Posttetanic facilitation: A clinical test for safe reversal of nondepolarising neuromuscular blockade.

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Introduction
During the 1970s and 1980s, regaining a train-of-four ratio (TOFR) of 0.7 after administration of non-depolarising neuromuscular blocking drugs, was regarded as an indication of return of mechanical respiratory reserve and the ability to maintain a patent airway. Evidence has accumulated that patients sent to recovery rooms with TOFR less than 0.9 have impaired function of their pharyngeal muscles that predisposes them to regurgitation and aspiration, and an increased risk for developing postoperative pulmonary complications. Furthermore it appears that a TOFR< 0.9 is associated with decreased chemoreceptor sensitivity to hypoxia. In spite of being able to maintain a sustained head lift and leg lift, patients had difficulty in swallowing, felt uncomfortable and could not sip water through a straw. Residual neuromuscular block is a major risk factor behind critical events in the immediate postoperative period and should be regarded as a serious adverse event in the same way as we regard ventilatory depression due to opioids and anaesthetic agents.

Clinical assessment of neuromuscular blockade by visual and tactile evaluation of the responses to train-of-four stimuli (TOF) to the ulnar nerve at the wrist is imprecise and it has been demonstrated that 20% of experienced anaesthesiologists are unable to detect residual neuromuscular blockade in the presence of a TOFR of 0.4. To make matters worse, devices for objective measurement of TOFR are seldom available in clinical practice. For this reason Viby-Mogenson and others developed the evaluation of double-burst stimulation (DBS), as an improved method for clinical assessment of the adequacy of reversal of non-depolarising neuromuscular blockade (NMB). However it was soon demonstrated that although more sensitive than clinical evaluation of TOF, many anaesthesiologists still could not detect significant residual NMB. There is therefore no guarantee that in spite of careful assessment of DBS, the absence of fade implies adequate, safe reversal of NMB. The purpose of this study was to establish whether the absence of posttetanic facilitation (PTF), long regarded as the “hallmark” of non-depolarising neuromuscular blockade, could be a reliable indicator of adequate reversal of drug effects. The hypotheses were:

1. The presence of PTF is a more sensitive indicator of residual non-depolarising block than DBS.
2. The absence of PTF is a reliable indicator that the TOF-ratio is ≥ 0.9.

Methods
After obtaining institutional approval for the study, informed, written consent was obtained from 40 adult, ASA I-III patients scheduled for elective surgery of expected duration longer than one hour. In the operating room the following nerve-stimulator devices were attached:

a) To the “Control arm”: an Innervator 272® nerve stimulator (Fisher & Paykel) for visual and tactile assessment of NMB.
b) To the “Test arm”: a TOF-Guard® monitor (Organon Teknika) for recording of TOFR by accelerometry. The arm, wrist and fingers were immobilised while ensuring free movement of the preloaded thumb according to recommended procedure.

After induction of anaesthesia with propofol and fentanyl, the TOF-Guard® was calibrated, cis-atracurium 0.15mg.kg was administered and the trachea intubated. Controlled ventilation of the lungs followed using 66% nitrous oxide in oxygen and a 0.7 kPa endtidal partial pressure of isoflurane.

On return of four responses to TOF on the control arm, a trained observer who was blinded to the TOFR readings on the Control arm assessed neuromuscular blockade on the Test arm visually and by feel. When it appeared that the four responses to TOF were equal, the observer then switched to assessment of DBS until fade could no longer be detected. At this point patients were randomly allotted to one of two groups. Group-1 was tested for the presence of PTF. In addition the TOFR was determined at which DBS-fade was undetectable. Group-2 was allowed to progress to a TOFR of 0.9 whereupon they were tested for the presence of PTF (to determine whether PTF was present at TOFR ≥ 0.9).

Results
In both groups fade on TOF and DBS were no longer detectable on the Test arm at TOFR of 0.4 and 0.7 respectively. The distribution of the TOFR in Group-1 is illustrated in Figure 1. PTF was present in all of these cases, notably when TOFR was between 0.7 and 0.83. The reliability of PTF to predict the presence of a TOFR < 0.9 is presented in Table 1.

Table 1:

<table>
<thead>
<tr>
<th>Sensitivity (%) (95% CI)</th>
<th>Specificity (%) (95% CI)</th>
<th>Positive Likelihood Ratio</th>
<th>Negative Likelihood Ratio</th>
<th>Positive Predictive Value (%)</th>
<th>Negative Predictive Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 (93–100)</td>
<td>85.0 (63.1–96.6)</td>
<td>6.7</td>
<td>0.0</td>
<td>87.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Conclusions

1. DBS is not a reliable method to determine whether a patient has recovered safely after nondepolarising neuromuscular blockade.
2. The presence PTF is a more sensitive indicator of residual non-depolarising block than DBS (when TOFR < 0.9).
3. The absence of PTF is a reliable indicator that the patient has safely recovered from NMB (when TOFR > 0.9).
4. PTF is simple and can easily be performed using any basic nerve stimulator, to ensure safe reversal of NMB.

References

12. Wion N, Joensen H, Yamamoto Y, Lindahl SG, Eriksson LI: Carotid body chemoreceptor function is impaired by vecuronium during hypoxia. Anesthesiology 1998; 89: 1471-9

95% CI = 95% confidence interval.