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Comparative Study of Efficacy and Safety of Rocuronium Bromide with Suxamethonium Chloride for Tracheal Intubation

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ABSTRACT

Background: Tracheal intubation is a cornerstone of modern anesthetic practice, with neuromuscular blocking agents playing a critical role. Among these agents, Suxamethonium chloride is widely used for its quick onset and brief duration. However, its associated side effects have prompted the search for alternatives like Rocuronium Bromide, a non-depolarizing agent known for its rapid onset, intermediate duration, and minimal adverse effects. The study aims to compare the effectiveness and safety of Suxamethonium chloride and Rocuronium Bromide. It evaluates their onset times, intubating conditions, duration of action, hemodynamic effects, and adverse reactions.

Materials and Methods: A randomized trial was conducted with 110 patients divided into two groups. Group A received Suxamethonium (1.5 mg/kg IV), and Group B was administered Rocuronium (0.9 mg/kg IV). Observations were made on intubation quality, onset timing, and hemodynamic changes.

Results: Group A exhibited faster onset and superior intubating conditions (100% excellent scores) compared to Group B (87.3% excellent scores). However, Rocuronium demonstrated longer duration of action, hemodynamic stability, with significantly lower postoperative heart rate and blood pressure fluctuations. Additionally, Group B had no reported adverse effects, while Group A experienced 12.7% postoperative myalgia.

Conclusion: Rocuronium represents a safer alternative for tracheal intubation, with enhanced hemodynamic stability and fewer side effects, despite slightly less favorable intubating conditions than Suxamethonium.

Keywords: Rocuronium Bromide, Suxamethonium Chloride, Tracheal Intubation, Neuromuscular Blocking Agents, Hemodynamic Stability, Postoperative Myalgia

INTRODUCTION

The use of neuromuscular blocking agents has played a crucial role in modern anesthesia, allowing for more precise muscle relaxation and improved airway control during surgical interventions. Before their advent, muscle relaxation was achieved using deep inhalation anesthesia, which often posed significant respiratory and cardiovascular risks.

The introduction of muscle relaxants redefined the "anesthetic triad" narcosis, analgesia, and muscle relaxation allowing for safer and more effective surgical procedures. These agents provide adequate laryngopharyngeal relaxation, enabling airway control and facilitating

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skeletal muscle relaxation during surgery.[1] Today, endotracheal intubation is a routine and essential component of anesthesia, particularly in the context of surgical procedures.

Muscle relaxants are broadly categorized into two classes: depolarizing and non-depolarizing agents. Depolarizing agents, such as Suxamethonium chloride (succinylcholine), mimic the action of acetylcholine at the neuromuscular junction, causing an initial depolarization (muscle fasciculations) followed by paralysis. Although effective, its adverse effects, including postoperative myalgia and rare but severe reactions like malignant hyperthermia, limit its use in some cases.[2,3] Moreover, patients with pseudocholinesterase deficiency may experience prolonged recovery, and in rare instances, Suxamethonium can trigger malignant hyperthermia.[3]

The ideal neuromuscular blocking agent is characterized by a non-depolarizing mechanism, quick onset, short duration of action, fast recovery, and the absence of cumulative effects or cardiovascular complications. Additionally, it should not trigger histamine release, be reversible with cholinesterase inhibitors, have high potency, and result in inactive metabolites. Rocuronium Bromide, a non-depolarizing agent, aligns closely with these attributes. It stands out among available non-depolarizing agents due to its rapid onset, intermediate duration, minimal impact on cardiovascular function, and lack of histamine release, making it a viable alternative to Suxamethonium for tracheal intubation.[4-6]

Given these pharmacological profiles, the objective of our study is to conduct a comparative analyzing their onset times, durations of action, intubation conditions, and associated hemodynamic changes during tracheal intubation following the use of Suxamethonium chloride and Rocuronium Bromide during tracheal intubation.[7,8] The advent of neuromuscular blocking agents transformed the practice of anesthesia, particularly by facilitating controlled airway management through tracheal intubation. Historically, deep inhalation anesthesia was required to achieve muscle relaxation, leading to substantial risks of respiratory and cardiovascular complications. With the introduction of muscle relaxants, the anesthetic triad narcosis, analgesia, and muscle relaxation became better defined.[8]

This study aims to assess and compare the effectiveness and safety of Suxamethonium chloride versus Rocuronium Bromide for tracheal intubation, with a focus on their onset times, conditions for intubation, duration of action, and hemodynamic impacts.

