min) than cisatracurium (3.1 ± 0.5 min). Duration of action was longer with cisatracurium (55.2 ± 6.1 min) versus atracurium (46.3 ± 5.4 min). Heart rate and mean arterial pressure remained more stable in the cisatracurium group. Recovery indices were comparable. No significant histamine-induced reactions were noted in either group. **Conclusion:** Both agents provide satisfactory muscle relaxation for laparoscopic surgery. Cisatracurium offers superior hemodynamic stability and longer duration, whereas atracurium provides a faster onset. Cisatracurium is thus preferable in patients where cardiovascular stability is a concern.

KEYWORDS : Cisatracurium, Atracurium, Neuromuscular blockade, Laparoscopic surgery, Hemodynamic stability.

INTRODUCTION

Neuromuscular blocking agents (NMBAs) are indispensable adjuncts to balanced anesthesia, enabling smooth tracheal intubation, controlled ventilation, and surgical muscle relaxation. Benzylisoquinolinium compounds such as atracurium and cisatracurium have become standard choices due to their non-depolarizing nature and predictable metabolism, minimizing postoperative residual curarization and cardiovascular instability[1].

Atracurium, introduced in the early 1980s, undergoes Hofmann elimination and ester hydrolysis, making it suitable for patients with hepatic or renal impairment[2]. However, it is associated with histamine release, transient hypotension, and tachycardia[3]. To address these limitations, cisatracurium-one of ten stereoisomers of atracurium-was developed. It is approximately three times more potent and produces minimal histamine release[4].

In laparoscopic surgeries, maintaining adequate muscle relaxation is crucial to counteract pneumoperitoneum and diaphragm elevation[5]. Smooth, sustained relaxation without hemodynamic compromise is desirable for both surgical exposure and patient safety. Cisatracurium, with its stable cardiovascular profile and predictable offset, is theoretically advantageous[6].

Previous studies have demonstrated variable differences between these agents regarding onset, duration, and recovery times[7–9]. Cisatracurium, despite its slower onset, provides longer duration and smoother recovery, while atracurium achieves faster onset but shorter duration. The choice may depend on clinical requirements and patient comorbidities[10].

This study aimed to compare equipotent doses-cisatracurium (0.1 mg/kg) and atracurium (0.5 mg/kg)-in adult patients undergoing elective laparoscopic abdominal surgeries. Parameters assessed included onset and duration of neuromuscular block, recovery characteristics, and hemodynamic stability. Such a comparison provides evidence to optimize NMBA choice for minimally invasive procedures under general anesthesia[11–15].

MATERIALS AND METHODS

This prospective, randomized, double-blind study was conducted in the Department of Anesthesiology at a tertiary care hospital after Institutional Ethics Committee approval. Written informed consent was obtained from all participants.

Sample Size And Grouping

Sixty adult patients (ASA I–II, aged 18–60 years) scheduled for elective laparoscopic cholecystectomy or appendectomy under general anesthesia were randomly allocated into two groups (n=30 each):

- **Group A:** Atracurium 0.5 mg/kg
- **Group C:** Cisatracurium 0.1 mg/kg

Randomization was achieved by computer-generated sequence; drug syringes were prepared by an anesthesiologist not involved in data collection.

Inclusion Criteria

- ASA physical status I–II
- Age 18–60 years
- Scheduled elective laparoscopic abdominal surgery
- Normal hepatic and renal function

Exclusion Criteria

- Known neuromuscular, hepatic, or renal disorders
- Pregnancy or lactation
- Patients on anticonvulsants, aminoglycosides, or calcium channel blockers
- History of hypersensitivity to study drugs

Anesthetic Technique

All patients were premedicated with midazolam 0.05 mg/kg and glycopyrrolate 0.004 mg/kg IV. Induction was done with fentanyl 2 µg/kg and propofol 2 mg/kg. After baseline vitals and TOF monitoring, patients received the allocated NMBA dose. Intubation was performed when 95% twitch suppression was achieved. Maintenance included oxygen-air-isoflurane mixture (FiO_2 = 0.5) with intermittent boluses of NMBA as needed.

Hemodynamic parameters (heart rate, systolic/diastolic/mean arterial pressure, SpO_2) were recorded at baseline, post-induction, post-intubation, and at 1, 3, 5, 10, 20, 30, 40 min intervals.

Outcome Measures

- **Onset time:** from drug administration to 95% suppression of T1 twitch.
- **Duration of action:** from injection to 25% recovery of T1.
- **Recovery index:** time from 25% to 75% recovery.
- **Hemodynamic stability:** change in HR and MAP.

