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Minimizing Movement-induced Changes in Twitch Response during Integrated Electromyography

To the Editor:—Integrated electromyography (IEMG) provides convenient and clinically useful quantification of the extent of neuromuscular blockade.¹ During the early course of investigations of newer nondepolarizing neuromuscular blocking agents at our institution using a Puritan-Bennett 221 IEMG monitor, we noted that the twitch response seldom returned to control despite complete pharmacologic reversal (IEMG T4/T1 > 95% and clinical criteria of normal neuromuscular function). We found that this failure to return to control twitch response resulted from alterations in hand position following repositioning and surgical manipulation of the patient. The importance of electrode placement for minimizing this movement-induced artifact is described.

We monitored twitch response with IEMG and electromyography (EMG, recorded with a digital storage oscilloscope) in anesthetized patients who did not receive neuromuscular blocking agents. The recording electrodes were placed in various positions as described by previous investigators.²⁻⁵ With the arm secured to a board, some of the electrode placements were more sensitive to patient movement (up to 60% change in twitch response) than others (fig. 1). Applying recording electrodes as described in figure 2, the same patient movement changed twitch response less than 3% (fig. 1).

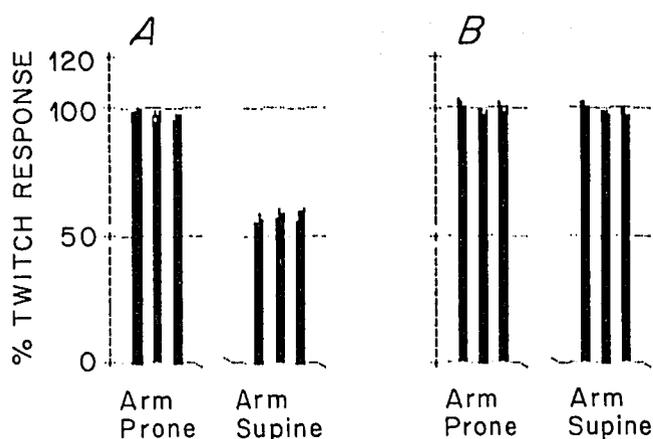


FIG. 1. The effect of patient movement on IEMG twitch response measured with Puritan-Bennett 221 IEMG monitor comparing different electrode placements. A. Electrodes placed across the adductor pollicis on opposite sides of the hand-arm pronation to supination changed twitch response by 40%. B. Electrodes applied as described in figure 2—the same movement caused minimal twitch response change.