MATERIALS AND METHODS

This study took place over a two-year duration at the Department of Anesthesia. Patients who fulfilled the selection criteria during this period were enrolled. A total of 110 patients, categorized as ASA grade I and II, scheduled for elective surgeries, participated in the study. The participants were randomly assigned into two groups: Group A, which received Suxamethonium Chloride (1.5 mg/kg IV), and Group B, which received Rocuronium Bromide (0.9 mg/kg IV), with 55 patients in each group.

Data collection procedure: Pre-anesthetic evaluation was conducted for all patients, including the recording of key demographic information such as name, age, sex, and weight (in kg). The medical history was reviewed for comorbidities including hypertension, diabetes mellitus, tuberculosis, asthma, epilepsy, drug allergies, and relevant family medical history. A comprehensive physical examination was performed, with specific attention to airway assessment, dental status, spine evaluation, and a systemic examination. Routine investigations such as complete blood count (CBC), blood sugar level (BSL), serum creatinine, serum electrolytes, and electrocardiogram (ECG) were obtained preoperatively.

Preoperative preparation involved recording baseline heart rate (HR) and blood pressure (BP) for all participants. Patients were required to remain nil by mouth (NBM) for six hours before surgery. Written informed consent was obtained for the surgical procedure, anesthesia, and study participation.

Upon arrival in the operating room, standard monitors were applied, including electrocardiography (ECG), non-invasive blood pressure (NIBP), and pulse oximetry. After intubation, additional monitoring was performed using end-tidal CO2 (EtCO2) and nasopharyngeal temperature probe.

A suitable catheter was used to establish an intravenous line, and 500 mL of Ringer's lactate solution was administered. Premedication was given 10 minutes prior to anesthesia induction. Preoxygenation with 100% oxygen was conducted for a duration of 3 minutes. Anesthesia was induced using intravenous propofol at a dose of 2 mg/kg body weight, until the loss of the eyelash reflex indicated adequate anesthesia. After confirming the ability to perform mask ventilation, the muscle relaxant was administered, Group A: Suxamethonium chloride 1.5 mg/kg IV. Group B: Rocuronium Bromide 0.9 mg/kg IV. The time of muscle relaxant administration was noted.

Direct laryngoscopy and orotracheal intubation were carried out 60 seconds later for both groups. Intubation conditions were evaluated using a four-point scale developed by Cooper et al., which considers factors such as jaw relaxation, vocal cord position, and the patient's response during the intubation process.[3]

Intubation score was noted. It is scored according to four-point scale of Cooper et al.[3] The grading of intubating conditions was based on a scale that evaluates jaw relaxation, vocal cord position, and the patient's response to intubation. The scoring is mentioned in table 1.

The total score for intubating conditions was categorized as follows: 8-9 -Excellent; 6-7 -Good; 3-5 -Fair; and 0-2 – Poor.

Table 1: Scoring system

Score	Jaw relaxation(laryngoscopy)	Vocal cords	Response to intubation
0	Poor(impossible)	Closed	Severe coughing or Bucking
1	Minimal(difficult)	Closing	Mild coughing
2	Moderate (fair)	Moving	Slight diaphragmatic Movement
3	Good (easy)	Open	None

If the total score was below 6, the patient was ventilated for an additional 60 seconds before attempting laryngoscopy and intubation again. Once the endotracheal intubation was completed, the cuff of the endotracheal tube was inflated, and controlled ventilation was initiated using a closed-circuit system. Anesthesia was sustained with a combination of 33% oxygen, 67% nitrous oxide, and sevoflurane (1-2%). Hemodynamic Parameters: Heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) were monitored and recorded at predetermined intervals:

- Baseline (before premedication)
- After premedication
- Immediately following muscle relaxant injection
- Post-intubation
- 5, 10, 15, and 20 minutes after intubation.

The duration of action of the muscle relaxants was recorded from the time of administration to the first appearance of spontaneous respiration, which was identified by observing changes in the EtCO2 graph (appearance of a notch).

During surgery, if required, patients were administered Injection Atracurium at a maintenance dose of 0.1 mg/kg every 20-25 minutes.

