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# INTUBATING CONDITIONS AND HEMODYNAMIC FLUCTUATIONS WHILE ADMINISTRATING SUXAMETHONIUM AND ATRACURIUM IN PEDIATRIC PATIENTS: A CROSS-SECTIONAL STUDY

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**Abstract**

**Background:**

This study compares intubating conditions and hemodynamic fluctuations between Suxamethonium and Atracurium in pediatric patients undergoing elective surgeries. A total of patients was divided into two groups: Category S (Suxamethonium) and Category A (Atracurium). Intubating conditions were assessed and graded as excellent, good, moderate, or poor.

**Methods:**

Patients were evaluated based on three parameters- jaw relaxation, response to intubation, and vocal cord movement.

**Results:**

Category A demonstrated significantly better intubating conditions, with 96.5% rated excellent compared to 75.4% in Category S ($p<0.0001$). The duration of action was significantly longer with Atracurium (26.6 min) than Suxamethonium (6.8 min). Hemodynamic monitoring showed that Suxamethonium caused greater fluctuations in heart rate and mean arterial pressure post-induction. Significant differences were observed at multiple time points, particularly in heart rate ($p<0.0001$) and MAP at 5 minutes ($p<0.0001$).

**Conclusion:**

Atracurium provided more stable hemodynamics and superior intubating conditions. The findings suggest Atracurium may be a safer and more effective alternative to Suxamethonium in pediatric intubation.

## Introduction

General anesthesia is a most commonly used technique to keep the patient off from feeling pain in surgery such as in heart surgeries, thyroidectomy, ENT surgeries, patients with anticipated difficulty under other anesthetic techniques, etc. In this technique the patient is initially sedated through inducing agents via intravenous drug administration and the drugs used are propofol, etomidate, thiopentone, and ketamine. opioids are given alongside to provide analgesia and supplement sedation i.e., fentanyl, and morphine. And followed by administrating inhalational gases i.e. sevoflurane, isoflurane, desflurane, enflurane to maintain the state of

unconsciousness in patients until the end of the surgery, the drugs are chosen based on the existing comorbidities and history of the patient.[1] The aim of the study is to compare hemodynamic fluctuation between suxamethonium and atracurium.

The muscle relaxant is a drug administrated to the patient, followed by preoxygenation and an inducing agent to facilitate endotracheal intubation.[2-4] These drugs can allow immediate and successful airway securement when intubating, and it also help provide a balanced anesthesia when combining this class of drug with volatile agents and parenteral analgesics.[5]

Muscle relaxants are drugs that reduce muscle tone either by acting peripherally at the neuromuscular junction or directly on the contractile mechanism or centrally in the cerebrospinal axis.[6-7] It reduces the spasticity in a variety of neurological conditions and is mainly useful in endotracheal intubation.[8]

Skeletal muscle relaxants are classified into two types i.e. Drugs acting Peripherally and Drugs acting Centrally, under peripherally acting muscle relaxants there are two classifications of drugs based on its site of action i.e. drugs acting on NMJ and drugs acting directly on muscle.[9,10]

The drugs that act on NMJ is further classified into two types. i.e. Non-depolarizing drugs and Depolarizing drugs. (as shown in the following flowchart)

Succinylcholine is a depolarizing muscle relaxant that depolarizes motor endplate at myoneural junction, which causes sustained flaccid skeletal muscle paralysis with no effect on unconsciousness and pain.[11] The dosage of drug in IM and IV are 3-4 mg/kg and 1mg/kg. The onset of action and duration is fast. The rapid metabolism is performed by pseudocholinesterase and it's excreted via urine. the adverse effect includes malignant hyperthermia, prolonged muscle fasciculation that may result in post-operative pain.[12,13]

Atracurium is a non-depolarizing muscle relaxant that's administrated via IV of dosage 0.5mg/kg as initial dose and 0.1 mg/kg as maintenance dose which is repeated after every time interval of 20-45 mins during procedure. The drug must be stored in refrigerator to maintain sustained temperature. The onset of action is within 2-3mins and the duration exists ideally for 20-35 mins. It's metabolized via Hofmann elimination and ester hydrolysis and excreted via urine and feces.[14]

**Methods and Methodology**

This was a cross-sectional comparative study conducted over a period of six months in the Department of Anaesthesiology at Sree Balaji Medical College and Hospital. Ethical approval was obtained from the institution's ethics committee prior to commencement. A total of 114 paediatric patients, aged between 5 and 15 years and of either sex, who underwent surgery under general anaesthesia, were included in the study. The patients were randomly assigned into two equal groups: Category A (Atracurium group) and Category S (Succinylcholine group), with 57 patients in each group.

