Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 32s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Comparison Of The Adductor Pollicis And Corrugator Supercilii As Indicators for Adequacy Of Neuro-Muscular Blockade Recovery With Train Of Four(Tof) For Tracheal Extubation

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Cite this paper as: Dr. Nagalla Shanmuka Gopinath, Dr. Kiran Velukuri, Dr. Chaitanya jakkam, Dr. Busetty Prithvi Raj, Dr. Kakani Vishnu Vandana, Dr. K. krishna chaithanya, (2025) Comparison Of The Adductor Pollicis And Corrugator Supercilii As Indicators for Adequacy Of Neuro-Muscular Blockade Recovery With Train Of Four(Tof) For Tracheal Extubation. *Journal of Neonatal Surgery*, 14 (32s), 2002-2007.

ABSTRACT

Background: Accurate assessment of neuromuscular blockade recovery is critical for safe tracheal extubation. Train-of-four (TOF) monitoring at different muscle sites, particularly the adductor pollicis (AP) and corrugator supercilii (CS), may vary in their ability to predict adequate recovery.

Aim: To compare the efficacy of AP and CS muscle monitoring using TOF in assessing adequate neuromuscular recovery for tracheal extubation.

Methods: A prospective observational study was conducted on 60 patients undergoing laparoscopic abdominal surgeries under general anaesthesia at Narayana Medical College. Patients were allocated into two groups: Group AP (n=30) received TOF monitoring at the adductor pollicis, and Group CS (n=30) at the corrugator supercilii. Anaesthetic management was standardized. Parameters including TOF ratio, BIS, hemodynamics, extubation criteria, and Ramsay sedation scores were recorded when TOF $\geq$ 0.9.

Results: There were no significant differences in demographic variables. However, at TOF 0.9, the CS group showed significantly lower BIS, heart rate, and blood pressure values ($p < 0.0001$), indicating deeper anaesthetic depth and better hemodynamic stability. Extubation criteria were met in 90% of the CS group and 92% of the AP group. Ramsay sedation scores were higher in the CS group, suggesting better sedation at similar TOF values.

Conclusion: Corrugator supercilii monitoring provides a reliable and earlier indication of adequate neuromuscular recovery and is associated with better hemodynamic and sedation profiles than the adductor pollicis. It is a superior site for TOF monitoring during emergence and extubation.

1. INTRODUCTION

Train-of-four (TOF) monitoring is gold standard for assessing the depth and recovery from neuromuscular blockade. Common monitoring sites include the adductor pollicis and corrugator supercilii muscles, innervated by the ulnar and facial nerves, respectively. The recovery of neuro muscular(NM) blockade differs from one muscle to another.[1] The sensitivity of different muscles to non-depolarizing neuromuscular blocking drugs varies.[1] Several differences are seen in the pharmacodynamics of neuromuscular block even between the adductor pollicis muscle and corrugator supercilii muscle, which are typical neuromuscular monitoring sites used during clinical anesthesia.[2] The respiratory and abdominal muscles tend to resist to a non-depolarizing neuromuscular block; therefore, it can be assumed that these centrally located muscles recover more rapidly from a neuromuscular block.[3] Monitoring at the corrugator supercilii may therefore be suitable during extubation from neuro muscular blockade, to prevent unintentional patient movements and tense abdominal muscles during

anesthesia.[4] Importantly, the time course of neuromuscular block induced at the corrugator supercilii accurately reflects that at the larynx[5] . NM blockade which reflects at the corrugator supercilii also reflects diaphragm[6]. Corrugator supercilii recovers earlier than other muscles and the faster recovery of neuromuscular function of the corrugator supercilii can assure optimum recovery from neuromuscular block better than that induced at the adductor pollicis.

We hypothesize that corrugator supercilii muscle monitoring using TOF is good predictor for assessing adequate neuromuscular recovery and better correlates with tracheal extubation.

