Comparative Investigation of Acceleromyography-based IntelliVue NMT and Electromyography-based TetraGraph Quantitative Neuromuscular Monitors: a pilot study

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Introduction

Objective neuromuscular (NM) monitoring decreases the incidence of postoperative residual NM blockade and complications. However, the most widely used acceleromyography-(AMG) based NM monitors have several limitations (lengthy set-up; need for a preload; fixed positioning of the hand) that make them unpopular among anesthesiologists. Electromyography-based (EMG) NM monitors are reported to be free of most of these limitations. The aim of the present pilot study was to compare the accuracy and performance of a new, EMG-based, battery-powered NM monitor (TetraGraph™, Senzime AB, Sweden, Fig. 1) to the AMG-based IntelliVue NMT module (Philips, Amsterdam, the Netherlands) in a two-arm comparative investigation.

Methods

After IRB approval and informed consent were obtained, seven patients were enrolled in the study. The AMG and EMG monitors were placed on the patients' arms (R or L) in random order, one on each arm. For AMG measurements, a hand adapter (Organon BV, Boxtel, the Netherlands) was placed in the groove between the thumb and the index finger to ensure that the thumb returns to the baseline position after each contraction. Surface electrocardiography electrodes (Red Dot™, 3M Health Care, St. Paul, MN) were used for ulnar nerve stimulation. The piezoelectric probe was attached to the thumb as per manufacturer's instructions. The arm was positioned by the side of the patient and care was taken to ensure free movement of the thumb. For EMG measurement, the TetraGraph's specifically designed surface strip electrodes (TetraSens™, Senzime AB, Uppsala, Sweden) were used for ulnar nerve stimulation and recording of compound muscle action potentials of the adductor pollicis muscle.

After induction of anesthesia, both monitors were calibrated to determine supramaximal stimulating current intensity. Before the administration of the neuromuscular blocking agent (NMBA), 2-5 baseline TOF measurements were performed to ensure baseline readings. Both devices performed TOF measurements every 20 sec until the onset of deep NM blockade (TOF count 0). Then the stimulation interval times were set to every 1 min. At the end of the procedure, before the administration of reversal agent (if needed), the stimulation interval time was set to 20 sec. The choice of NMBA and reversal agent was at the discretion of the attending anesthesiologist.

Figure 1

Fig. 1 – The electromyography-based, quantitative TetraGraph™ neuromuscular monitor.