After the surgical procedure, orotracheal suction was performed, and spontaneous respiratory efforts were evaluated using clinical indicators such as hand grip strength and the sustained head lift test. Residual neuromuscular blockade was antagonized by administering an intravenous dose of Glycopyrrolate (0.4 mg) and Neostigmine (2.5 mg). Following extubation, patients received oxygen for 5 minutes prior to being transferred to the recovery room for continuous monitoring. Any adverse events or complications during the intraoperative and postoperative periods were recorded and appropriately managed.

Statistical Analysis:

For continuous variables, data was presented with mean and SD whereas for categorical variables, the data was presented with number and percentage. Comparison between groups was performed by t-test for normally distributed data and Mann- Whitney for non-normally distributed data. Comparison between groups for categorical variables was performed by chi-square test. A p-value less than 0.05 were considered as significant. Data analysis was done by using software SPSSv20.0 and EPIinfo.

RESULTS

A total of 110 patients were included in this study, the majority of participants were female, comprising 85.5% in Group A and 83.6% in Group B. The male-to-female ratio was comparable between the groups (p = 0.79). The mean age distribution was similar between groups (p = 0.77). The most common age group in Group A was 40–49 years (43.6%), while in Group B, it was 50–59 years (36.4%).

No comorbidities were present in either group. All enrolled patients were ASA I or ASA II and were medically stable before surgery. No significant abnormalities were observed in preoperative laboratory investigations (CBC, RFT, LFT, coagulation profile). All values were within normal reference ranges.

Table-1: Basic characteristics

Characteristics	Group A (n=55) N (%)	Group B (n=55) N (%)	p-value
Age			
20-29	6 (10.9)	6 (10.9)	0.77
30-39	9 (16.4)	13 (23.6)	
40-49	24 (43.6)	13 (23.6)	
50-59	13 (23.6)	20 (36.4)	
60-69	3 (5.5)	3 (5.5)	
Sex			
Male	8 (14.5)	9 (16.4)	0.79
Female	47 (85.5)	46 (83.6)	
Weight (Kg)			
40-49	8 (14.5)	7 (12.7)	0.72
50-59	12 (21.8)	10 (18.2)	
60-69	15 (27.3)	20 (36.4)	
70-79	11 (20)	11 (20)	
80-89	9 (16.4)	7 (12.7)	
Duration of action	5.68 ± 0.58	100.49 ± 9.09	<0.001

Table 2: Comparison of Intubation score between groups

Score	Group A (n=55) N (%)	Group B (n=55) N (%)
Excellent (8-9)	55 (100)	48 (87.3)
Good (6-7)	0	7 (12.7)
Fair (3-5)	0	-
Poor (0-2)	0	-

P value 0.01

Table 3: Incidence of adverse effect between groups

Adverse effect	Group A (n=55) (%)	Group B (n=55) (%)
Post operative myalgia	7 (12.7)	0
None	48 (87.3)	55 (100)

P value 0.01

Group B has a significantly longer duration of action compared to Group A (p<0.001) There were no significant differences between Group A and Group B in terms of age, gender, or weight (p >0.05) (Table-2).

It was observed that, Group A (Suxamethonium) showed superior intubation conditions, with 100% of patients achieving excellent scores, compared to 87.3% in Group B (Rocuronium), which was statistically significant (p = 0.01) (24). However, 12.7% of patients in Group B exhibited "good" intubating conditions (Table-3).

In the present study, Group A has a higher incidence of postoperative myalgia (12.7%) compared to Group B (0%) (p=0.01). Group B shows no adverse effects, while 87.3% in Group A report no adverse effects (Table-4).

Heart Rate: After intubation, Group A shows a sharp increase in heart rate (peaking at 102.36) followed by a gradual decline. Group B shows a smaller increase (peaking at 92.95) with a more stable decline. The heartratewasfound to be decreased slightlyfrombaseline afterpremedication and then increased after muscle relaxant in both groups. But it gradually declined towards normal. On comparing these two groups, the rise in heartrate with injection Suxamethonium chloride was significantly more after intubation and5,10,15,20 minutes after intubation than with injection rocuronium bromide. (p value<0.05) **(Figure 1)**.