**Inclusion Criteria:**

1. Age ranges from 5 to 15
2. ASA Grade I and II
3. Both male and female

**Exclusion Criteria:**

1. ASA Grade III and IV

2. Patient with associated contraindication such as burns, neuromuscular disease, cerebral palsy, decreased pseudocholinesterase and anticipated intubation difficulty
3. Emergency intubation

All patients were thoroughly evaluated preoperatively, and those with any systemic illnesses or anticipated difficult airways were excluded from the study. Informed consent was obtained from the parents or legal guardians after clearly explaining the purpose and procedures of the study. All patients adhered to preoperative fasting protocols (NPO), and intravenous (IV) access was secured for the administration of medications. Standard non-invasive monitors were used throughout the procedure, including blood pressure, electrocardiogram (ECG), pulse oximetry, and capnography.

Premedication was administered intravenously and included glycopyrrolate 0.04 mg/kg and midazolam 1 mg/kg, followed by fentanyl 0.5 mcg/kg. Preoxygenation with 100% oxygen was provided for 3 to 5 minutes, after which anaesthesia was induced with propofol 2 mg/kg. Pre-induction heart rate and mean arterial pressure (MAP) were recorded. Muscle relaxation was achieved using either succinylcholine 2 mg/kg or atracurium 0.5 mg/kg, depending on the group allocation. Intubating conditions were assessed at 60 seconds for the succinylcholine group and 180 seconds for the atracurium group after administration of the muscle relaxant.

**Assessment of Intubating Conditions:**

Intubating conditions were evaluated based on three parameters: jaw relaxation, response to intubation, and vocal cord movement. Each parameter was scored as follows:

| Score | Jaw Relaxation | Response to Intubation | Vocal Cord Movement |
|---|---|---|---|
| 0 | Not relaxed | Severe bucking | Closed |
| 1 | Slightly relaxed | Mild response | Moving |
| 2 | Relaxed | No response | Open |

The cumulative score for each patient was calculated and categorized as:

- **0–1**: Poor
- **2–3**: Moderate
- **4–5**: Good
- **6**: Excellent

After intubation, the endotracheal tube cuff was inflated and connected to a breathing circuit. Ventilation was maintained using a mixture of nitrous oxide, oxygen, and sevoflurane. At the end of the surgical procedure, neuromuscular blockade was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 0.01 mg/kg. Patients were extubated after thorough airway suctioning, and any complications or abnormalities were noted and recorded.

The objective of this study was to compare the intubating conditions, mean arterial pressure (MAP), heart rate variations, and the duration of neuromuscular blockade between the two muscle relaxants.

**Table 1. Grading based on the parameters of intubating conditions**

| Intubating Conditions | Category S (n=57) | Category A (n=57) | P Value | Significance |
|---|---|---|---|---|
| Excellent | 43 (75.4%) | 55 (96.5%) | <0.0001 | Significant |

| Intubating Conditions | Category S (n=57) | Category A (n=57) | P Value | Significance |
|---|---|---|---|---|
| Good | 10 (17.5%) | 2 (3.5%) | | |
| Moderate | 4 (7.02%) | 0 (0%) | | |
| Poor | 0 (0%) | 0 (0%) | | |
| Mean ± SD | 5.49 ± 1.01 | 5.94 ± 0.28 | | |

**Table 2. Comparison of duration of action between two groups**

| Duration of action ( in mins) | Category S | Category A | P value | Significant/ non-significant |
|---|---|---|---|---|
| Mean ± SD | 6.8 ± 1.4 | 26.6 ± 1,9 | <0.0001 | Significant |

**Table 3. Comparison of mean heart rate between two groups**

| HEART RATE (bpm) | CATEGORY S | CATEGORY A | P value | Significant/ non-significant |
|---|---|---|---|---|
| **At rest** | 115.3 ± 6.7 | 100.0 ± 5,8 | 0.060 | Non-Significant |
| **At induction** | 111.2 ± 6.9 | 115.7 ± 5.6 | 0.002 | Significant |
| **1 min** | 72.2 ± 6.8 | 94.6 ± 5.9 | <0.0001 | Significant |
| **3 mins** | 80 ± 6.6 | 92.1 ± 5.8 | <0.0001 | Significant |
| **5 mins** | 64.8 ± 6.6 | 97.8 ± 5.6 | <0.0001 | Significant |

