# Neuromuscular Transmission

Title: TRAIN OF FOUR ASSESSMENT AT VARIOUS MONITOR CURRENTS

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Introduction. Perioperative assessment of neuromuscular function by peripheral nerve stimulator is considered to be a highly reliable means for monitoring the extent of neuromuscular blockade. Several authors report that a supramaximal stimulus is required to recruit the number of fibers necessary to achieve optimal twitch response.[1] In recent years, the train of four (TOF) has been employed in order to facilitate interpretation of twitch responses; however, it has been stated that this, too, should be evaluated with supramaximal stimuli.[2] The present study sought to determine the actual output of the blockade monitors routinely employed at our institution and if indeed a supramaximal stimulus is required for accurate TOF testing.

Methods. Part A: Eight peripheral nerve stimulators of four different designs were randomly selected from the operating rooms at our institution. The 8 monitors were tested by interfacing the positive and negative terminals (active to red; ground to black) with a Tektronix 7603 oscilloscope. Oscilloscope controls were set for a pulse width of 2 msec with a voltage division to 5 volts. To assure uniform tracings, the triggering amplifier was set to automode with AC coupling and internal source. A decade box provided variable resistances ranging from 500 to 1500 ohms in 500 ohm increments (to approximate the normal skin resistance when using surface electrodes with coupling gel). For each test, the blockade monitor was set to the maximal voltage output in the 0.5 Hz twitch mode. Each monitor was tested at 500, 1000 and 1500 ohms impedances. By using Ohm's Law the current was determined by dividing the voltage by the resistance (I = E/R).

Part B: Following approval of the institutional Human Investigation Committee, train of four (TOF) neuromuscular responses to a series of 20, 30 and 50 mA stimuli (Digistim III PNS, Neuro Technology Inc., Houston, TX) were assessed in 64 postoperative patients. Responses were quantified with a Medar APM adductor pollicis monitor (Medar Corp., Scarsdale, NY) interfaced to a strip chart recorder. The patients were divided into 3 groups: Group 1 which consisted of 10 patints who received no non-depolarizing muscle relaxants and were considered the controls. Group 2 consisted of 16 patients who had received non-depolarizing relaxants and had a $T_4/T_1$ ratio of greater than 0.95; and Group 3 consisted of 38 patients who had received non-depolarizing relaxants and demonstrated a $T_4/T_1$ ratio of less than 0.95. In each group, the twitch height and the $T_4/T_1$ ratio then were recorded at 20, 30 and 50 mA. The data at each amperage was expressed as mean $\pm$ 1 SD and analyzed by ANOVA; $P < 0.05$ was considered statistically significant.

Results. Part A. The output for the different nerve stimulators ranged from 16 to 64 mA. However, each of the eight nerve stimulators tested was able to maintain a nearly constant current output at the three different resistances. A coefficient of variation was determined for each monitor and averaged 4.5% with a range of 2-8%

Part B. The table illustrates the twitch height and $T_4/T_1$ ratio for the Group 3 patients. Although the twitch heights were significantly different in each individual group at 20, 30, and 50 mA ($p<0.05$), there was no statistical difference between the twitch heights at 20 mA among the three groups. Similarly, no statistical difference was evident in the twitch between the three groups at 30 mA and 50 mA.

In each of the three groups, there was no statistical difference in the $T_4/T_1$ ratios at the three different amperages. In addition, there was no statistical difference in the $T_4/T_1$ ratio between Group 1 (controls) and Group 2 ($T_4/T_1 > 0.95$). However, Group 3 ($T_4/T_1 < 0.95$) evidenced statistically significant differences ($P < 0.05$) in $T_4/T_1$ when compared to both Group 1 and Group 2 at each of the three amperages.

Discussion. Mylrea et al demonstrated a large variability in the degree of current output by various nerve stimulators.[3] This was confirmed by Part A of our study. Ali et al[3] has also stated that supramaximal stimulus (50mA) is necessary to properly assess neuromuscular function. Although the current generated by different nerve stimulators varies greatly, we have demonstrated that in the normal range of resistances (500-2000 ohms), each nerve stimulator maintained an almost constant current output. We further demonstrated that the $T_4/T_1$ ratios were significantly different between Group 3 and Groups 1 and 2. However, the $T_4/T_1$ ratio was statistically the same in each group regardless of the mA used in testing. Therefore, accurate assessment of $T_4/T_1$ ratio can be accomplished without a supramaximal stimulus and with virtually any properly functioning nerve stimulator.

References.

1. Epstein RA, Epstein RM: The electromyogram and the mechanical response of indirectly stimulated muscle in anesthetized man following curarization. Anesthesiology 38:212-223, 1973

2. Ali HH, Savarese JJ: Monitoring of neuro muscular function. Anesthesiology 45:216-249, 1976

3. Mylrea KC, Hameroff SR, Calkins JM, et al: Evaluation of peripheral nerve stimulators and relationship to possible errors in assessing neuromuscular blockade. Anesthesiology 60:464-466, 1984

Group III: Results

| | Twitch Height | T4/T1 |
|---|---|---|
| 20 mA | 9.75 $\pm$ 8.2 | 76.72 $\pm$ 19.4 |
| 30 mA | 14.69 $\pm$ 9.3 | 76.44 $\pm$ 19.3 |
| 50 mA | 17.21 $\pm$ 9.8 | 74.50 $\pm$ 17.2 |