Figure 2

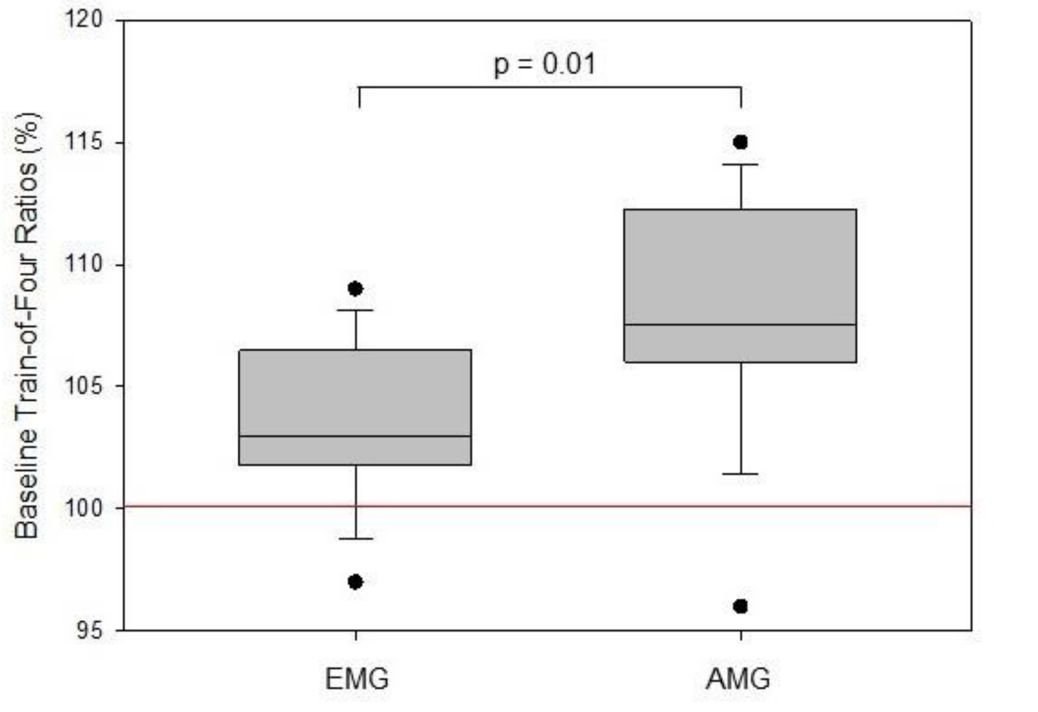

Fig. 2 – Box plot diagram of electromyography- (EMG) and acceleromyography- (AMG) derived baseline train-of-four ratios (%). Boxes represent medians and interquartile ranges, whiskers represent 10th and 90th percentiles, dots represent outlier values.

Figure 3

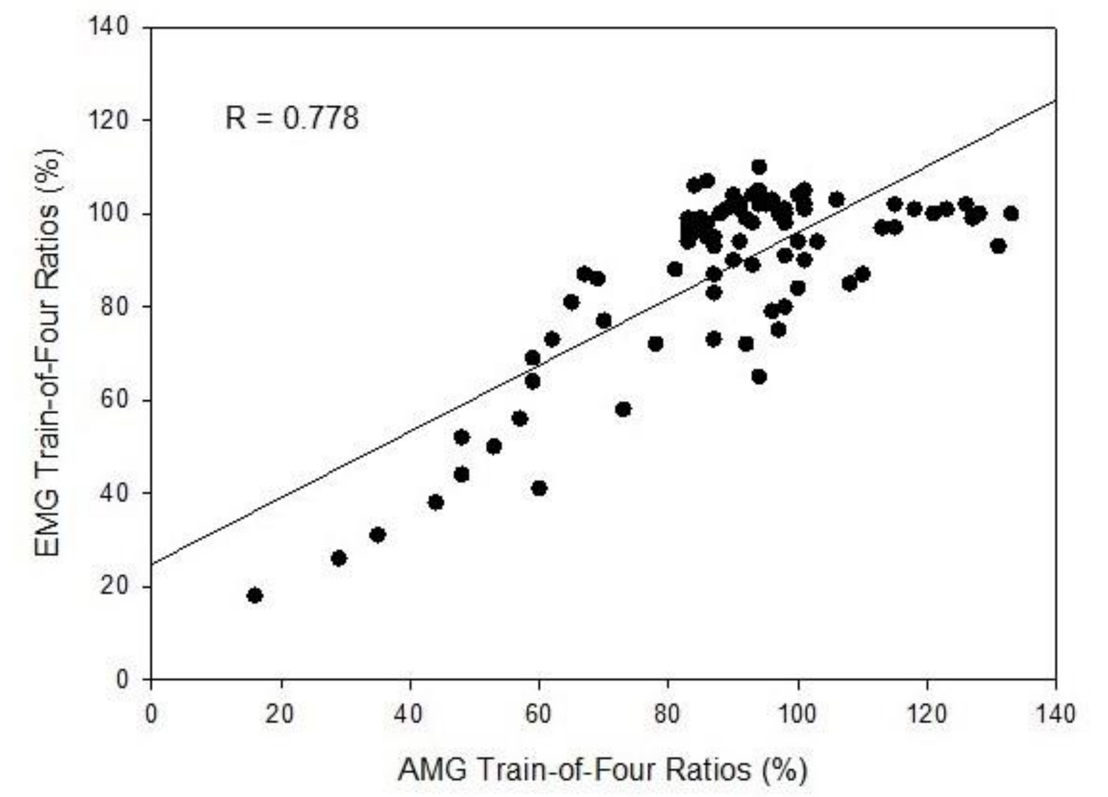

Fig. 3 – Linear regression of electromyography- (EMG) and acceleromyography- (AMG) derived recovery train-of-four ratios (%).

