Comparative Investigation of TOF-Watch SX and a New Electromyography Based Neuromuscular Monitor, the TetraGraph

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ABSTRACT

Background: Management of intraoperative neuromuscular (NM) blockade based on objective NM monitoring decreases the incidence of postoperative residual NM blockade. However, the most widely used acceleromyography based (AMG) NM monitors have limitations that make it unpopular among anesthesiologists. These include the lengthy set-up time, the need to use a preload and secure the hand in the supine position to obtain precise measurements (Fig. 1). Electromyography (EMG) based NM monitors are reported to be free of most of these limitations. In addition, EMG monitors reflect the function of the neuromuscular junction itself. The aim of the present study was to compare the accuracy and performance of the prototype of a new, EMG-based, battery-powered NM monitor (TetraGraph, Senzime AB, Sweden) to the most widely used, AMG-based TOF-Watch SX device in a two-arm pilot study (Fig. 2).

Methods: The study was approved by the Hungarian Office of Health Authorization and Administrative Procedures (028605-010/2014/OTIG). After written informed consent, nine patients were recruited (age: 45.78 ± 13.44 years, male: female ratio 3:6, BMI: 25.9 ± 3.28). The EMG device was placed on the right hand and the AMG device on the left hand. Both arms were placed on an arm board in the lateral position and fixed to it. After propofol-fentanyl induction, AMG and EMG monitoring were started simultaneously in train-of-four (TOF) mode (50 mA stimulating current intensity, 0.2 msec pulse width). Before the administration of the NM blocking agent, 5-10 baseline TOF measurements were obtained. Both devices were allowed to run automatically until tracheal extubation. For acceleromyography the ulnar nerve was
stimulated at the wrist via surface ECG electrodes. A preload was applied to the hand and the piezoelectric probe was attached to the thumb (Fig. 1). For EMG, the device’s dedicated TetraSens strip electrode (Fig. 3, Technomed, Maastricht, the Netherlands) was used. The stimulating electrodes were placed along the ulnar nerve on the volar forearm and the recording electrodes were placed over the adductor pollicis muscle and the interphalangeal joint of the thumb. The variability of baseline measurements and the correlation between the two data sets (AMG and EMG) were determined.

**Results:** There was no statistical difference regarding the baseline TOF ratios (TOFR) between the two devices: AMG TOFR median (range): 110 (84 - 128) vs. EMG TOFR median (range): 106.5 (93 - 120). Although neurostimulation resulted in clinically palpable and visible muscle twitches in all measurements, the EMG prototype did not record early recovery data (Fig. 4). However, good correlation was found in the later phase of recovery (Pearson’s r = 0.359), which improved even further when missed detections were excluded from analysis (Pearson’s r = 0.742, p<0.001). It is likely that the 2 mV electrical threshold level built into the software algorithm was responsible for the lack of TOF readings during late neuromuscular block onset and early recovery.

**Conclusions:** The new EMG-based TetraGraph NM monitor was easy to use and fast to set up. The device displays the actual muscle action potentials in real time, allowing the clinician to determine the validity of the responses. The repeatability of the baseline measurements was good, and the EMG-derived data correlated with the AMG obtained data. Based on the results obtained at deep level of block and early recovery, we conclude that the software algorithm will need to further refine the sensing threshold of 2 mV in order to obtain more consistent action potential measurements.