2. MATERIALS AND METHODS

The prospective observational study was conducted at Narayana Medical College, Nellore, Andhra Pradesh, India, between June 3, 2023 and February 25, 2024, with the approval of the Institution's Ethics Committee. A total of 60 patients aged 18 to 60 years belonging to American society of anaesthesiologist ASA 1 & 2 undergoing laparoscopic cholecystectomy and laparoscopic hernia repair were enrolled in the study after obtaining informed and written consent. Patients who have declined to provide consent for surgery and with neuro muscular disorders are excluded from the study. All patients were informed about the study protocol, the assessment of muscle recovery by TOF and written informed consent was obtained during the Pre-anaesthetic Check. Allocation (n=60) was done with each group containing 30 members. 60 Members were Allocated into 2 groups of 30 members each. Group AP received adductor pollicis neuro-muscular monitoring with **TRAIN OF FOUR(TOF)** stimulation to the ulnar nerve. Group CS received corrugator supercilli N-M monitoring with **TRAIN OF FOUR(TOF)** stimulation to the temporal branch of the facial nerve. All standard anaesthesia protocol were followed and at the time of arrival in the operating theatre, ECG, pulse oximetry, and non- invasive blood pressure were monitored. No premedication was given, RL fluid was started and anaesthesia was induced by infusion of iv lignocaine 2% 1mg/kg/hr followed by propofol 2mg/kg, cisatracurium 0.2mg/kg. Patients were intubated with I-Gel 3 & 4 depending on the weight and maintained with sevoflurane 2 MAC & cisatracurium 0.02mg/kg. In all patients, **the bispectral index (BIS)** was also monitored using a mx550 philips intellivue patient monitor with a bis quatrotm sensor (aspect medical systems). Surface electrodes placed 3 to 5 cms distance over the external part of the superciliary arch for the CS(figure-1) and to the medial side of the volar aspect of forearm for the AP(figure-2). At the end of the surgery, Temporal branch of the facial nerve was stimulated for CS. The ulnar nerve was stimulated at the wrist for the AP. All nerves were stimulated with train-of-four (TOF) stimulation every 5min after last dose of muscle relaxant. Typical current intensity of 65mA for the facial nerve and for the ulnar nerve was used. The evoked responses at the thumb and near the eye were measured by **xavant stimpod nms450x nerve stimulator & TOF monitor.** BIS, heart rate, and systolic and diastolic arterial pressure were measured. When train of four (TOF) achieved value of 0.9, sedation score(Table-1) & extubation criteria were also assessed and extubated when train of four achieved value of 0.9. Our primary objective was to compare the corrugator supercilii and adductor pollicis muscle for adequate recovery from neuro muscular blockade with train of four (TOF). Our secondary objectives were to assess for hemodynamic variability, extubation criteria and sedation scores during muscle recovery in both the groups. Headlift > 5secs, PIP(peak inspiratory pressure) >20cm h20, spontaneous breathing, TV> 6ml/kg were assessed for extubation criteria.

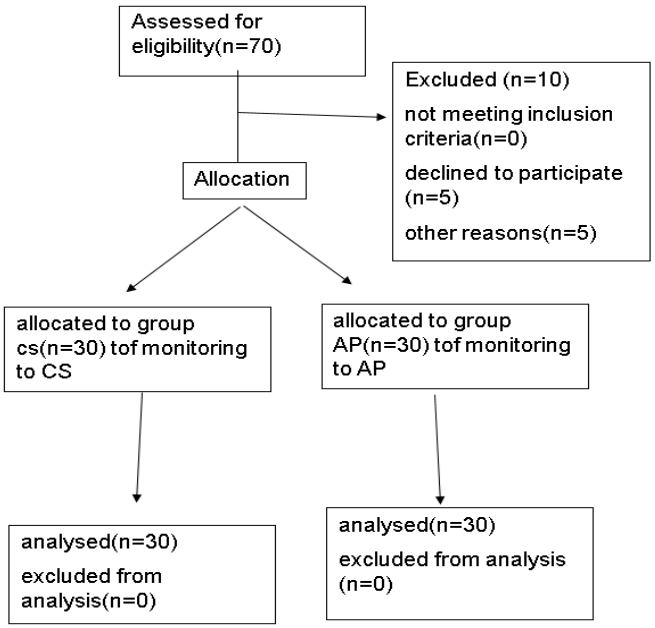
Figure:-1 Lead placement for corrugator supercilii

Figure:-2 lead placement for adductor pollicis

Table :- 1- Ramsay sedation score

Sedation level	Score
Patient is anxious and agitated or restless or both	1
Patient is cooperative, oriented and tranquil	2
Patient responds to commands only	3
Patient exhibits brisk response to light glabellar tap or loud auditory stimulus	4
Patient exhibits sluggish response to light glabellar tap or loud auditory stimulus	5
Patient exhibits no response	6

Consort diagram



3. STATISTICAL ANALYSIS

- All the recorded data was entered into MS excel software.
- Statistical analysis was done using SPSS version 25 software and continuous variables were presented as mean and standard deviations.
- P- values were calculated using student t- test.
- P-values of <0.05 is considered as statistically significant.