Systolic Blood Pressure: Both groups show a peak after intubation, but Group A has a higher systolic pressure spike (143.80) compared to Group B (135.19) The systolic blood pressure was found to be decreased slightlyfrombaseline after premedication and then increased after muscle relaxant in both groups. But it gradually declined towards normal after10 min.

On comparing these two groups, the rise in systolic blood pressure with injection Suxamethonium chloride was significantly more after intubation and5 min after intubation than with injection Rocuronium bromide. (p value <0.05) **(Figure 2)**.

Diastolic Blood Pressure: Group A shows a larger increase in diastolic blood pressure after intubation (90.62), while Group B peaks lower (82.38). The diastolic blood pressurewasfound to be decreased slightlyfrombaseline after premedication and then increased after muscle relaxant in both groups. But it gradually declined towardsnormalafter10 min. On comparing these two groups, the rise in diastolic blood pressure with injection Suxamethonium chloride was significantly more after intubation and5 min after intubation than with injection Rocuronium bromide (p <0.05) **(Figure 2)**.

Mean Arterial Pressure: Similar trends with Group A showing a higher increase post-intubation (107.31) compared to Group B (99.84), though both groups decline to near-baseline levels **(Figure 3)**.

Both groups experienced an increase in heart rate and blood pressure following intubation, but Group A exhibited more pronounced fluctuations. Heart rate and blood pressure peaks were significantly higher in Group A, with values normalizing within 10 minutes post-intubation (p <0.05 for HR, SBP, and DBP)

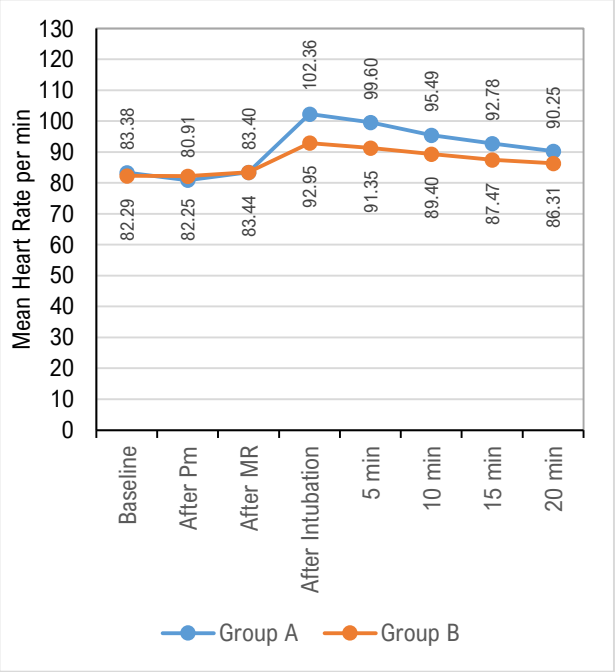

Figure 1: Effect on Heart Rate

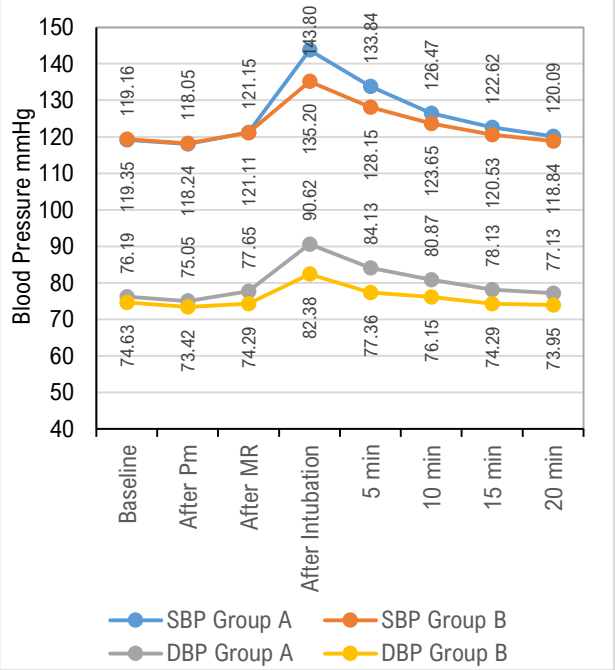

Figure 2: Effect on Systolic blood pressure and Diastolic blood pressure

DISCUSSION

Ensuring a quick and secure endotracheal intubation is an essential aspect of administering general anesthesia. Suxamethonium chloride (succinylcholine), a depolarizing muscle relaxant, has been the preferred choice for rapid sequence intubation (RSI) due to its rapid onset, ultra-short duration, and excellent intubating conditions.