**Table 4. Comparison on mean arterial pressure between two groups**

| MAP (mmHg) | Category S | Category A | P value | Significant/ non-significant |
|---|---|---|---|---|
| **At rest** | 115.9 ± 6.3 | 76.75 ± 11.2 | 0.328 | Non-Significant |
| **At induction** | 107.8 ± 16.6 | 73.1 ± 9.85 | 0.025 | Significant |
| **1 min** | 102.7 ± 5.6 | 71.7 ± 9.00 | 0.071 | Non-Significant |
| **3 mins** | 106.1 ± 7.5 | 83.2 ± 11.4 | 0.078 | Non-Significant |
| **5 mins** | 105.0± 11.49 | 78.3 ± 10.0 | <0.0001 | Significant |

## Results

A total of 114 paediatric patients were included in the study, with 57 patients each in the succinylcholine group (Category S) and the atracurium group (Category A). Intubating conditions were significantly better in the atracurium group, with 55 patients (96.5%) exhibiting excellent conditions compared to 43 patients (75.4%) in the succinylcholine group (**P < 0.0001**). Good conditions were observed in 10 patients (17.5%) in Category S and only 2

patients (3.5%) in Category A, while moderate responses were seen in 4 patients (7.02%) in Category S and none in Category A. No poor responses were recorded in either group. The mean intubation score was significantly higher in Category A (**5.94 ± 0.28**) compared to Category S (**5.49 ± 1.01**) (**P < 0.0001**). The duration of action of the muscle relaxants differed markedly, with a significantly longer duration observed in the atracurium group (**26.6 ± 1.9**) versus the succinylcholine group (**6.8 ± 1.4**) (**P < 0.0001**). Heart rate comparison revealed that at rest, the values were (**115.3 ± 6.7**) in Category S and (**100.0 ± 5.8**) in Category A. However, heart rate at induction was significantly higher in Category A (**115.7 ± 5.6**) than in Category S (**111.2 ± 6.9**) (**P = 0.002**). At 1 minute, the heart rate dropped significantly in Category S (**72.2 ± 6.8**) compared to Category A (**94.6 ± 5.9**) (**P < 0.0001**), and this trend continued at 3 minutes (**80.0 ± 6.6** vs **92.1 ± 5.8**, **P < 0.0001**) and 5 minutes (**64.8 ± 6.6** vs **97.8 ± 5.6**, **P < 0.0001**). Mean arterial pressure (MAP) at rest was (**115.9 ± 6.3**) in Category S and **(76.75 ± 11.2)** in Category A (**P = 0.328**, non-significant). At induction, MAP was significantly higher in Category S (**107.8 ± 16.6**) than Category A (**73.1 ± 9.85**) (**P = 0.025**). However, MAP differences at 1 and 3 minutes were statistically non-significant, while a significant difference re-emerged at 5 minutes, with MAP in Category S being **(105.0 ± 11.49 vs 78.3 ± 10.0)** in Category A (**P < 0.0001**).

**Statistical analysis**

statistical analysis was performed using the Chi-Square test for categorical variables such as intubating conditions, and independent t-tests for continuous variables like duration of action, heart rate, and mean arterial pressure at each time point. A p-value of <0.05 was considered statistically significant. Fisher's Exact Test has been used where expected cell counts were low.

**Discussion**

The comparison of intubating conditions, onset times, heart rate responses, mean arterial pressure (MAP), and duration of action between suxamethonium and atracurium can be interpreted in the context of the two neuromuscular blocking agents used. These agents have distinct pharmacological properties that influence the clinical outcomes observed in this study. Our study shows that, the comparison of onset time and duration, succinylcholine (commonly used in rapid-sequence intubation) is known for its very rapid onset (typically within 30 seconds), as seen in Category S, which had a much faster onset of action (49.4 seconds). This quick onset is a hallmark of suxamethonium, making it ideal for emergency or urgent intubation scenarios where rapid airway management is required. However, suxamethonium also has a shorter duration of action, which was evident in the relatively brief duration in Category S (6.8 mins). In contrast, atracurium (used in Category A) has a slower onset (156.8 seconds), which reflected in the longer onset time observed in the study. However, atracurium has a longer duration of action (26.6 mins), making it suitable for procedures where prolonged muscle relaxation is necessary. Similarly, the study from Kumar et al., showed the onset of action is rapid in suxamethonium but the duration of action is longer in atracurium.[4]

