Title: COMPARISON OF THUMB ACCELERATION AND THENAR EMG RESPONSES IN THE PHARMACODYNAMIC EVALUATION OF NEUROMUSCULAR BLOCKADE

Authors: O.A.Meretoja, M.D., M.U.Werner, M.D., K.Wirtavuori, M.D., and T.Luosto, M.D.

Affiliation: Department of Anesthesiology, Children's Hospital, University of Helsinki, SF-00290 Finland and Department of Anesthesiology, University of Lund, Sweden

Introduction: Several methods are available for monitoring pharmacodynamic effects of neuromuscular blocking drugs. Visual, manual, mechanical, and electromyographic responses can be evaluated following either single, train-of-four, or tetanic nerve stimulation. Although the recorded level of neuromuscular block (NMB) varies with the monitoring method used, few comparisons have been made between different methods (1-2). No dose-response studies have been carried out to compare the results with different monitoring methods. Therefore, we evaluated the pharmacodynamic properties of alcuronium, a long-acting neuromuscular blocking agent, by simultaneously recording electromyographic (EMG) and acceleration (A) response of the adductor pollicis muscle to ulnar nerve train-of-four (TOF) stimulation.

Methods: Following Ethical Committee approval and informed consent of the patients and the parents, ten ASA I patients (8 ±1 yr, 27 ±4 kg; mean ± SEM) were studied. The patients did not have any medication or disease known to affect neuromuscular transmission. After premedication with flunitrazepam, anesthesia was carried out with fentanyl, thiopental, and 70% nitrous oxide in oxygen. End-tidal carbon dioxide was maintained at 5-5.5%, and skin temperature at >34°C. Volatile anesthetics were not given. Surface electrodes were attached over the adductor pollicis muscle on the thenar eminence and over the proximal phalanx of the middle finger for EMG (NMT221, Puritan Bennett) Acceleration transducer (3) was used on the volar surface of the thumb of the opposite hand.
In every patient, cumulative dose-response curves of alcuronium were created using log-probit transformation. Thereafter, incremental alcuronium doses (1/3 of individual ED95 measured by EMG) were given to maintain surgical relaxation. At the end of surgery, residual NMB was antagonized with neostigmine, 50 µg/kg together with glycopyrrolate, 10 µg/kg. Individual ED50, ED95, the slope of the dose-response curve and the duration of >90% NMB were calculated. The EMG- and A-results were compared using paired t-test. Linear regression analysis was used to correlate the level of NMB and the TOF-ratios obtained using the two techniques following neostigmine administration.

Results. During the onset of NMB, A indicated a greater increase in the block than EMG after every incremental alcuronium dose. Concurrently, ED-values calculated from A were 20% less than those obtained using EMG, while the slopes of the dose-response curves were identical (Table). The duration of >90% NMB was significantly shorter when measured from EMG. When A had recovered to 90% NMB, EMG showed only a 76±2% NMB (P<0.001). At the end of surgery and before neostigmine was given, EMG indicated a NMB of 65±7% and A a NMB of 76±8% (P<0.05) (Figure). EMG and A showed complete recovery of both the NMB and the TOF-ratio within 10 minutes after neostigmine. On the average recorded NMB was 10% greater with A than with EMG during the recovery period. The TOF-ratios were closely correlated (y = 0.97x + 1%, n=164, r=0.94, P<0.001). Both A and EMG were clinically easy to use.

Discussion: This is the first study to evaluate the dose-response relationship of a nondepolarizing neuromuscular blocking drug using two different monitoring method simultaneously. The dose-response curve of aluronium determined using A was located to the left and the duration of NMB was longer when compared to EMG. The results have important implications in evaluating the pharmacodynamic characteristics of neuromuscular blocking agents. When the pharmacodynamic properties of a neuromuscular blocking agent are evaluated, it is critical to know which monitoring method has been used.

Table. Pharmacodynamic determinants of alcuronium-induced NMB calculated by using acceleration and EMG.

	ED50 µg/kg	ED95 µg/kg	slope probit/log	duration min
Acceleration	122 ± 6	221 ±13	6.4 ±.2	27.0 ±2.4
EMG-recording	154 ±11	276 ±19	6.4 ±.3	15.4 ±2.2
P-value	<0.001	<0.001	NS	<0.001

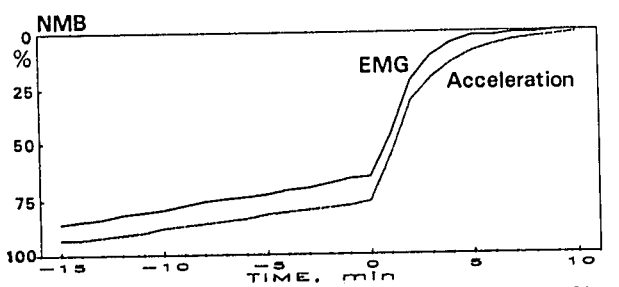

Figure. Recovery of alcuronium-induced NMB as reflected by EMG and Acceleration starting 15 minutes before and ending 10 minutes after neostigmine.

References:
1. Kopman AF: The relationship of evoked electromyographic and mechanical responses following atracurium in humans. Anesthesiology 63:208-211,1985
2. Ebert J, Carroll SK, Bradley EL Jr: Quantitative comparison of thenar electromyographic and force displacement signals during automated vecuronium infusion Anesthesiology 67:A343,1987
3. Jensen E, Viby-Mogensen J, Bang U: The Accelograph a new neuromuscular transmission monitor. Acta Anaesthesiol Scand 32:49-52,1988