RELATIONSHIP BETWEEN POST-TETANIC TWITCH AND SINGLE TWITCH RESPONSE AFTER ADMINISTRATION OF VECURONIUM

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SUMMARY

We have studied the relationship between post-tetanic twitch (PTT) and single twitch response after administration of vecuronium 0.2 mg kg\(^{-1}\) in 100 patients during neuroleptanaesthesia (NLA) (droperidol and fentanyl) and during anaesthesia with halothane, isoflurane, enfurane or sevoflurane. Intervals from PTT to single twitch, and post-tetanic-count (PTC) (number of PTT responses) at the onset of single twitch were determined electromyographically. These intervals in the isoflurane, enflurane and sevoflurane groups differed from those in NLA and halothane groups. PTC in the isoflurane, enfurane and sevoflurane groups differed from those in the NLA group, and PTC in the sevoflurane group significantly from those in the NLA and halothane groups. These results are consistent with the view that PTT reflects prejunctional block, whilst the single twitch response is indicative of postjunctional block. (Br. J. Anaesth. 1993; 71: 443-444)

KEY WORDS


Absence of post-tetanic twitch (PTT) indicates intense neuromuscular block, because a PTT response appears earlier than single twitch or train-of-four (TOF) responses during the recovery of neuromuscular transmission [1]. We have reported previously the time courses of recoveries of PTT and TOF after administration of vecuronium under different types of anaesthesia [2]. In this study, we have investigated the relationship between PTT and single twitch during neuroleptanaesthesia (NLA) and during anaesthesia with halothane, isoflurane, enfurane and sevoflurane.

METHODS AND RESULTS

We studied 100 adult patients (54 male), ASA I or II, undergoing elective general surgical, orthopaedic, gynaecological, urological, ENT and ophthalmological procedures, after obtaining institutional Review Board approval and written informed consent. None of the patients had neuromuscular, renal or hepatic disorders or was receiving any medications that might affect neuromuscular transmission. The patients were allocated randomly to five groups (20 patients in each) to receive: neuroleptanaesthesia (NLA group), halothane, isoflurane, enfurane or sevoflurane. All patients were premedicated with atropine 0.01 mg kg\(^{-1}\) and hydroxyzine 1 mg kg\(^{-1}\) i.m.

Stimulating surface electrodes were placed on the ulnar nerve at the elbow and recording electrodes on the abductor digiti minimi muscle. Anaesthesia was induced with sodium thiamylal 5 mg kg\(^{-1}\), then the ulnar nerve was stimulated supramaximally (50 mA) with an electrical stimulator (SEN-3201, Nihon-Kohden Inc., Tokyo). Rectangular pulses of 0.1 ms duration were triggered automatically by computer as described elsewhere [2]. When the response to single twitch stimuli was stable, the magnitude of the single twitch was taken as the control twitch height.

Vecuronium 0.2 mg kg\(^{-1}\) i.v. was administered to facilitate tracheal intubation. Anaesthesia was maintained with 66% nitrous oxide in oxygen and fentanyl 5 \(\mu\)g kg\(^{-1}\) and droperidol 0.2 mg kg\(^{-1}\) in the NLA group, and with 66% nitrous oxide in oxygen and 1 MAC of inhalation anaesthetics (end-tidal) in the four other groups (0.76% halothane, 1.15% isoflurane, 1.68% enfurane or 1.17% sevoflurane). End-tidal concentrations of carbon dioxide, nitrous oxide and inhalation anaesthetics were measured using a Capnomac Ultima-S-S1-03 (Datex Inc., Helsinki). The patient's lungs were ventilated to normocapnia. Body temperature was maintained at 35.5-36.8°C using a warming blanket.

For PTT stimulation, a tetanic stimulus (50 Hz) was applied for 5 s and after an interval of 3 s, single twitch stimuli (1 Hz) were applied for 20 s. The twitch height of each stimulus was amplified via an amplifier (AVB-11, Nihon-Kohden Inc., Tokyo) and displayed on an oscilloscope (VC-11, Nihon-Kohden Inc., Tokyo).

