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## A comparison of train of four monitoring and double burst stimulation to assess residual neuromuscular blockade

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### Abstract

**Background and Aim:** After introduction of train of four (TOF) monitoring residual neuromuscular blockade was reduced but without quantitative recording of evoked response it is difficult to estimate the TOF ratio. Thus, when TOF ratio is recovered to more than 0.4 -0.5 fade in response cannot be identified visually or manually. To overcome this double burst stimulation (DBS) was introduced. The aim of this study is to assess whether DBS is more sensitive than TOF in assessing neuromuscular blockade.

**Methods:** 55 patients, aged 18 to 60 years undergoing elective surgery under general anaesthesia using endotracheal intubation where randomised selected. Neuromuscular transmission was not monitored until following reversal of neuromuscular blockade. Following neostigmine administration, TOF stimulation was given with 50mA every 30 seconds. DBS was given only when there was absence of fade of TOF. if fade is present in DBS stimulation was given every 30 seconds till there was no fade.

**Results:** In our study the duration from TOF equal to DBS equal varied from 2.6 minutes to 6.7 minutes with mean of 4.6minutes. More number of patients were extubated on DBS equal group.

**Conclusion:** DBS is more helpful than TOF in detecting residual neuromuscular blockade.

**Keywords:** Residual paralysis, train of four, double burst stimulation, neostigmine

### Introduction

Post operative residual neuromuscular blockade is a common finding in anaesthesia practice with incidence ranging from 26% to 88% (Fortier *et al.* 2015) [1]. After the introduction of TOF monitoring in 1970 (Ali, Utting, and Gray 1970) [2], residual neuromuscular blockade was defined as TOF ratio <0.7 (Cammu 2020) [3]. TOF stimulation is the most common mode of peripheral nerve stimulation used during general anaesthesia. But without quantitative recording of the evoked response, it is difficult to estimate the TOF ratio. Thus, when the TOF ratio has recovered to more than 0.4-0.5/ fade in the response cannot be identified visually or manually with sufficient accuracy to exclude residual curarization (Engbæk, Østergaard, and Viby-Mogensen 1989) [4]. To overcome this technique of DBS was introduced. It consists of two short tetani which are seen and felt as two contractions. Various stimulus pattern has been used, but best results are obtained with two 50Hz trains of 60ms duration, 750ms apart (McGrath and Hunter 2006) [5]. This study was done to assess whether DBS is more sensitive than TOF in assessing neuromuscular blockade

### Methodology

After getting institutional approval, 55 patients aged (18-60years), ASA physical status 1 & 2, were studied during elective surgical procedure under general anaesthesia using endotracheal intubation & controlled ventilation. Patients with post-surgery intensive care admission, BMI >35kg/m<sup>2</sup>, Hepatic & renal disease, Drugs that interfere with neuromuscular transmission, any contraindication or known allergy to neostigmine or atropine, Hypothermia patients were excluded from the study.

Patients were monitored with 3 lead electrocardiography, pulse oximetry, non-invasive blood pressure and nasopharyngeal temperature. IV access was established. All patients are premedicated with midazolam 0.05mg/kg and glycopyrrolate 0.01mg/kg. Neuromuscular transmission was not monitored during anaesthesia until following reversal of neuromuscular blockade.

Patient was induced with propofol 2mg/kg IV, fentanyl 2mcg/kg IV and vecuronium 0.1mg/kg IV followed by intubation with appropriately sized cuffed endotracheal tube. Anaesthesia will be maintained with isoflurane with delivery gas; N2O/O2 in the ratio of 50:50 and muscle relaxant provided throughout the surgery with IV vecuronium. The last dose of vecuronium was given 30 to 40 minutes before the reversal of neuromuscular blockade and time was noted. Towards the end of surgery all anaesthetics were cut off. A peripheral nerve stimulator having both TOF and DBS mode was attached over the patient's ulnar nerve at the wrist. The time of administration of neostigmine and the dose of neostigmine were all judged by concerned anaesthesiologist. Neuromuscular blockade was reversed with neostigmine and glycopyrrolate. Time at which neostigmine given was noted.

Following neostigmine administration, TOF stimulation was given with 50mA every 30 seconds. The TOF was visually evaluated. At this moment the clinical recovery of the patient was evaluated by noting the patient's ability to open eyes, mouth, and grip the examiner's hand.

