

Relationship of Train-of-Four (Neuromuscular Monitoring) With Head Lift for Five Seconds During Emergence From General Anesthesia

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ABSTRACT

Objective: To establish relationship between train-of-four ratio and clinical signs including head lift during emergence from general anesthesia.

Study Design: Cross Sectional Study.

Place and Duration of Study: Combined Military Hospital, Rawalpindi Pakistan, from Apr to Sep 2021.

Methodology: A total of 93 patients with age range 18–60 years and ASA (American society of Anesthesiologist's) physical Status I or II undergoing an elective procedure lasting more than 60 minutes under general anesthesia were included in study. Train-of-four ratio was calculated using a nerve stimulator at the time of extubation followed by the appearance of each clinical sign.

Results: Of 93 patients 63(67.7%) were males while 30(32.2%) were females with mean age 35.6±12.5 years. 77(82.7%) patients were graded as ASA-I and 16(17.2%) were graded as ASA-II. The mean duration of surgery was 83.5±8.3 mins however the mean TOFR was 0.35±1.1. At the appearance of each clinical sign mean TOFR was calculated and recorded. The results showed significant relationship between clinical signs (sustained head lift, ability to retain tongue depressor, hand grip 60% of control and ability to cough) and Train-of-four ratio.

Conclusion: There is a significant relationship between clinical signs (sustained head lift, ability to retain tongue depressor, hand grip 60% of control and ability to cough) and Train-of-four ratio.

Keywords: Nerve Stimulation, Neuromuscular, Neurological Manifestations, Signs and Symptoms, Train-of-four ratio.

How to Cite This Article: Haider SZ, Iqbal MR, Adil M. Relationship of Train-of-Four (Neuromuscular Monitoring) With Head Lift for Five Seconds During Emergence From General Anesthesia. *Pak Armed Forces Med J* 2024; 74(3): 763-766. DOI: <https://doi.org/10.51253/pafmj.v74i3.8772>

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INTRODUCTION

Operative procedures requiring general anesthesia requires effective muscle relaxation making neuromuscular relaxants vital during the induction of anesthesia.¹ Recovery from these relaxants are the mainstay of smooth recovery after general anesthesia. Train-of-four method came into use in late 70's. A train-of-four (TOF) refers to four supramaximal stimulus delivered at 0.5 seconds interval which in turn result in four measurable muscle twitches (T1, T2, T3 and T4). The use of train-of-four ratio (TOFR) was derived from certain clinical signs including the ability to open eyes, ability to cough, attain vital capacity of 15-20ml/kg and sustained head lift for 5 days. Train-of-four ratio along with monitoring of clinical signs is an effective modality used during the recovery phase of anesthesia and after recent researches a TOFR of >0.9 implies adequate return neuromuscular function.^{1,2} Anesthesiologists assess the adequacy of neuromuscular function by recovery of clinical signs

such as head lift for 5 seconds, grip strength, ability to clench teeth, ability to cough and protrude tongue etc.^{3,4} An increased number of patients emerging from general anesthesia still shows high incidence of post operative residual blockade, residual paralysis and hence increase morbidity and mortality in the recovery room.⁵ Clinical knowledge of neuromuscular blocking agents and steps in treating neuromuscular residual blockade is compulsory for anesthesia provider. Previous studies have shown that a large number of patients are intubated before adequate muscle relaxation is achieved and a large number of patients were extubated before adequate recovery of neuromuscular function which makes the use of quantitative neuromuscular monitoring very useful in decreasing the risk of airway complications and life threatening situations in the post anesthesia care units.^{6,7} Nerve stimulators are widely used for monitoring of TOFR but these devices are not routinely available in hospitals located at the peripheries which increases the incidence of adverse events in the post operative period.⁸ These devices have two stimulating electrodes (black and red). Two muscles (Adductor pollicis and Orbicularis oculi) are

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Received: 23 May 2022, revision received: 25 Jun 2022; accepted: 30 Jun 2022

mainly stimulated for tactile evaluation. Fade of twitches are observed and then T4 twitch is compared to T1 twitch and ratio T4:T1 is obtained.^{9,10} The use of clinical signs vs TOFR and other objective monitoring have been studied by various researchers with the aim to decrease the incidence of residual paralysis in Post-Anesthesia Care Unit (PACU) with a general consensus that all the patients undergoing surgery under general anesthesia should be monitored objectively by the use of a nerve stimulator along with clinical signs to reduce the morbidity and mortality.⁸

The objective of the study is to evaluate the use of clinical signs and compare it with objective monitoring using Train-of-four ratio (using 0.7 as a test value) during emergence from general anesthesia.

