Post-tetanic count and single twitch height at the onset of reflex movement after administration of vecuronium under different types of anaesthesia

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SUMMARY
We have studied post-tetanic count (PTC) and single twitch height at the onset of reflex movement to carinal stimulation after administration of vecuronium with five different types of anaesthesia. Seventy-five adult patients were allocated randomly to five groups of 15 patients each, to receive one of the following anaesthetics: neuroleptanaesthesia (fentanyl and droperidol) or 1 MAC of either halothane, isoflurane, enflurane or sevoflurane with 66% nitrous oxide in oxygen. During spontaneous recovery from vecuronium-induced neuromuscular block, the carina was stimulated with a suction catheter every 150 s. Single twitch heights at the onset of reflex movement were similar (2.0-2.7% of control values) between the five groups. In contrast, PTC at the onset of reflex movement to carinal stimulation differed (7.4-17.0) between groups.

KEY WORDS

It has been reported that some patients exhibit reflex movement to carinal stimulation at the first appearance of the train-of-four (TOF), whereas few patients respond at the first appearance of post-tetanic twitch (PTT) [1]. It has also been observed that the post-tetanic count (PTC) at the onset of reflex movement differed between fentanyl and halothane anaesthesia [1]. However, there have not been any studies on the relationship between PTT or PTC and reflex movement to carinal stimulation with other types of anaesthesia. The present study was designed to examine PTC and single twitch heights at the onset of response to carinal stimulation with five different types of general anaesthesia.

METHODS AND RESULTS
We studied 75 adult patients (40 male), ASA I or II, undergoing elective surgical procedures. Institutional Review Board approval and written informed consent were obtained. The patients were allocated randomly to five groups of 15 patients to receive one of the following: neuroleptanaesthesia (NLA group), halothane (H group), isoflurane (I group), enflurane (E group) or sevoflurane (S group).

Premedication comprised atropine 0.01 mg kg⁻¹ and hydroxyzine 1 mg kg⁻¹ i.m. Stimulating surface electrodes were placed over the ulnar nerve at the elbow and recording electrodes at the abductor digitii minimi muscle. Anaesthesia was induced with thiopental 5 mg kg⁻¹ i.v. The ulnar nerve was then stimulated every 10 s at 50 mA with single twitch stimuli of 0.1-ms duration using an electrical stimulator (SEN-3201, Nihon-Kohden Inc., Tokyo, Japan). Twitch height immediately after induction of anaesthesia with thiopental was taken as the control value, then vecuronium 0.2 mg kg⁻¹ i.v. was administered and the trachea intubated.

After determination of control twitch height, the pattern of nerve stimulation was changed to a combination of PTT and single twitch stimulation. PTT stimulation was given every 150 s. For PTT stimulation, tetanic stimulation (50 Hz, 50 mA) was applied for 5 s and after an interval of 3 s, 30 single twitch stimuli (1 Hz, 0.1-ms duration, 50 mA) were delivered for 30 s. Further, one single twitch stimulation (0.1-ms duration, 50 mA) was delivered 120 s after the beginning of tetanic stimulation and PTT was again applied 30 s after single twitch stimulation. Responses to ulnar nerve stimuli were assessed electromyographically, as described previously [2].

PTC was defined as the number of detectable PTT responses. Single twitch height was expressed as a percentage of control twitch height.

The carina was stimulated for 3 s with a soft rubber suction catheter (MAR 2531-12-C, Nihon-Sharwood Inc., Tokyo, Japan) via the tracheal tube at the end of each PTT until the onset of reflex movement to carinal stimulation was observed. A reflex was regarded as present when one of the authors, who was unaware of the type of anaesthesia used, found any diaphragmatic response by inspection of the patient's abdominal wall. PTC at the onset of reflex movement and twitch height obtained 30 s previously was defined as PTC and single twitch height at the onset of reflex movement.

Anaesthesia in the NLA group was maintained...
PTC AND SINGLE TWITCH AT ONSET OF MOVEMENT