Statistical Analysis

Data were analyzed using SPSS v25. Continuous variables were expressed as mean ± SD and compared using *t*-test; categorical data were analyzed with Chi-square test. $P < 0.05$ was considered statistically significant.

RESULTS

Table 1. Demographic Profile

Parameter	Group A (Atracurium)	Group C (Cisatracurium)	p value
Age (years)	38.4 ± 10.2	36.9 ± 9.8	0.54
Weight (kg)	64.7 ± 7.2	65.2 ± 6.9	0.71
Gender (M/F)	14/16	13/17	0.80
ASA I/II	18/12	19/11	0.84

Table 2. Neuromuscular Parameters

Parameter	Atracurium	Cisatracurium	p value
Onset (min)	2.5 ± 0.4	3.1 ± 0.5	0.001*
Duration (min)	46.3 ± 5.4	55.2 ± 6.1	0.002*
Recovery index (min)	12.4 ± 2.5	13.1 ± 2.2	0.27

(*p < 0.05 significant)

Table 3. Heart Rate (bpm) Changes

Interval	Atracurium	Cisatracurium	p value
Baseline	82.6 ± 9.1	81.9 ± 8.7	0.73
Post-intubation	95.4 ± 11.2	86.3 ± 9.5	0.004*
5 min	90.1 ± 9.7	83.2 ± 8.6	0.03*
20 min	84.2 ± 7.6	81.3 ± 7.1	0.18

Table 4. Mean Arterial Pressure (mmHg)

Interval	Atracurium	Cisatracurium	p value
Baseline	92.5 ± 8.3	91.9 ± 8.7	0.80
Post-intubation	104.1 ± 9.2	96.2 ± 8.9	0.01*
10 min	96.4 ± 8.0	92.5 ± 7.5	0.04*
30 min	91.2 ± 6.8	90.1 ± 7.1	0.56

Table 5. Incidence of Adverse Events

Event	Atracurium	Cisatracurium	p value
Histamine-induced flushing	3	0	0.08
Hypotension	2	0	0.14
Bradycardia	1	1	1.00
Hypoxia	0	0	–

Table 6. Surgeon's Satisfaction Score

Scale (1–5)	Atracurium	Cisatracurium
Excellent (5)	20	25
Good (4)	8	4
Fair (3)	2	1
Poor (1–2)	0	0

DISCUSSION

This study demonstrated that both atracurium and cisatracurium provide reliable neuromuscular blockade for laparoscopic surgeries, but with distinct pharmacodynamic profiles. Atracurium produced a faster onset, while cisatracurium exhibited a longer duration and greater hemodynamic stability.

Our results align with those of El-Kasaby et al. (2016) who observed similar onset and recovery differences between equipotent doses in general anesthesia[16]. The slower onset of cisatracurium is attributed to its higher potency and reduced molar concentration at the neuromuscular junction[17]. However, its longer duration enhances surgical convenience during prolonged laparoscopic procedures.

Hemodynamic stability is a crucial determinant in NMBA selection, especially in elderly or cardiovascularly compromised patients. Consistent with earlier findings by Kirov et al. (2018) and Misra et al. (2020), cisatracurium produced minimal heart rate and blood pressure variation compared to atracurium[18,19]. This likely reflects the negligible histamine release associated with cisatracurium metabolism via Hofmann degradation-a temperature- and pH-dependent process independent of hepatic or renal function[20].

Atracurium's histamine release may cause transient hypotension and tachycardia[21]. Although no severe events occurred in this study, mild flushing was noted only in the atracurium group. The recovery indices were comparable, corroborating the findings by Gupta et al. (2021) and Zhang et al. (2019)[22,23].

Our findings support using cisatracurium for hemodynamically sensitive patients and atracurium where rapid onset is prioritized, such as short procedures. Both drugs are suitable for balanced anesthesia in laparoscopic surgery. Limitations include modest sample size and absence of plasma histamine assay. Future studies could evaluate cost-effectiveness and pharmacogenetic influences on NMBA metabolism.

CONCLUSION

Both atracurium (0.5 mg/kg) and cisatracurium (0.1 mg/kg) provide effective neuromuscular blockade for laparoscopic surgeries. Atracurium offers a faster onset, while cisatracurium ensures longer duration and superior hemodynamic stability. Hence, cisatracurium is recommended where cardiovascular stability is paramount, with either agent suitable for routine laparoscopic anesthesia.

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