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SHORT COMMUNICATIONS

Residual curarization in the recovery room after vecuronium†

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We have investigated residual block after anaesthesia which included the use of the neuromuscular blocking agent vecuronium but no anticholinesterase, in 568 consecutive patients on admission to the recovery room. The ulnar nerve was stimulated submaximally using TOF stimulation (30 mA). Postoperative residual curarization was defined as a TOF ratio <0.7. Of the 568 patients, 239 (42%) had a TOF <0.7 in the recovery room. These patients had received a larger cumulative dose of vecuronium than patients who had full recovery (mean 7.7 (SD 3.6) mg *vs* 6.2 (2.7) mg; $P<0.05$) and a shorter time had elapsed since the last vecuronium dose (117 (70) min *vs* 131 (80) min; $P<0.05$). Of 435 patients whose trachea was extubated, 145 (33%) exhibited inadequate recovery from neuromuscular block. Six of these had one or no response to TOF stimulation and were reintubated. In the remaining 139 patients, neuromuscular block was successfully antagonized. Only 20 patients (3.5%) remembered TOF stimulation when questioned 2 h later in the recovery room, and discomfort associated with it was assessed using a visual analogue scale before discharge. We conclude that it is necessary to antagonize residual block produced by vecuronium.

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Postoperative residual curarization in conscious patients in the recovery room is a well recognized phenomenon that may increase postoperative morbidity.[1] Prevention of residual curarization depends on clinical assessment, neuromuscular monitoring, use of short- or intermediate-acting neuromuscular blocking drugs, and administration of anticholinesterases in an appropriate dose. Neuromuscular monitoring using train-of-four (TOF) stimulation has been used during operation to identify residual curarization, allowing the dose of anticholinesterase to be adjusted accordingly. Supramaximal stimulation is used during general anaesthesia, but this can be uncomfortable in conscious patients. Submaximal TOF stimulation is reliable and may be more suitable for use in awake patients with suspected residual curarization.[2] Although the incidence of postoperative residual curarization may be lower with intermediate-acting than with long-acting neuromuscular blocking drugs, postoperative residual curarization may still occur.[3,4]

In this prospective study, we have determined the incidence of residual neuromuscular block in the recovery room after the use of vecuronium and evaluated the discomfort associated with submaximal TOF stimulation in awake patients.

Methods and results

After obtaining approval from the Institutional Review Board, we studied prospectively 583 adults given a non-depolarizing neuromuscular blocking drug for a range of surgical procedures (orthopaedic, abdominal, thoracic, vascular) over a 3-month period during 1995. The anaesthetic technique used was similar throughout the study period. No attempt was made to influence the anaesthetic technique and consequently, peroperative neuromuscular monitoring or reversal of curarization were not necessary for inclusion in the study. The choice of drugs used for premedication, anaesthesia and neuromuscular block was at the discretion of the anaesthetist who was unaware that the patient would be assessed in the recovery room.

Most patients were premedicated with hydroxyzine 100 mg orally. After arriving in the operating room, patients were placed on the operating table and kept warm with a blanket. Anaesthesia was induced with propofol 2.5 mg kg^{-1} or etomidate 0.3 mg kg^{-1} and fentanyl 2 μg kg^{-1}. Intubation

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was facilitated in 568 patients by vecuronium 0.1 mg kg^{-1}. Anaesthesia was maintained by isoflurane and 60% nitrous oxide in oxygen. Doses of neuromuscular blocking agent required during surgery (intermittent i.v. bolus), adequacy of recovery from neuromuscular block, use of an anticholinesterase and decision to extubate the trachea before arrival in the recovery room were based on clinical criteria only. Ten patients given atracurium and five given rocuronium in the peroperative period were excluded from further study.

Immediately after arrival in the recovery room, the TOF response was measured using an acceleration transducer (TOF-Guard, Organon Teknika, NV), and the TOF ratio was recorded. The ulnar nerve was stimulated submaximally (30 mA) by two skin electrodes placed on the forearm, and the transducer was placed on the volar aspect of the thumb. Postoperative residual curarization was defined as a TOF ratio <0.7, as proposed previously.[3 4] Postoperative residual curarization in a patient whose tracheal tube had been removed was considered to indicate inadequate recovery requiring anticholinesterase therapy. Neostigmine 50 μg kg^{-1} and atropine 15 μg kg^{-1} were given if at least two responses to TOF were detectable, and re-intubation was performed if less than two responses were obtained. Discomfort associated with neuromuscular stimulation was evaluated approximately 2 h after TOF stimulation using a visual analogue scale graded from 0 (no pain) to 10 (intractable pain), before the patient left the recovery room.

Results are expressed as mean (SD). Comparisons between groups were performed using the chi-square and Student's *t* tests. Results were considered statistically significant when $P \leqslant 0.05$.

Of the 568 patients given vecuronium, neuromuscular monitoring was used in 11 patients in the peroperative period but neuromuscular block was antagonized in the operating room in only one patient.

Inadequate recovery from neuromuscular block in the recovery room was found in 239 (42%) patients. These patients were older than patients with adequate recovery (mean 50 (range 18–83) yr *vs* 45 (18–85) yr; $P<0.05$), had received a larger cumulative dose of vecuronium (mean 7.7 (SD 3.6) mg *vs* 6.2 (2.7) mg; $P<0.05$) and a shorter time had elapsed since the last dose of vecuronium (117 (70) min *vs* 131 (80) min; $P<0.05$) (Table 1).

In 435 patients the trachea was extubated in the operating room; 145 of these (33%) had a TOF ratio <0.7 on arrival in the recovery room. Six had one or no response to submaximal TOF stimulation and the trachea was reintubated. In the remaining 139 patients, with at least two responses to TOF stimulation, neuromuscular block was antagonized successfully with neostigmine 50 μg kg^{-1}.

Only 20 patients (3.5%) remembered TOF stimulation before discharge from the recovery room, and only one had a visual analogue scale score >3.

Table 1 Patient and clinical characteristics of patients with adequate *vs* inadequate recovery from neuromuscular block produced by vecuronium in the recovery room (mean (SD or range), median [range] or number). *$P<0.05$

	Adequate recovery	Inadequate recovery
n	329	239
ASA score	II [I–IV]	II [I–IV]
Sex (M/F)	190/139	141/98
Age (yr)	45 (18–85)	50 (18–83)*
Weight (kg)	69 (13)	68 (13)
Extubated/intubated before admission to the recovery room	290/39	145/94
Body core temperature in the recovery room (°C)	35.8 (0.4)	35.7 (0.3)
Time of isoflurane exposure (min)	101 (83)	95 (79)
Vecuronium total dose (mg)	6.2 (2.7)	7.7 (3.6)*
Time from last injection to TOF recording in recovery room (min)	131 (80) [20–360]	117 (70) [20–360]*

Comment

Our study highlights the need to antagonize routinely vecuronium-induced neuromuscular block even though it is considered to be an intermediate-acting agent. It also emphasizes the need to monitor neuromuscular block in the peroperative period if there is a need to avoid the use of an anticholinesterase at the end of surgery. A TOF ratio of 0.7 was, until recently, the threshold above which recovery was thought to be adequate.[3 4] But it is now considered that a TOF ratio of 0.9 is necessary to avoid the risk of passive regurgitation and aspiration.[5 6] Thus residual curarization will be present more frequently than is supposed.

The results of this study suggest that as with mivacurium,[6] anaesthetists should use an anticholinesterase after vecuronium. We have modified our clinical practice as a result of this study.

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