INFUSION OF VECURONIUM ASSESSED BY TACTILE EVALUATION OF EVOKED THUMB TWITCH

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The non-cumulative properties of vecuronium and atracurium make these drugs suitable to provide surgical paralysis of any duration exceeding 25–30 min [1]. During longer procedures, an infusion regimen overcomes the inconvenience of frequent supplements and minimizes fluctuations in the level of neuromuscular blockade [2]. The increased cost and complexity of this mode of administration is offset by a smoother course of paralysis, ability to alter the level of blockade with changing surgical requirements and, most important, rapid and reliable reversal shortly after the end of infusion. Monitoring of neuromuscular block is imperative to guide the adjustment of the infusion rate and to find the time for safe antagonism of residual block. This study was designed to clarify if tactile assessment of evoked thumb adduction is a reliable guide to the infusion rate of vecuronium required to render a smooth course of blockade.

METHODS AND RESULTS

We studied 15 patients (ASA group I–II) undergoing intra-abdominal gynaecological surgery. The ages and weights were 48.9 yr (31–68 yr) and 64.3 kg (50–84 kg) (mean with range).

Premedication comprised diazepam 10–20 mg by mouth. Anaesthesia was induced with pethidine 1 mg kg$^{-1}$ and thiopentone 3–5 mg kg$^{-1}$ i.v. and maintained with 66% nitrous oxide in oxygen, supplemented by increments of pethidine and thiopentone.

SUMMARY

In 15 patients (ASA I–II) undergoing intra-abdominal gynaecological surgery, muscle paralysis for tracheal intubation and surgery was achieved by a combined bolus and demand infusion of vecuronium. The initial loading dose of 67 µg kg$^{-1}$ and the rate of subsequent infusion were determined by evaluation of the tactile twitch response to train-of-four (TOF) stimulation of the ulnar nerve while the neuromuscular blockade obtained was recorded blindly for control on the contralateral arm. A maintenance dose of 4.9 mg h$^{-1}$ (2.0–7.6 mg h$^{-1}$) produced a smooth course of blockade with minimum and maximum values of twitch height during infusion of 2% and 12%, respectively. A period of 15.9 min elapsed from the end of infusion to a TOF-ratio of 0.7, when neostigmine 2.5 mg was administered at the point of two palpable twitches to TOF-stimulation. Simple tactile evaluation of peripheral nerve stimulation is sufficient to determine the infusion rate of vecuronium required to produce stable and appropriate neuromuscular blockade during intra-abdominal surgery.

On one arm, neuromuscular blockade was monitored by the use of a force displacement transducer (Biometer, Denmark) measuring the evoked thumb adduction. Supramaximal train-offour (TOF) stimuli were delivered every 10 s to the ulnar nerve at the wrist via surface electrodes. Similarly, the contralateral arm was stimulated and the tactile response assessed by the anaesthetist, who was unaware of the transducer recordings.

An intubating dose of vecuronium was given as a bolus of 0.03 mg kg$^{-1}$ followed by a fast infusion
of 1 mg min⁻¹ (0.89 mg ml⁻¹, 70 ml h⁻¹) until a reduction of thumb adduction was felt. In the following 1 min, the infusion rate was halved and then stopped. Tracheal intubation was accomplished when no or minimal twitch response could be felt.

A continuous infusion was started at a rate of 0.09 mg kg⁻¹ h⁻¹ at the reappearance of the first tactile twitch response to TOF stimulation. Subsequent regulations were made in accordance with the tactile response to TOF stimulation, allowing only recovery of the first twitch. The size of adjustments were approximately 25% of the initial infusion rate. The infusion was discontinued 10 min before termination of surgery and the residual block antagonized with neostigmine 2.5 mg and atropine 1 mg, implying at least two palpable twitches of the TOF response. Tracheal extubation was carried out when no fade was felt in the TOF response.

In order to avoid development of a temperature gradient between the arms, i.v. fluids were warmed to 37 °C before administration through a peripheral vein in the arm stimulated for tactile evaluation. Arterial pressure was measured non-invasively every 5 min and the ECG, heart rate and core temperature monitored continuously. Intraoperative arterial blood-gas analysis confirmed that normoventilation was maintained.