TABLE I. PTC and single twitch heights at the onset of reflex movement to carinal stimulation in the five groups (mean (SD) [range]). PTC in the isoflurane (I), enfurane (E) and sevoflurane (S) groups differed significantly from those in the neuroleptanaesthesia (NLA) and halothane (H) groups (** P < 0.01). PTC in groups H, I, E and S differed significantly from that in group NLA (†† P < 0.01). In contrast, single twitch heights did not differ significantly in the five groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>PTC</th>
<th>Single twitch heights (%)</th>
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<tbody>
<tr>
<td></td>
<td>7.4 (3.7) [0-16]</td>
<td>2.0 (0.7) [0.6-3.3]</td>
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<tr>
<td>NLA</td>
<td>10.3 (3.1)††</td>
<td>2.6 (1.2) [0-9.3]</td>
</tr>
<tr>
<td>H</td>
<td>15.7 (4.5)***††</td>
<td>2.5 (0.8) [1.4-3.7]</td>
</tr>
<tr>
<td>I</td>
<td>15.4 (4.2)***††</td>
<td>2.5 (0.9) [1.4-3.6]</td>
</tr>
<tr>
<td>E</td>
<td>17.0 (4.7)***††</td>
<td>2.7 (0.9) [1.5-4.7]</td>
</tr>
<tr>
<td>S</td>
<td>17.0 (4.7)***††</td>
<td>2.7 (0.9) [1.5-4.7]</td>
</tr>
</tbody>
</table>

with 66% nitrous oxide in oxygen, fentanyl 5 μg kg⁻¹ and droperidol 0.2 mg kg⁻¹ i.v. In the other groups, anaesthesia was maintained with 66% nitrous oxide in oxygen and the inhalation anaesthetics in oxygen (0.8% halothane, 1.2% isoflurane, 1.7% enfurane or 1.7% sevoflurane, each at an end-tidal concentration of almost 1 MAC). The end-tidal concentrations of carbon dioxide, nitrous oxide and inhalation anaesthetics were measured using a Capnomac Ultima-S-31-03 (Datex Inc., Helsinki, Finland).

ANOVA and Duncan’s multiple range test were used for comparing data from the five groups. $P < 0.01$ was considered significant. Results are expressed as mean (SD) and [range].

There were no significant differences in the number of patients, age, sex, height and body weight between the groups.

Mean PTC values at the onset of reflex movement in each group are shown in table I. A wide range of PTC values (from 7.4 for the NLA group to 17.0 for group S) was observed between groups. There was a significant difference in PTC for groups I, E and S compared with groups NLA and H. There was also a significant difference in PTC between groups H, I, E and S and that of group NLA.

In contrast with PTC, single twitch heights at the onset of reflex movement were almost identical in the five groups and ranged from 2.0 to 2.7% of control twitch heights. There was no significant difference between groups (table I).

COMMENT

Fernando and colleagues [1] reported that at the onset of reflex movement to carinal stimulation, there were more PTC values during halothane than during fentanyl anaesthesia [1]. In the present study, we found that PTC values at the onset of reflex movement differed significantly between groups. In contrast, single twitch heights did not differ significantly between groups. In addition, one patient in the fentanyl anaesthesia group in the study of Fernando and colleagues [1] and one patient who received neuroleptanaesthesia in the present study had reflex movement, even with a PTC of 0. These findings presumably reflect the method of monitoring neuromuscular transmission (PTC and single twitch) and the effect of inhalation anaesthetics on neuromuscular block.

PTT is thought to represent prejunctional block and twitch height of single twitch or TOF is thought to be related to postjunctional block [2]. Inhalation anaesthetics enhance neuromuscular block by acting mainly in the postjunctional but not in the prejunctional region [3]. We demonstrated previously [2] that recovery of PTC did not reflect well the effect of inhalation anaesthetics on neuromuscular block but twitch height of single twitch or TOF indicated, to a better extent, the augmentation of neuromuscular block induced by inhalation anaesthesia. The present results also indicate that single twitch height shows the degree of neuromuscular block more accurately than PTC, especially when reflex movement is to be prevented.

Fernando and colleagues [1] also noted that the disappearance of reflex movement to carinal stimulation was an indication that the diaphragm was totally paralysed, although the degree of reflex movement did not, of course, only reflect the degree of diaphragmatic paralysis. Inhalation anaesthetics and fentanyl also depress reflex movement themselves [4, 5]. In the present study, single twitch heights at the onset of reflex movement did not differ significantly between groups, suggesting that halothane, isoflurane, enfurane and sevoflurane, at a concentration of 1 MAC, and the combination of fentanyl 5 μg kg⁻¹ and droperidol 0.2 mg kg⁻¹ may inhibit reflex movement to the same extent.

PTT stimuli may influence subsequent neuromuscular monitoring [6]. Silverman and Brull [6] noted that PTT every 120 s had no significant effect on subsequent nerve transmission while neuromuscular responses after tetanic stimulation returned to pre-tetanic values within 90 s. In the present study, PTT stimuli were delivered every 150 s and single twitch heights were determined 120 s after tetanic stimulation. Thus in this study, the effect of PTT stimuli on subsequent neuromuscular transmission should have been negligible.

REFERENCES