Figure 4

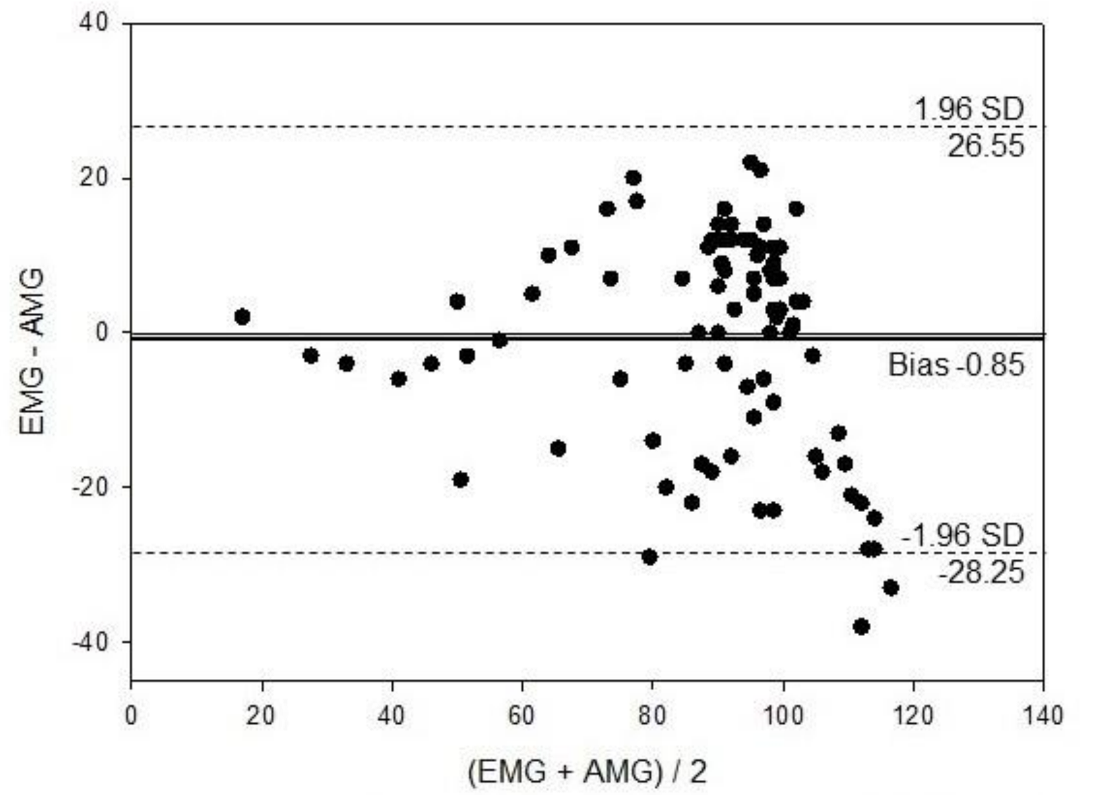

Fig. 4 – Bland-Altman plot of electromyography- (EMG) and acceleromyography- (AMG) derived recovery train-of-four ratios (%).

Results

This pilot study enrolled 7 patients. Two patients were excluded from data analysis because the AMG-based monitor failed to measure recovery train-of-four ratios or because it developed technical problems and did not record responses. The demographic data of the five included patients are the following: age 61.4 ± 7 years; males n=3, females n=2; weight: 79.0 ± 21 kg; height: 1.78 ± 0.1 m; BMI 24.7 ± 3.6. The baseline TOF ratios were significantly lower with the EMG device than with AMG: 103.5 ± 3.4 vs 107.9 ± 4.8, respectively, p=0.01 (Fig. 2). In 4 out of 5 patients, the EMG showed faster onset of neuromuscular blockade and detected recovery of TOF ratios later than AMG. The recovery EMG and AMG TOF ratios showed good correlation (R = 0.778, p<0.001, Fig. 3) with a bias of -0.854 (95% CI: -28.25 to +26.55, Fig. 4).