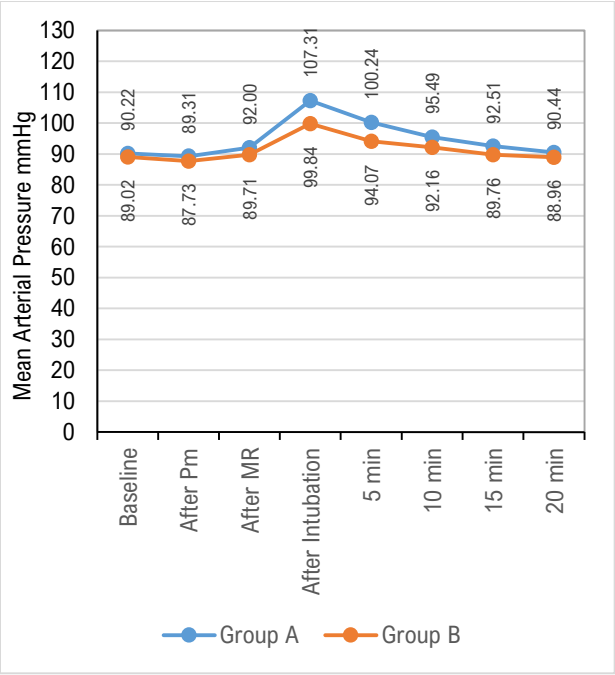

Figure 3: Effect on Mean arterial pressure

It is especially valuable in patients with anticipated difficult airways, those with full stomachs, and even in routine elective cases.

However, despite these pharmacokinetic advantages, Suxamethonium's use is often accompanied by undesirable side effects, including bradycardia, dysrhythmias, muscle fasciculations, postoperative myalgia, hyperkalemia, and increased intraocular, intra-abdominal, and intracranial pressure. Furthermore, it can occasionally trigger malignant hyperthermia, particularly in susceptible individuals.[9]

Rocuronium Bromide is a modern non-depolarizing neuromuscular blocking agent known for its fast onset, intermediate duration of action, and hemodynamic stability. Additionally, it does not trigger histamine release. Clinical studies, including the present study, suggest that Rocuronium provides intubating conditions and hemodynamic responses similar to Suxamethonium but without the adverse side effects commonly associated with the latter. Rocuronium's favorable profile has led to its increasing use as an alternative for RSI, though its higher cost and limited availability can restrict its routine use.[10]

Several studies, including our own, have demonstrated that Rocuronium rapidly produces clinically acceptable intubating conditions.[11] While its onset is slightly slower than Suxamethonium, Rocuronium offers a safer alternative in situations where Suxamethonium is contraindicated. Early animal studies indicated that Rocuronium's lower potency contributed to its quicker onset in comparison to older agents such as pancuronium and vecuronium. Later clinical research confirmed that Rocuronium acts faster than equipotent doses of atracurium and vecuronium but is slightly slower than Suxamethonium.[12,13]

Several clinical studies have demonstrated that Rocuronium induces neuromuscular blockade more rapidly than equipotent doses of atracurium and vecuronium, though its onset remains slightly slower than that of Suxamethonium.[14]

The dose of injection rocuroniumbromide have been used in range of 0.6-1.2 mg/kg in most of the studies. Ratan Singh et al. conducted a study that found no statistically significant difference in intubation conditions between Succinylcholine and Rocuronium at a dose of 1.2 mg/kg. However, Succinylcholine was considered clinically superior due to its shorter duration of action. At this high dose, the duration of action of rocuroniumbe comes prolonged and can result in an increased incidence of adverse outcomes.[15]

The study concluded that Rocuronium is marginally less effective than Succinylcholine in providing optimal intubation conditions. Therefore, Rocuronium may be a suitable alternative when Succinylcholine is contraindicated or when prolonged intubation is required.[15]

Bhandari et al. reported that administering Rocuronium at a dose of 0.6 mg/kg requires a waiting period of 90 seconds to achieve intubation conditions similar to those obtained with Succinylcholine.[16]

In our study the duration of surgeries included was around 1-2 hours, hence prolonged duration of action of becomes beneficial here and also decreases the need of maintenance dose of muscle relaxant. Hence the dose of injection rocuroniumbromide was selected as0.9 mg/kg.

