Tactile Evaluation of the Posttetanic Count (PTC)

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The methods commonly used for monitoring neuromuscular transmission do not allow evaluation of an intense neuromuscular blockade, i.e., a blockade where no response to single, tetanic, and train-of-four (TOF) nerve stimulation is seen. In a previous paper we found an inverse correlation between time to return of response to TOF nerve stimulation and number of posttetanic twitches after a tetanic stimulation, the posttetanic count (PTC). However, in that study, extensive monitoring equipment was used, and the possibility existed that the relatively frequent use of a tetanic stimulation (every 6th minute) might have influenced recovery of neuromuscular blockade. The present study therefore was designed to evaluate whether 1) the method of counting posttetanic twitches can be used without access to monitoring equipment, and 2) whether the application of a tetanic stimulation (50 Hz for 5 s) every 6 to 10 min influences the recovery of neuromuscular transmission.

Materials and Methods

Seventy-seven adult patients (ASA class I and II) were studied. The study plan was approved by the Ethical Committee of our hospital. No patient had neuromuscular disease or received any drug that might alter neuromuscular function. The patients ranged in age from 25 to 72 years (mean: 46.4 years).

One hour after giving 0.2 mg/kg diazepam orally, anesthesia was induced either with dihydralyzperidol (5–10 mg), fentanyl (0.2–0.5 mg), thiopental (3–5 mg/kg) and nitrous oxide 70% (group 1: 49 patients), or thiopental (3–5 mg/kg) and halothane 0.75–1.50% inspired concentration in nitrous oxide 50% (group 2: 28 patients). Following induction of anesthesia, the ulnar nerve was stimulated at the wrist through cutaneous electrodes connected to a nerve stimulator. Basically, TOF nerve stimulation was used. After supramaximal stimulation was achieved, 0.08 mg/kg or 0.1 mg/kg pancuronium was given (table 1).

The trachea was intubated when the response to TOF nerve stimulation had disappeared. Every 6–10 min the mode of stimulation was changed as described previously. First, 1-Hz, single twitch stimulation was applied for one min, followed by a tetanic stimulus (50 Hz) for 5 s. Three seconds later, the single twitch (1 Hz) was again applied for 1 min, followed by TOF stimulation. This pattern of stimulation was continued until 10 min after reappearance of the first twitch in TOF nerve stimulation. The number of twitches after tetanic stimulation was judged simply by feeling the response at the thumb, as shown in figure 1.

To evaluate the influence of tetanic stimulation on the recovery of neuromuscular blockade, 43 of the patients were stimulated on both arms. One arm was stimulated with TOF stimulation only, while the other arm with the pattern of stimulation described above.

Analysis of linear regression was used, and prediction regions were obtained using random coefficient regression models.

Results (Fig. 2)

The first response to the posttetanic twitch stimulation was felt 38 min (mean) before reappearance of the first response to TOF stimulation. The mean number of posttetanic twitches was 10.9 when the first response to TOF stimulation was felt. For each patient there was a close linear relation between time to first reaction to TOF nerve stimulation and the square root of PTC:

| Table 1. Distribution of Patients in the Two Groups According to Dose of Pancuronium |
|---------------------------------|----------|----------|--------|
|                                | 0.08 mg/kg | 0.10 mg/kg | Total Number of Patients |
| Group 1 (Neurolept-anesthesia) | 14        | 35        | 49     |
| Group 2 (Halothane)            | 15        | 13        | 28     |

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Fig. 1. Tactile evaluation of the number of posttetanic twitch responses (the posttetanic count, PTC).

\[ \sqrt{PTC} = \alpha + \beta \]  
(equation 1)

which were found to be independent of sex, age, height, and weight of the patients, as well as dose of pancuronium and type of anesthesia.

For a given value of PTC, the time to first reaction to TOF stimulation can then be predicted by

Fig. 2. Relationship between time in minutes to first reaction to train-of-four (TOF) nerve stimulation and number of posttetanic responses felt at the thumb in 77 patients. The predicted curve and 95% confidence limits are shown \[ t = (\sqrt{PTC} - 3.302)/0.0623 \]. ○ and ● indicate data from group 1 (NLA) and group 2 (halothane), respectively.
\[
t = \frac{\sqrt{PTC} - \hat{\beta}_0}{\hat{\alpha}_0}
\]

where \(\hat{\alpha}_0\) and \(\hat{\beta}_0\) denote the estimates of the common regression coefficients \(\alpha_0\) and \(\beta_0\). These estimates (SE) were found to be \(\hat{\alpha}_0 = 0.0623 (0.0023)\) and \(\hat{\beta}_0 = 3.302 (0.043)\).

The uncertainty of the prediction is mainly a result of the variation of the individual regression coefficients \(\alpha\) and \(\beta\) around \(\alpha_0\) and \(\beta_0\); the variation around the individual regression lines and the uncertainty in estimates \(\hat{\alpha}_0\) and \(\hat{\beta}_0\) are negligible in this connection. Figure 2 summarizes the results. There was no difference between groups 1 and 2 regarding the relationship between the first reaction to TOF stimulation and PTC. Also the initial dose of pancuronium had no influence.

In 43 patients stimulated on both arms, mean time (SE) to first reaction to TOF nerve stimulation was 53.6 min (19.0) for the arm stimulated with TOF stimulation and 53.0 min (18.3) for the arm stimulated with intermittent tetanic stimulations every 6 to 10 min. This difference is not statistically significant.

**DISCUSSION**

There is a close inverse correlation between number of posttetanic twitches derived from a recording (the posttetanic count: PTC) and time to first response to TOF nerve stimulation.\(^1\) The numbers of posttetanic responses detected by a transducer are, however, not necessarily the same as the number of responses that can be felt manually. We found that it is possible to predict time to reappearance of first response to TOF nerve stimulation with reasonable accuracy simply by feeling the response at the thumb and counting the number of posttetanic responses.

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**Detection of Paradoxical Air Embolism by Transesophageal Echocardiography**

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Venous air embolism is a potentially serious complication that most commonly occurs during neurosurgery with the patient in the sitting position. Paradoxical air embolism is rare, but may represent a serious complication. Although signs and symptoms of paradoxical air embolism have been described during neurosurgical procedures in the sitting position,\(^1,2\) a definitive diagnosis has not been established. We previously described the use of transesophageal echocardiography for detecting venous air embolism and have suggested arterial air embolism can also be detected by this method.\(^3\) We describe a case of paradoxical air in the left atrium and aorta that was...