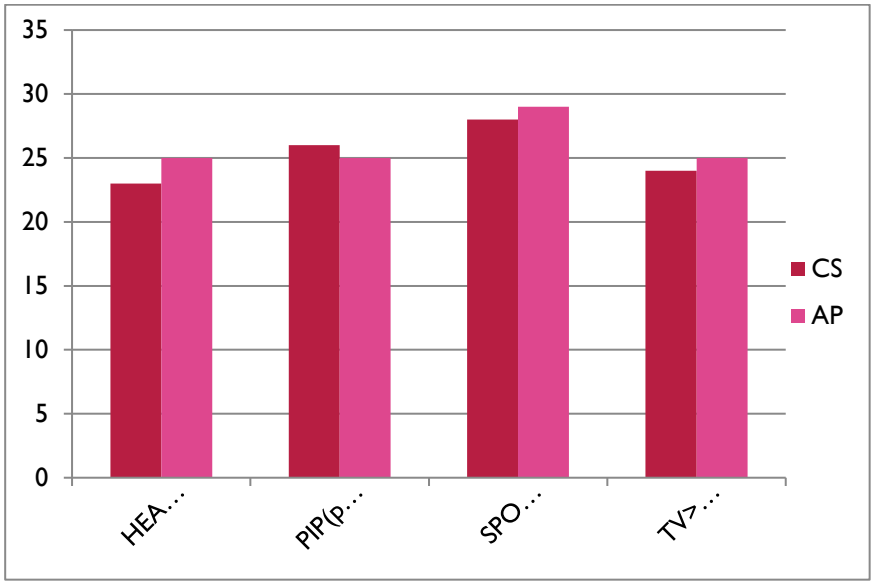
4. RESULTS

Our study didn't show any statistical difference in terms of age, BMI, gender distribution and ASA status of patients.

Table 2:- THE BIS, HR, SYSTOLIC & DIASTOLIC BP WHEN TOF ACHIEVED 0.9

	Group	MEAN	Std. Deviation	p-value
BIS	AP	86.60	5.096	<0.0001
	CS	69.13	7.842	
HR	AP	97.867	9.5040	<0.0001
	CS	76.787	9.5468	
Systolic BP	AP	139.26	12.23	<0.0001
	CS	108.36	9.32	
Diastolic BP	AP	91.90	8.70	<0.0001
	CS	78.46	8.53	

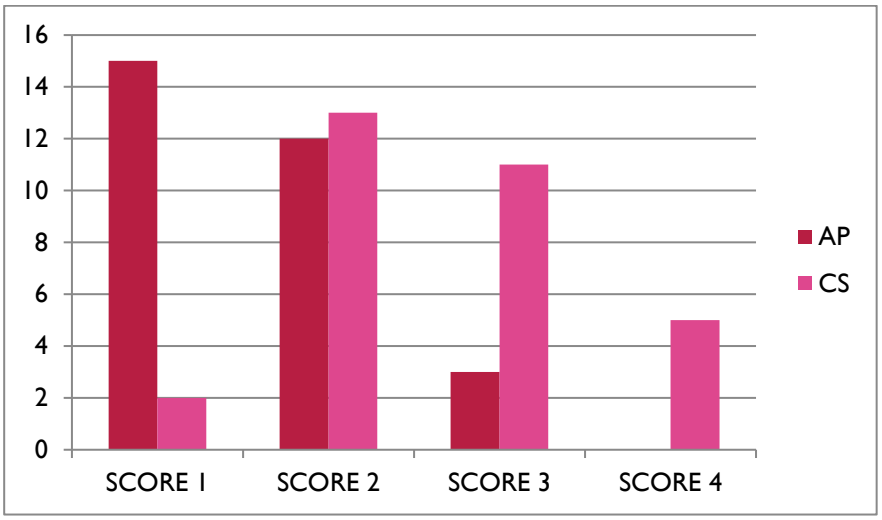
In the present study, we found that when TOF achieved 0.9 HR, BIS, Systolic BP, Diastolic BP shows significant difference between AP and CS group. When TOF achieved 0.9 in both the groups, Mean BIS values in group AP are 86.60 ± 5.096 and group CS are 69.13 ± 7.842 (p = <0.0001). Mean HR values in group AP are 97.867.60 ± 9.5040 and group CS are 76.787± 9.5468 (p = <0.0001). Mean systolic BP values in group AP are 139.26 ± 12.23 and group CS are 108.36 ± 9.32 (p = <0.0001). Mean diastolic BP values in group AP are 91.90± 8.70 and group CS are 78.46 ± 8.53 (p = <0.0001).