Intubation Score: Our study evaluated intubating conditions using Cooper's four-point scale, and the findings align with previous research. Weiss et al. observed that administering Rocuronium at a dose of 0.9 mg/kg results in intubation conditions similar to those achieved with Suxamethonium at 1.5 mg/kg.[17] Similarly, Bunburaphong et al. found that different doses of Rocuronium (0.3 mg/kg, 0.6 mg/kg, and 0.9 mg/kg) produced clinically acceptable intubating conditions in 50%, 85%, and 95% of cases, respectively.[11] Kulkarni et al. also reported that Rocuronium at a dose of 0.9 mg/kg has a high likelihood of enabling successful rapid tracheal intubation, comparable to Suxamethonium at 1.5 mg/kg.[18]

In our study, 100% of patients in the Suxamethonium group achieved clinically acceptable (excellent or good) intubating conditions, while in the Rocuronium group, 87.3% of patients had excellent conditions and 12.7% had good conditions. This difference was statistically significant. These results align with the findings of Bhandari et al., who reported that 93.33% of patients receiving Rocuronium (0.9 mg/kg) achieved excellent intubating conditions, compared to 100% in the Suxamethonium (1.5 mg/kg) group.[16]

Duration of Action: In our study, the average duration of action for Suxamethonium was recorded as 5.68 ± 0.58 minutes, consistent with previous findings by Singh A et al. (5.3 minutes)[19], Bhandari et al. (5.4 ± 1.14 minutes) [16], and Shukla A et al. (7.5 ± 0.95 minutes) [20]. For Rocuronium, the mean duration of action was 100.49 ± 9.09 minutes, which aligns with results from Cooper RA et al. (83 and 93 minutes)[3] and Hemmerling TM et al. (77 ± 21 minutes)[21]. The longer duration of Rocuronium in our study could be influenced by variations in the depth of anesthesia, which may prolong the effect of muscle relaxants.

Hemodynamic Changes: Both Suxamethonium and Rocuronium were associated with transient increases in heart rate and blood pressure immediately after intubation, but these parameters returned to baseline within 10 minutes. However, the hemodynamic response with Suxamethonium was more pronounced than with Rocuronium. After intubation, both systolic and diastolic blood pressure, along with mean arterial pressure (MAP), were significantly elevated in the Suxamethonium group. In addition, the heart rate in the Suxamethonium group showed a significant increase post-intubation and remained higher at the 5, 10, 15, and 20-minute intervals when compared to the Rocuronium group. These findings suggest that Rocuronium offers greater hemodynamic stability, a result supported by studies such as those by Verma RK[22] and Ibemhal-Heisnam et al.[23].

Adverse Effects: In our study, 12% of patients in the Suxamethonium group experienced postoperative myalgia, a common side effect of depolarizing agents. No adverse effects were observed in the Rocuronium group. This aligns with earlier studies indicating that Rocuronium is linked to a reduced incidence of side effects, including myalgia, bradycardia, and histamine release. For study, Singh A et al. reported bradycardia in 10% of patients and laryngospasm in 5% with Suxamethonium[19]. Our findings confirm that Rocuronium is a safer alternative with a more favorable side effect profile, particularly in patients at risk of Suxamethonium-related complications.

CONCLUSION

Our study results indicate that Rocuronium (0.9 mg/kg) provides clinically acceptable intubation conditions similar to Suxamethonium (1.5 mg/kg), with the added advantages of better hemodynamic stability and fewer side effects. Although Suxamethonium continues to be the preferred agent for rapid sequence induction, Rocuronium offers a viable alternative in cases where Suxamethonium is contraindicated.

Author contribution: AW: Contributed to study conception, data collection, analysis, interpretation, and manuscript preparation, playing a pivotal role throughout the research. **AK:** Led study conception, design, data analysis, interpretation, and manuscript preparation, ensuring accurate presentation of findings. **SP:** Contributed to study conception, design, and manuscript preparation, aiding in shaping the research direction. **VD:** Involved in study conception, design, data collection, analysis, interpretation.

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