Twitch heights are presented as median values, all other data as mean values with ranges in parentheses.

The combined bolus–fast infusion loading dose of 67 µg kg⁻¹ (56–86 µg kg⁻¹) was delivered within 4 min and this depressed twitch response completely in 10 patients. In five patients the mechanical twitch response was only just detectable at its minimum, approximately 2%. Onset time from end of bolus administration to maximal blockade was 2.6 min (1.8–3.5 min). Tracheal intubation was accomplished 3.6 min (1.8–4.5 min) after bolus.

The continuous infusion was started 20.4 min (3–39 min) after bolus administration at the first tactile response to TOF stimulation. Tactile detection of the twitch response was preceded by mechanical detection, typically by a few minutes, but in five patients minimal mechanical response (0–2%) was present 10–15 min before manual detection. The infusion rate was adjusted, on average, 7.6 times per hour, the frequency of regulation decreasing with time. The duration of infusion was 61 min (17–111 min).

The maintenance dose during the infusion period (following total loading dose) was 4.9 mg h⁻¹ (2.0–7.6 mg h⁻¹) and the corresponding level of blockade was approximately 5%, with a median maximum value of 12% (2–34%) and a minimum of 2% (0–4%) (fig. 1). No correlation existed between the required infusion rate and patient’s weight.

On stopping the infusion, twitch height recovered spontaneously from 4% (0–20%) to 20% (1–34%) within 10.1 min (5.1–16.1 min) at which point neostigmine 2.5 mg and atropine 1 mg were administered (fig. 2). A TOF ratio of 0.7 was reached 5.1 min (2.9–9.5 min) later. Tracheal extubation was carried out 8.4 min (1.1–18 min) after antagonism of residual block. The duration of infusion of vecuronium did not correlate with the time from end of infusion to a TOF ratio of 0.7.

The individual values of the period from
administration of neostigmine to a TOF ratio of 0.7 were scattered widely (2–9.5 min), but correlated with the twitch height level at the moment of antagonism. The total period from the end of the infusion to a TOF ratio of 0.7 was 15.9 min (11–20.5 min).

**DISCUSSION**

The use of a small loading bolus of vecuronium (ED$_{50}$) followed by a fast infusion might be expected to delay the moment of maximal neuromuscular blockade and time to tracheal intubation. However, we found that maximal blockade was achieved at 2.6 min (1.8–3.5 min) after the end of bolus administration and tracheal intubation was completed 1 min later. With the same loading regimen, Østergaard [3] found a mean time from bolus to tracheal intubation of 4 min. These data suggest that induction of neuromuscular blockade is not (or only slightly) prolonged when the loading dose of vecuronium is divided, administering approximately 50% as a bolus and the remainder as a tapering infusion over 2–3 min.

In this regimen, the duration of time between loading dose and start of infusion is governed by the loading dose and the ability of the anaesthetist to sense initial, discrete twitches. Although the use of our regimen might be expected to reduce the period of no response, in our hands tactile thumb adduction was not felt and the infusion not commenced until 20.4 min (3–39 min) after the end of bolus administration. Nevertheless the level of blockade was kept within acceptable limits (fig. 1).

The maintenance dose of vecuronium during the period of infusion was 4.9 mg h$^{-1}$ (2.0–7.6 mg h$^{-1}$) which is comparable to the results of other investigators [4, 5]. The large inter-individual variation in dose requirements requires monitoring if a 90–95% level of blockade is required. We found that tactile evaluation of evoked thumb twitch was simple and effective and we suggest that, in routine clinical practice, more sophisticated methods of monitoring are not necessary.

In conclusion, stable and appropriate neuromuscular blockade can be achieved by an infusion of vecuronium, determined solely by tactile evaluation of the twitch response to TOF stimulation. A valuable aspect of this demand infusion of vecuronium is that rapid, reliable antagonism of blockade may be obtained on administration of antagonists at early stages of spontaneous reversal and after a prolonged blockade.

**REFERENCES**