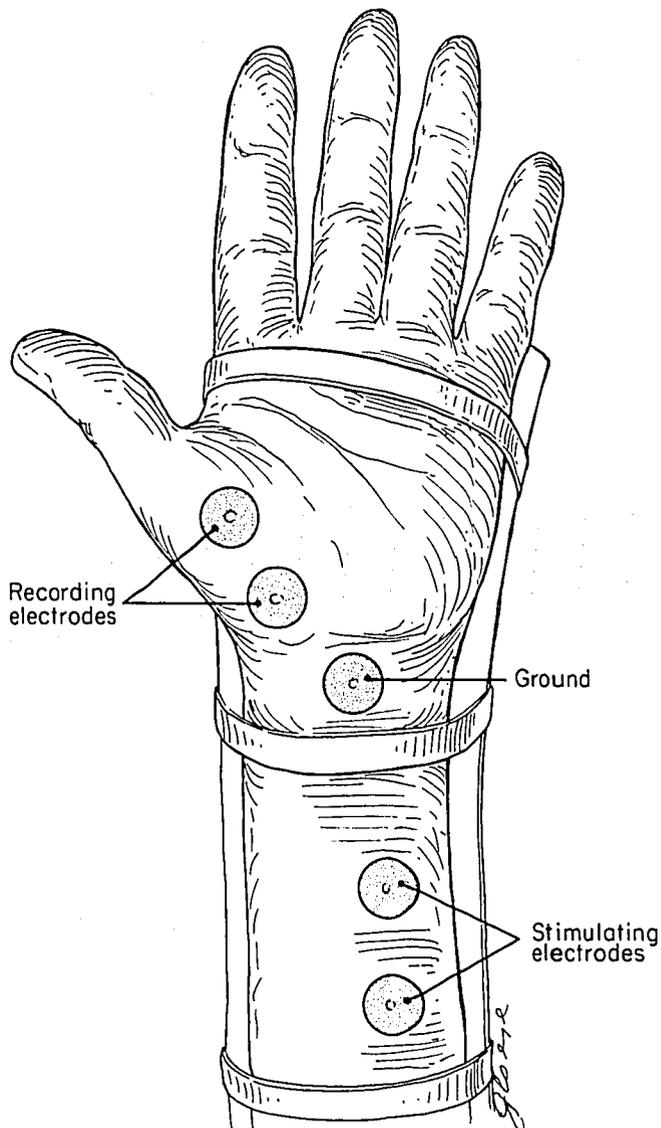


FIG. 2. Electrode placement and hand fixation. One monitoring electrode is placed near the origin of the adductor pollicis, and the other 2 cm distal to the first over the body of the muscle. The hand and forearm are securely taped to a board.

We believe that the observed changes in IEMG (and EMG) amplitude without corresponding change in neuromuscular function resulted from movement of the skin and recording electrodes with respect to the underlying muscle. Assuming that the muscle depolarization vector follows the anatomic orientation of the muscle, we expected that positioning the electrodes parallel to the vector (fig. 2) should minimize movement-induced changes in IEMG twitch height. Our observa-

tions confirmed this prediction. We recommend that, during integrated electromyography, electrode placement and hand fixation, as described in figure 2, be used to minimize movement induced twitch response change.

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In Reply—Our experience*† with intraoperative integrated electromyography partially supports the conclusions of the authors. We agree that improper fixation of the recorded muscle(s) may result in altered evoked EMG responses. Constant pretension on the *specific recorded muscle*, not the simple limb fixation recommended by Kosek *et al.*, is essential to avoid movement artifact. However, the nature of the waveform alteration cannot be reliably predicted; response amplitude may increase or decrease. Therefore, movement-related changes are an unlikely explanation for the commonly observed "incomplete" recovery of EMG waveforms at the end of surgery.

Mechanomyometric (twitch) and electromyometric methods of monitoring neuromuscular function do not measure the same process, so that discrepancies between the two often occur. In the absence of artifact, EMG monitors reliably document depressed muscle responsiveness to motor nerve stimulation. This phenomenon is described by the manufacturers.^{1,2} It apparently relates to residual effects of anesthetics and neuromuscular blocking agents. Signs of residual depression are not often visually detected from twitch because of the inherent lower sensitivity and reliability.³

Optimal placement of stimulating and recording electrodes depends both on the needs of the anesthesiologist and the clinical circumstances.

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Therefore, we challenge the notion that there is one best, all-purpose recording site. The upper facial and diaphragmatic muscles are far more resistant to non-depolarizing neuromuscular blockers than are the hand muscles.⁴ Thus, complete block of abdominal muscles is better monitored from facial than hand muscles. In contrast, this differential sensitivity illustrates the value of hand muscle monitoring during recovery, to assure the responsiveness of respiratory muscles. Interpatient EMG response variation is largest for the muscles of the hand, due to occupational differences. The flexor hallucis brevis provides an attractive alternative for those wishing to either minimize variation or monitor infants.

The authors' figure 2 seems inconsistent with their recommendation. The stimulating electrodes appear to lie midway between the ulnar and median nerves. Simultaneous activation of many palmar muscles with such a placement would generate a complex and virtually uninterpretable evoked EMG response. Similarly, if the intent was to *specifically* monitor the adductor pollicis, recording electrode placement appears to be almost perpendicular to the vector. Finally, recording from this muscle dictates immobilization of the thumb, preferably with a specified degree of pretension.

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