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Undetected Residual Neuromuscular Block Has Consequences

FIVE years ago, an editorial in this journal opined that "it is time to introduce objective neuromuscular monitoring in all operating rooms . . . Objective neuromuscular monitoring is an evidence-based practice and should consequently be used whenever a nondepolarizing neuromuscular blocking agent is administered. Such monitoring is noninvasive, has little risk, and there are strong reasons to believe that its use can improve patient outcome."[1] By objective monitoring, the author was referring to any device that displayed the evoked train-of-four (TOF) fade ratio in real time to the clinician. In the current issue of ANESTHESIOLOGY, Murphy *et al.*[2] present evidence supporting the editorial's hypothesis: Objective monitoring of intraoperative neuromuscular function reduces the incidence of adverse respiratory events in the immediate postoperative period.

In this study, the authors compared the incidence of arterial desaturation and episodes of airway obstruction in two groups of well-matched patients in the 30 min after tracheal extubation. In one group, the extent of intraoperative neuromuscular block was assessed using a convention peripheral nerve stimulator (PNS; n = 90). In the other, the actual TOF ratio was measured using an acceleromyographic monitor (AMG; n = 89). In both groups, 0.05 mg/kg neostigmine was administered before extubation, and the TOF ratio was measured upon arrival in the postanesthesia care unit. In the PNS group, 10 individuals needed some degree of airway support during transport to the postanesthesia care unit, and 19 individuals had transient decreases of arterial saturation to less than 90% during transport (no supplemental oxygen provided). In the AMG group, these episodes did not occur. Upon arrival in the postanesthesia care unit, the lowest TOF ratio recorded in the AMG group was 0.84. In the PNS group, 12 individuals had TOF values less than 0.70 (3 had values less than 0.60). Therefore, residual neuromuscular block was more common in the PNS group and was associated with a significantly higher incidence of adverse respiratory events.

This study is of interest for several reasons. First, outcome studies correlating residual neuromuscular block with adverse events are limited in number. Any additional data in this area are welcome. Second, this is the first investigation to compare the efficacy of objective neuromuscular monitoring (the AMG group) with subjective evaluation of the evoked muscular response to TOF stimulation (the PNS group) in preventing residual neuromuscular block. Although it is difficult to find fault with the authors' data and the results seem plausible and even confirm what "common sense" would predict, questions remain.

Dosing of relaxant in both groups was based on the visual TOF count. As a result, there were no significant differences between the two groups in the total dose of rocuronium administered, level of block at reversal, or time to extubation. Why, then, were adverse events less common in the AMG group? The authors do not provide a totally convincing explanation. They hypothesize that acceleromyography may have allowed for more "rational" titration of rocuronium toward the end of the anesthetic, but they provide no data to substantiate this premise. The only other logical mechanism that might explain the "better" results in the AMG group would be a greater reluctance to extubate (based on known TOF values), resulting in a longer neostigmine-to-extubation interval. However, this interval was at most 2 min longer in the AMG group, probably not enough to explain their results. In addition, the authors' protocol may not have mimicked actual clinical practice. Clinicians were instructed to keep the TOF count at two or three responses. Therefore, incremental doses of rocuronium may have been administered when additional surgical relaxation was not necessary. If clinicians had not received specific protocol instructions, would the results of this study have been different? It is impossible to say. Finally, the study was limited to observations in the first 30 min after extubation. We do not know whether long-term morbidity was increased in the PNS group.

These caveats not withstanding, this study has important implications. First, even small degrees of residual block were shown to have at least short-term clinical ramifications. This is disturbing because there is ample evidence that unsuspected postoperative residual neuromuscular block is a common occurrence.[3–7] In part, this is because subjective estimation of the extent of TOF fade is notoriously inaccurate.[8] Of greater concern, a significant proportion of anesthesia providers do not customarily use even convention peripheral nerve stimulators in their daily practice,[9,10] and routine reversal of

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residual block is far from universally practiced.[3] Unfortunately, the traditional "bedside" tests of neuromuscular function used by many clinicians, such as head lift and tidal volume, are unreliable indicators of adequacy of neuromuscular recovery.[11,12] Therefore, Murphy *et al.* conclude that quantitate monitoring of neuromuscular function is required if postoperative residual block is to be minimized.

A case can perhaps be made that objective monitoring is not always necessary. If the palpable TOF count at the adductor pollicis is four easily detectable responses with moderate fade, antagonism with anticholinesterase antagonists can be expected to produce prompt and adequate reversal. Nevertheless, objective monitoring is clearly desirable in several common clinical situations. One setting is when reversing profound neuromuscular block. If the TOF count is 2 or less, prompt recovery of neuromuscular function cannot be assured by anticholinesterase administration. Nevertheless, neostigmine antagonism of deep block may result in the rapid return of all four evoked responses to TOF stimulation with minimal or no subjectively detectable fade (a TOF ratio >0.40). Therefore, a prolonged period of time may exist where the TOF ratio is above 0.40 but below satisfactory recovery levels of recovery. Unless the clinician is aware of this possibility, tracheal extubation may be undertaken when it is inappropriate.[13] Finally, if satisfactory recovery of neuromuscular function has occurred spontaneously, there are cogent reasons to avoid administering unnecessary antagonists. However, objective evidence that acetylcholinesterase administration is unnecessary should be obtained when nondepolarizing neuromuscular block is not antagonized.[14]

It is a bit odd that, 50 yr after the use of peripheral nerve stimulators were first suggested as aids in monitoring neuromuscular function,[15] the utility of these instruments is still being argued.[16] In its published "Standards for Basic Anesthetic Monitoring" (last amended by the House of Delegates in October of 2005), the American Society of Anesthesiologists remained silent on the need for neuromuscular monitoring. The recent "Report of the American Society of Anesthesiologists Task Force on Postanesthetic Care" stated that "Assessment of neuromuscular function primarily includes physical examination and on occasion *may* include neuromuscular monitoring."[17] Therefore, clinicians who opt not to use even conventional PNS units are practicing within "official" guidelines.

The above notwithstanding, the article by Murphy *et al.* in this issue of ANESTHESIOLOGY adds to the growing body of evidence[11,18,19] that strongly suggests that quantitative monitoring does effect patient well-being for the better. Portable battery-operated acceleromyographic monitors are only fractionally more expensive than top-of-the-line conventional peripheral nerve stimulators. In this author's opinion, objective monitors should be available in every recovery room and every modern anesthetizing location where neuromuscular blocking drugs are administered. Undetected residual neuromuscular block does have clinical consequences.[20]

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