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Figure 5

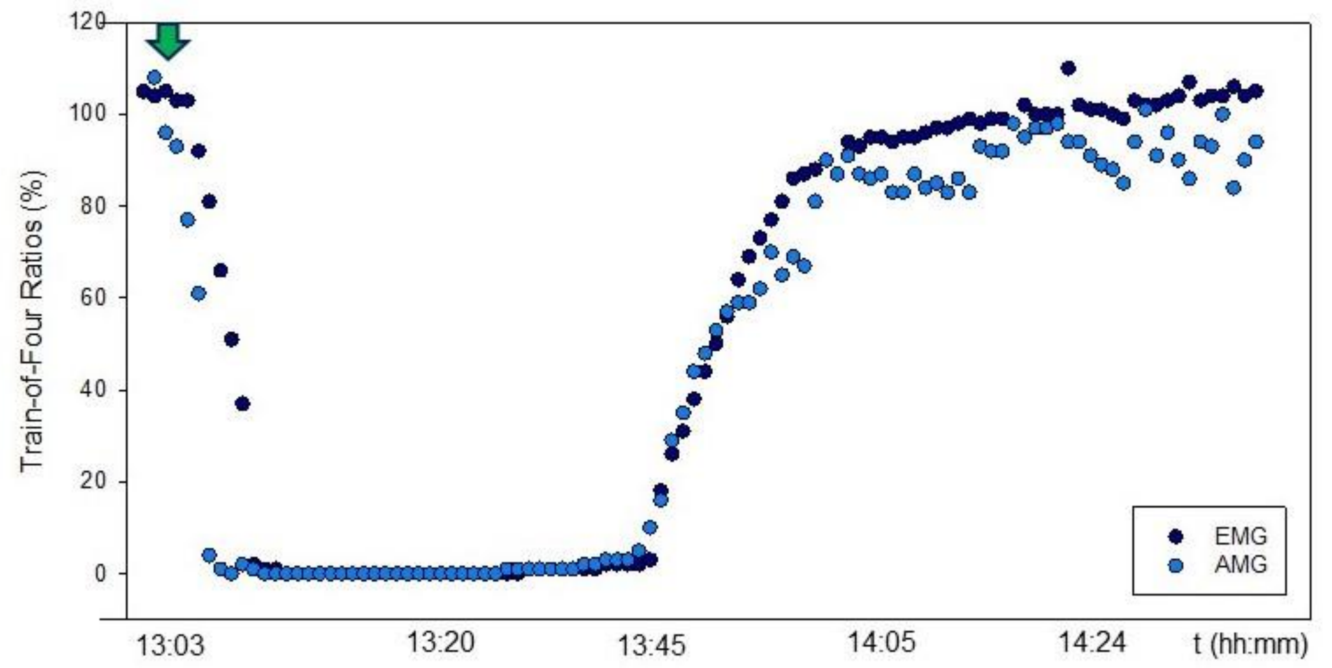

Fig. 5 – The course of neuromuscular blockade in Patient 2 (spontaneous recovery). The dark blue dots represent electromyography- (EMG) derived train-of-four ratios and train-of-four counts. Light blue dots represent acceleromyography- (AMG) derived values. The green arrow shows the time of neuromuscular blocking agent administration.

Conclusions

In this pilot study, the EMG-based TOF measurements were more consistent compared to the AMG-based measurements (Fig. 5). Though AMG proved more sensitive in detecting lower levels of neuromuscular blockade, the overall reliability and ease of use of the new electromyography-based device was better.