- Co: No clinical sign present
- C+: One sign present
- C++: Two signs present
- C+++: Three signs present

Whether the patient's trachea was extubated or not, was also noted

DBS was given only when there was absence of fade of TOF. If fade was present on DBS, the stimulation was given every 30 seconds, till there was no fade (DBS D2/D1=1). The time at which fade disappeared was noted. At this context the clinical status of the patient was again noted by evaluating the patient's ability to open eyes, mouth and grip the examiner's hand. The patient's trachea was extubated or not was also noted.

**Results**

We studied a total number of 55 patients. In all the patients TOF and DBS were compared. Characteristics of the

patients like age, height, weight, body mass index, sex, ASA physical status and type of surgery were presented in (Table 1).

Observations like duration of surgery, time of last vecuronium to neostigmine, time between neostigmine to TOF equal, TOF equal to DBS equal, neostigmine to DBS equal, TOF value and DBS value was also noted The time from TOF equal to DBS equal varied from 2.6 minutes to 6.7 minutes with mean of 4.6 minutes (Table 2).

The relationship between clinical signs of recovery with TOF and DBS equal, extubation was noted (Table 3). The percentage of patient extubated when DBS equal was 85.4% whereas percentage of patient extubated when TOF equal was 14.5% (Table 4).

Correlation analysis was done between duration of anaesthesia and time when TOF was equal and duration of anaesthesia and time when DBS was equal. It was found that there was a linear correlation between the duration of anaesthesia and recovery from neuromuscular blockade as revealed by TOF and DBS monitoring (Table 5). No correlation was found between the duration from the last dose of pancuronium and the recovery after reversal with intravenous neostigmine. (Table 6).

**Table 1:** Basic characteristics

Demographic data	Mean
Age	41.4
Weight(Kgs)	63.9
Height (cms)	157.1
BMI	25.8

**Table 2:** Perioperative data

Observations (durations)	Mean	Standard deviation
Duration of surgery (min)	137.4	25.6
Time of last vecuronium to neostigmine	31.8	3.6
Neostigmine to tof equal	4.7	0.9
Tof equal to dbs equal	4.6	0.8
Neostigmine to dbs equal	9.3	1.2
Tof value (%)	94.6	3.6
Dbs value (%)	92.7	5.7

**Table 3:** Shows Clinical status and Tof equal & dbs fade

Clinical status	Tof equal & dbs fade				Tof & dbs equal			
	No of patients	Percentage	No of patients extubated	Percentage	No of patients	Percentage	No of patients extubated	Percentage
C0	19	34.5	0	0	10	18.1	1	1.81
C+	2	3.6	0	0	1	1.8	1	1.81
C++	3	5.5	0	0	3	5.5	3	5.5
C+++	31	56.4	8	14.5	41	74.5	42	76.3

**Table 4:** No of patients extubated and Percentage

Mode	No of patients extubated	Percentage
TOF	8	14.5
DBS	47	85.4

**Table 6:** Correlation between duration of anaesthesia and last dose of neostigmine

Mode	'r' value	'p' value
TOF	0.01	>0.05
DBS	0.21	>0.05

**Table 5:** Correlation between duration of anaesthesia and recovery from neuromuscular blockade

Mode	'r' value	'p' value
TOF	0.70	<0.05
DBS	0.10	<0.05

**Discussion**

The recovery from neuromuscular blockade following reversal with intravenous neostigmine is usually evaluated clinically. But this clinical assessment may not always be reliable. In many patients, clinical signs may be absent even when the recovery from the neuromuscular blockade is complete. To overcome these drawbacks monitoring of

neuromuscular function with a peripheral nerve stimulator is always recommended. Train-of-four was the mode of peripheral nerve stimulation widely used so far to evaluate the adequacy of recovery. Due to the difficulty in clinically (manually or visually) evaluating the fade on TOF, DBS was introduced.

In our study of 55 patients we found that all the patients had fade on DBS when TOF was equal. In our study the duration from TOF equal to DBS equal varied from 2.6 minutes to 6.7 minutes with mean of 4.6 minutes (Table 2). And also, more number of patients had all the clinical signs of recovery when DBS was equal than when TOF was equal 41 vs 31 (Table 3). More number of tracheas were extubated on the DBS equal group than the TOF equal group 47 vs 8 (Table 4). From this it is clear that DBS is more reliable than TOF in assessing complete recovery from neuromuscular blockade

### Conclusion

Duration of anaesthesia has definite correlation with reversal of neuromuscular blockade; the more the duration of anaesthesia, the greater the residual block following reversal with I.V. neostigmine.

DBS is more helpful than TOF in detecting residual neuromuscular blockade.

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