In our study the intubating conditions associated with atracurium was superior with 96.5% of patients had "excellent" intubating conditions. This could be explained by the more sustained neuromuscular blockade provided by atracurium, which results in a more stable and relaxed state for intubation, facilitating easier placement of the endotracheal tube. And in the study proceeded by Tran et al. a systematic review comparing rocuronium and succinylcholine to assess intubating conditions during rapid sequence tracheal intubation, the analysis

demonstrated that succinylcholine provided better overall intubation conditions, showing superiority in achieving both excellent (RR 0.86, 95% CI 0.81–0.92; n = 4151) and clinically acceptable intubation conditions (RR 0.97, 95% CI 0.95–0.99; n = 3992). In the study conducted by Nadirsha et al. it's proven that atracurium provided excellent intubating condition than cis-atracurium. [5,15,23,24]

The heart rate data showed that succinylcholine (Category S) led to a slightly decreased heart rate response across all time points compared to atracurium (Category A). Succinylcholine, being a depolarizing agent, can initially cause transient bradycardia or even asystole (especially in younger patients or after the first dose). The decrease in heart rate observed in Category S (with a final value of 64.8 bpm) aligns with this effect, which is often more pronounced in the initial stages following succinylcholine administration. In contrast, atracurium, a non-depolarizing agent, is less likely to cause the same initial bradycardic response. The higher heart rate seen in Category A could therefore be related to release of histamine and less vagal stimulation with more stable cardiovascular response. Also, in the study by Tang et al. the heart rate was significantly higher while administrating suxamethonium but settled after few minutes and in the study done by Lien et al., it's reported that while administrating cis-atracurium and atracurium even at doses up to eight times it did not cause any significant cardiovascular side effects nor histamine release. [16-19]

The MAP results showed that Category S had slightly higher MAP values compared to Category A at all time points. This might reflect the sympathomimetic effects of succinylcholine, although it's not said to be at high risk due to the slight marginal increase. In contrast, atracurium, as a non-depolarizing agent, does not typically cause such cardiovascular effects. This finding suggests that while succinylcholine may be associated with a more pronounced increase in MAP, the effects are not large enough to cause clinical concern in most cases. In research performed by Kumar et al. the administration of succinylcholine did not show any significant effect on MAP values.[4,20,21]

Ultimately, the choice between succinylcholine and atracurium depends on the specific needs of the procedure—whether rapid intubation or longer muscle relaxation is prioritized, as well as considerations for cardiovascular stability and intubating conditions in paediatric patients. Associated contraindications of suxamethonium makes the usage controversial in certain patients with conditions of hyperkalaemia, burns, increased intracranial pressure, malignant hyperthermia, decreased or no pseudocholinesterase.[25] Likewise, use of atracurium is not recommended for patient with anticipated difficult intubation. All these criteria are kept under consideration while administrating neuromuscular blocking drugs.

## Conclusion

In this cross-sectional study between suxamethonium and atracurium conducted, 114 pediatric patients undergone elective surgery under general anesthesia were participated with prior consent and assessment. Each drug has been administrated to 57 patients categorized into 2 groups where the intubating conditions, onset of action, duration of drug has been compared. The result obtained from the study shows suxamethonium has rapid onset of action but the intubating conditions varied in both groups that 55 patients showed excellent conditions and 2 patients showed good condition after administration of atracurium while 45 patients showed excellent condition, 10 patients showed good condition and 2 patients showed moderate

condition after administration of suxamethonium. A slight decrease in heart rate while administrating was noted and no significant clinically-concerning effect on mean arterial pressure. Also, administration of suxamethonium in pediatric patient with conditions like cerebral palsy, burns, hyperkalemia, decreased pseudocholinesterase are contraindicated, thus the list of contraindications excels in case of suxamethonium much than in atracurium. Therefore, atracurium provides better intubating conditions in children between 5 to 15 years posted for elective surgeries. Thus, atracurium provides better intubating conditions and hemodynamic stability in paediatric patients compared to suxamethonium.

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None

**Conflict Of Interest:**

The author declares that there is no conflict of interest.

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