Graph 1:- Comparision of CS and AP group in terms of extubation criteria when TOF achieved 0.9

In the present study, we found that when TOF achieved 0.9, 90% of CS group achieved head lift, PIP(peak inspiratory pressure) >20cm h20, spontaneous breathing, TV>6ml/kg and met the extubation criteria where as 92% of AP group

achieved head lift, PIP(peak inspiratory pressure) >20cm h20, spontaneous breathing, TV>6ml/kg and met with extubation criteria.



Graph 2:- Comparision of CS and AP group in terms of Ramsay Sedation Score when TOF achieved 0.9

In the present study, we found that when TOF achieved 0.9, group CS showed higher sedation scores compared to AP group.

5. DISCUSSION

Neuromuscular blockade monitoring plays a vital role in modern anaesthesia practice to ensure safe extubation and recovery. While the adductor pollicis (AP) has traditionally been the standard site for TOF monitoring, increasing evidence suggests that the corrugator supercilii (CS) may provide a better reflection of upper airway muscle recovery, which is crucial for safe extubation. This study compared the utility of the adductor pollicis (AP) and corrugator supercilii (CS) muscles as indicators of neuromuscular recovery using train-of-four (TOF) monitoring.

Our findings demonstrated that TOF recovery at the CS site was associated with significantly lower BIS values, heart rate, and blood pressure, indicating a more profound level of sedation and autonomic stability at the point of TOF ratio reaching 0.9, compared to the AP group. This suggests that patients in the CS group were less responsive and possibly more adequately recovered from surgical stimulation, despite meeting the same TOF criterion.

The corrugator supercilii reflects recovery in muscles that are innervated similarly to the diaphragm and larynx, both of which are crucial for respiratory and airway protection. As such, TOF monitoring at the CS may offer a more clinically relevant indicator of recovery in relation to airway muscle function than the AP, which recovers later and reflects distal skeletal muscle activity.

Furthermore, extubation criteria such as sustained Head lift > 5sec, PIP(peak inspiratory pressure)>20cm h20, tidal volume >6ml/kg, and spontaneous breathing were more consistently achieved in the CS group at TOF 0.9. Although the difference in meeting these criteria was marginal (90% vs. 92%), the trend favours CS monitoring as a more sensitive and earlier indicator of neuromuscular recovery.

Another significant finding was the higher Ramsay sedation scores in the CS group, indicating better sedation at TOF 0.9. This may help prevent agitation, coughing, or hemodynamic instability during emergence and extubation.

These results are in line with earlier studies by Claudius et al[7] who noted that the CS muscle recovers faster than the AP and correlates more closely with recovery of upper airway muscle tone. Given that residual neuromuscular blockade can lead to serious complications like hypoventilation or airway obstruction, selecting a monitoring site that reflects airway muscle recovery is clinically relevant.

Till now no study was done to detect adequate muscle recovery for tracheal extubation with the TOF. H.J. Lee, K.S. Kim et al[8] compared adductor pollicis and corrugator supercilli as indicators of adequacy of muscle relaxation for tracheal intubation and observed that monitoring of CS group allows intubation earlier than that of AP group.

The present study supports the use of corrugator supercilii muscle as a superior indicator for neuromuscular recovery during extubation when compared to the adductor pollicis. TOF monitoring at the CS site not only corresponds with favorable hemodynamic and sedation parameters but also better predicts the return of protective airway reflexes. Incorporating CS-

based TOF monitoring may enhance patient safety during emergence from anesthesia, especially in laparoscopic surgeries where optimal muscle tone recovery is critical.

6. CONCLUSION

The corrugator supercilii muscle is a reliable predictor of neuromuscular blockade recovery and shows effective correlation with laryngeal muscles and diaphragm for tracheal extubation.

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