METHODOLOGY

The cross-sectional study was conducted at Department of Anesthesiology Combined Military Hospital, Rawalpindi, Pakistan, from April to September 2021. The study protocols were approved by Hospital Ethical Review Committee (ERB Ser No 236) prior to commencement of study.

Inclusion criteria: Patients aged 18-60 years with ASA (American Society of Anesthesiologists) physical Status I or II undergoing an elective procedure lasting more than 60 mins under GA (general anesthesia) were included.

Exclusion criteria: Patients suffering from neuromuscular, hepatic or renal disease diseases or taking any kind of medications which interacts with neuro muscular functioning or electrolyte balances and patients with difficult intubations were excluded.

A total sample size of 60 was estimated by using WHO sample size calculator. Non-probability consecutive sampling was used for data collection. Informed written consent was obtained from all the participants. Preoperative anesthesia assessment was done as per the hospital guidelines through history taking, clinical examination and relevant investigations. Preparation was done a day before procedure by keeping the patient nil per oral (NPO) for at least 08 hours before the surgery, followed by assessment by a classified anesthesiologist on the day of surgery before shifting the patient to the operation theatre.

On the day of surgery, patients were shifted to operation theatre and standard ASA monitoring including pulse oximetry, ECG, blood pressure monitoring and temperature probe was attached to the

patients. Before attaching neuromuscular monitor, the patient was counselled and explained about the procedure. Neuromuscular monitoring was done using a peripheral nerve stimulator (Life -Tech EZstim II MODEL ES400) with its two electrodes placed on the ulnar nerve i.e. negative (black) electrode on the proximal crease of the wrist and the positive (red) electrode 3cm proximal to it and baseline TOFR was recorded prior to induction. Prior to anesthesia induction, patient was pre-medicated with injection nalbuphine 0.1mg/kg, injection dexamethasone 0.08mg/kg and metoclopramide 0.1mg/kg via an 18-gauge cannula. This was followed by induction of anesthesia with propofol 1.5 mg/kg and intermediate neuromuscular blocker i.e., atracurium 0.5mg/kg at the time of intubation and preoxygenation for 3 minutes. Maintenance of anesthesia was done by using Isoflurane 1-2 MAC and by atracurium 0.1mg/kg for every 25-30 minutes.

After completion of the procedure reversal was done using 50mcg/kg of neostigmine and 10mcg/kg of glycopyrrolate as per the hospital protocol i.e., when the patient was able to perform purposeful body movements and could make a tidal volume of approx. 150ml. At the time of extubation TOFR0 was recorded and for subsequent appearance of clinical signs corresponding TOFR was recorded i.e., TOFR1 - eye opening, TOFR2 -tongue protrusion, TOFR3- Sustained Head Lift for 5 seconds, TOFR4 - Ability to retain tongue depressor, TOFR5 -hand grip 60% of control, TOFR6 - ability to cough. The best of 3 recordings at each clinical sign were documented. Table-I shows percentage of neuromuscular blockade at each TOF count.

Patient's demographic and clinical data was recorded on pre-designed proforma. Data was analyzed using Statistical Package for Social Sciences (SPSS) version 26. Qualitative variables were analyzed as frequency and percentage while mean and standard deviation were used for continuous variables. The mean values of TOF were compared against each clinical sign using one-sample t-test keeping the *p*-value of ≤ 0.05 was considered significant.

RESULTS

Of 93 patients enrolled in the study, 63(67.7%) were males while 30(32.2%) were females with male to female ratio of 2.1:1. The mean age of patients were 35.6 ± 12.5 years. 77(82.7%) patients were classified as ASA-I while 16(17.2%) patients were graded as ASA-II as shown in Table II.

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The mean duration of surgery was calculated as 83.5±8.3 mins. At the appearance of each clinical sign, mean TOFR was calculated as given in Table-III.

