British Journal of Anaesthesia 1996; **76**: 565–566

Magnesium sulphate enhances residual neuromuscular block induced by vecuronium

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Summary

Magnesium sulphate ($MgSO_4$) is currently used for haemodynamic control during anaesthesia and the early postoperative period. We have investigated the effect of this treatment on residual neuromuscular block after administration of vecuronium. Twenty adult patients were allocated randomly to one of two groups to receive $MgSO_4$ 60 mg kg^{-1} either at recovery from vecuronium block to a train-of-four (TOF) ratio of 0.7, or 1 h after recovery to a TOF ratio of 0.7. Neuromuscular transmission was monitored using electromyography and TOF stimulation. $MgSO_4$ caused rapid and profound recurarization in all 20 patients. $MgSO_4$ decreased the amount of acetylcholine released at the motor nerve terminal and thus may lead to recurarization in patients previously exposed to neuromuscular blocking agents. (*Br. J. Anaesth*. 1996; **76**: 565–566)

Key words

Neuromuscular block, vecuronium. Neuromuscular block, recovery. Ions, magnesium. Measurement techniques, electromyography.

Magnesium sulphate ($MgSO_4$) may be given during anaesthesia and the early postoperative period for its antihypertensive and anti-arrhythmic properties [1, 2]. While the effect of $MgSO_4$ pretreatment on the pharmacodynamics of neuromuscular blocking agents has been reported [3], less is known about its effects when given after neuromuscular block has recovered clinically (i.e. TOF ratio $\geqslant 0.7$). This question may be of clinical relevance as $MgSO_4$ decreases the amount of acetylcholine (ACh) released at the motor nerve terminal, thus reducing the safety margin of neuromuscular transmission. We therefore hypothesized that $MgSO_4$ may enhance residual neuromuscular block. The aim of the present study was to determine if $MgSO_4$ administration at different times after recovery to a TOF ratio of 0.7 is safe.

Methods and results

After obtaining institutional Ethics Committee approval and written informed consent, we studied 20 patients, ASA I or II, undergoing elective surgery. We excluded patients with known neuromuscular disease or receiving medications influencing neuromuscular function. After premedication with midazolam 7.5 mg, patients were anaesthetized with fentanyl 2–3 μg kg^{-1}, thiopentone 4–5 mg kg^{-1} and 1 % isoflurane with 60 % nitrous oxide in oxygen. Patients' lungs were ventilated to normocapnia and skin temperature over the adductor pollicis was maintained greater than 34 °C. Neuromuscular function was assessed by supramaximal stimulation of the ulnar nerve with TOF stimuli at 2 Hz every 20 s and recording the electromyographic response (twitch height, TOF ratio) of the adductor pollicis muscle (Relaxograph, Datex Instrumentarium Corporation, Finland). When the end-tidal isoflurane concentration had stabilized, the Relaxograph was recalibrated, the control twitch height (first response of TOF) determined, and vecuronium 100 μg kg^{-1} administered. Patients were allocated randomly to one of two groups of 10 each to receive $MgSO_4$ 60 mg kg^{-1} in saline 100 ml as a short infusion either at recovery to a TOF ratio of 0.7 or 1 h after recovery to a TOF ratio of 0.7. The onset of recurarization (time from end of perfusion of $MgSO_4$ to minimum twitch height), minimum twitch height, number of TOF responses at minimum twitch height, and time to recovery of the TOF ratio to 0.7 again, were recorded.

The typical time course of vecuronium neuromuscular block and subsequent effect of $MgSO_4$ are shown in figure 1. In the group that received $MgSO_4$ at a TOF ratio of 0.7, the following values were recorded before administration of $MgSO_4$: mean twitch height 78 (SD 3) % and TOF ratio 0.71 (0.02). Onset of maximal block was 328 (79) s, minimum twitch height was 23.5 (11) %, median number of TOF responses at minimum twitch height was 2 (range 0–4) and time to recovery to a TOF ratio of 0.7 was 28.8 (10.5) min. In patients who received $MgSO_4$ 1 h after recovery to a TOF ratio of 0.7 the following values were obtained: twitch height 88 (6) %, TOF ratio 0.87 (0.14), onset of maximal block 480 (120) s, minimum twitch height 34 (20) %, median number of TOF responses at minimum twitch height 3 (range 2–4) and time to recovery to TOF 0.7 22 (7.6) min.

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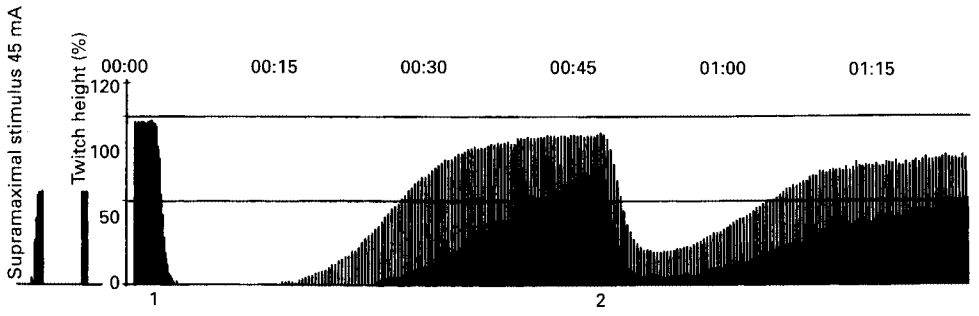

Figure 1 Time course of vecuronium neuromuscular block and $MgSO_4$-induced recurarization: 1 = administration of vecuronium 100 μg kg^{-1}; 2 = recovery of TOF ratio to 0.7 and infusion of $MgSO_4$ 60 mg kg^{-1}.

Comment

This study has demonstrated that administration of $MgSO_4$ after return of neuromuscular function to a TOF ratio of 0.7 leads to recurarization. The risk of muscle paralysis persists, at least during the first hour after recovery to a TOF ratio of 0.7. Recurarization is rapid in onset and profound enough to compromise respiration.

We chose $MgSO_4$ 60 mg kg^{-1} as this dose is used currently in anaesthetic practice [2]. However, at these concentrations, $MgSO_4$ without neuromuscular blockers does not induce measurable block [4].

Decreased ACh release at the motor nerve terminal by $MgSO_4$ is the most likely explanation for the observed recurarization. According to the concept of the margin of safety of neuromuscular transmission [5], the twitch response may be normal with 70–80 % of the ACh receptors at the neuromuscular junction still blocked by a non-depolarizing neuromuscular blocking agent. However, in this situation, any decrease in ACh release may enhance neuromuscular block with subsequent clinical consequences such as recurarization. Patients in the early postoperative period, with a large percentage of ACh receptors still occupied, are particularly vulnerable to drug interaction at the neuromuscular junction.

In summary, $MgSO_4$ in clinically relevant doses caused profound recurarization when given to patients recovered from neuromuscular block. We conclude that when $MgSO_4$ is given in the postoperative period, respiration and neuromuscular function have to be monitored carefully to avoid complications caused by muscle weakness.

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