Single twitch stimuli were given every 30 s and PTT stimuli every 150 s. Thereafter, we measured the intervals from PTT to single twitch and PTC (number of PTT responses) at the onset of single twitch.
twitch during recovery of neuromuscular transmission. The maximum PTC which had been detected before the first single twitch response appeared was designated the "PTC at the onset of single twitch".

The responses to electrical stimulation were considered detectable when the changes were larger than or equal to 1 % of control twitch height.

Data were analysed statistically using ANOVA and Duncan's multiple range test [3], \( P < 0.01 \) being considered significant. All results are expressed as mean (SD or range).

There were no significant differences in patient characteristics (age, sex, height and weight) between groups.

Intervals between PTT, and single twitch in the isoflurane, enfurane and sevoflurane groups differed significantly from those in the NLA and halothane groups. PTC at the onset of single twitch in the isoflurane, enfurane and sevoflurane groups differed from those in NLA group, and those in the sevoflurane group differed significantly from those in the NLA and halothane groups (table I).

**COMMENT**

We have found that the intervals from PTT, to single twitch, and PTC at the onset of single twitch differed significantly between the different anaesthetic groups. These findings suggest that the relationship between PTT and single twitch varies with different types of anaesthesia.

We reported previously that, during recovery of vecuronium-induced neuromuscular transmission, the appearance of PTT followed a similar time course with five types of anaesthesia (neuroleptanaesthesia, halothane, isoflurane, enfurane or sevoflurane), while those of T1, T2, T3 and T4 were delayed to various extents [2].

PTT is thought to indicate a prejunctional effect of non-depolarizing neuromuscular blocking agent. In contrast, the single twitch or TOF twitch height is thought to reflect postjunctional effects [2]. Inhalation anaesthetics prolong neuromuscular block by acting mainly on the postjunctional region of the neuromuscular junction [2], thus delaying the onset of the single twitch response, but not the PTT. The prolongation of PTT, single twitch intervals in the isoflurane, enfurane and sevoflurane groups would result entirely from the delayed onset of the single twitch. Similarly, the finding that PTC at the onset of single twitch varied according to the anaesthetic used results from the difference in time to the onset of single twitch in the five groups.

The concentrations of isoflurane and enfurane at the neuromuscular junction increase slowly and reach equilibrium after 90 min [4] and 200–240 min [5], respectively. However, the PTT, and single twitch appeared after approximately 30–45 min from induction of anaesthesia in our study, so the concentration of inhalation anaesthetic at the neuromuscular junction would have been small and should have had little influence on our data. In addition, the time-dependent increase is slight [4, 5].

PTT stimuli were carried out at 2.5-min intervals in our study. This relatively short interval was used for more precise determination of the relationship between PTT and single twitch. However, this may have affected spontaneous recovery of neuromuscular block in the investigated arm [1, 6]. Ali [6] reported that tetanic stimulation may increase muscle blood flow, and this would promote delivery of neuromuscular blocking agent to the neuromuscular junction and intensify the block. This suggestion requires further investigation.

**REFERENCES**


**TABLE 1. Intervals from PTT, to single twitch (mean (SD)) and PTC at the onset of single twitch (mean (range)). NLA = Neuroleptanaesthesia. Significant difference \( P < 0.01 \) compared with **NLA; group; † halothane**

<table>
<thead>
<tr>
<th></th>
<th>NLA</th>
<th>Halothane</th>
<th>Isoflurane</th>
<th>Enflurane</th>
<th>Sevoflurane</th>
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<tbody>
<tr>
<td>PTT—single twitch interval (min)</td>
<td>8.0 (3.3)</td>
<td>9.1 (3.5)</td>
<td>14.4 (3.3)††</td>
<td>14.8 (4.0)††</td>
<td>15.3 (4.5)††</td>
</tr>
<tr>
<td>PTC at the onset of single twitch</td>
<td>7.3 (4-10)</td>
<td>7.9 (6-11)</td>
<td>8.9 (6-14)**</td>
<td>9.3 (7-14)**</td>
<td>10.1 (7-16)**††</td>
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