The results showed significant relationship between all clinical signs including eye opening, tongue protrusion, sustained head lift for 5 seconds, ability to retain tongue depressor, hand grip 60% of control and ability to cough when a test value of 0.7 was used.

Table-I: Residual Neuromuscular Blockade at Different Tof Count 5

Train-of-four count	% Neuromuscular Blockade
4	0 - 75%
3	75%
2	80%
1	90%
0	100%

Table-II: Demographic Data and American Society of Anesthesiologists (Asa) Classification of Respondents (N=93)

Characteristics	n(%age)
Age (Mean±SD)	35.6±12.5 yrs
Gender	
Male	63(67.7%)
Female	30(32.3%)
ASA Status	
ASA-I	77(82.7%)
ASA-II	16(17.2%)

Table-III: Relationship between Train-Of-Four Ratio (TOFR) and Clinical Signs (Test Value 0.7)(n=93)

Clinical Signs	Mean±SD	p-value
Eye opening	0.567±0.1014	<0.001
Tongue protrusion	0.642±0.0803	<0.001
Sustained head lift for 5 sec	0.756±0.0673	<0.001
Ability to retain tongue depressor	0.836±0.0436	<0.001
Hand Grip	0.832±0.0652	<0.001
Ability to cough	0.912±0.0254	<0.001

DISCUSSION

This study was done to evaluate the significance of neuromuscular monitoring via a nerve stimulator and the reliability of the clinical signs to decrease post operative residual paralysis. Results of the study revealed a significant impact of TOFR in assessing the return of neuromuscular function after surgical procedures and a significant correlation with a few clinical signs as opposed to others.

TOFR of >0.9 reliably signifies the return of muscle function and none of the clinical signs can effectively demonstrate the same signifying a reliable result hence decreasing the post operative

complications.¹² Debaene B *et al* demonstrated in his study that even TOFR of 0.9 is not adequate to confirm the safety of airway after extubation thus a better approach is to assess both the clinical signs and use of TOFR for a better outcome.¹³

In another study TOFR was measured at upper and lower limbs with different devices and readings obtained from the upper limb were more reliable as compared to those obtained from the lower limb.¹⁴ TOFR is measured using a nerve stimulator by giving four stimuli after intervals and measuring the response of the first and the fourth stimuli followed by calculating the ratio between the two responses.¹⁵ Saitoh *et al.* concluded from his study that the absence of fading after stimulation of the index finger with a nerve stimulator is a reliable indicator of the return of neuromuscular activity at emergence of anesthesia.⁶ Another study revealed the same result with TOFR as a more useful tool to decrease the airway complications by signifying adequate return of muscle power hence stressing the use of nerve stimulator to decrease the mortality and morbidity during emergence from surgeries.¹⁶

A consensus was made by a team which concluded that clinical signs of recovery can be used in regions where nerve stimulator was not present, but they should not be used in favor of objective monitoring and a nerve stimulator must be used for all the procedures in which the patients have received a neuromuscular blocker.¹⁷ A strategy aimed at assessing the recovery with the use of only clinical signs is not adequate and TOF monitoring should be used wherever available and applicable according to the study done by Wardhana A *et al.* However, use of clinical signs as indicators of recovery where nerve stimulator are not available still can reduce the number of complications.¹⁸

Residual neuromuscular blockade has an incidence of 33.4% and most of the anesthetists show lack of knowledge to the use of a nerve stimulator in different setups.¹⁷ The knowledge and use of nerve stimulator and its different modalities by every anesthetist is pivotal in decreasing the complications and prompt detection of airway complications but due to the unavailability of such equipment in peripheries clinical signs are reliable indicators in predicting the return of muscle function thus reducing the number of complications. All of these findings are in line with the results of our study.

CONCLUSION

We found that there is a significant relationship between clinical signs (sustained head lift, ability to retain tongue depressor, hand grip 60% of control and ability to cough) and TOFR. Clinical signs are reliable indicators when used to a corresponding TOFR of 0.7, signifying adequate recovery of return of neuromuscular function. However, nerve stimulator as shown by multiple studies still has a role superior to these clinical signs in prediction of adequate recovery after anesthesia.

Conflict of Interest: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

SZH & MRI: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

MA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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