



Original contribution

Magnesium sulfate accelerates the onset of low-dose rocuronium in patients undergoing laryngeal microsurgery^{☆,☆☆}

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ABSTRACT

Study objective: We evaluated the effect of magnesium sulfate—an enhancer of neuromuscular blockade—on onset and duration of low dose of rocuronium, and on operating conditions during laryngeal microsurgery.

Design: Randomized, prospective, double-blinded study.

Patients: Eighty-four patients scheduled for elective laryngeal microsurgery.

Interventions: Patients were randomly allocated to receive different doses of rocuronium: 0.6 mg/kg (group C, n = 28), 0.45 mg/kg (group LR, n = 28), or 0.45 mg/kg plus magnesium sulfate 30 mg/kg (group LM, n = 28).

Measurements: We measured the onset time and duration of action of rocuronium, and evaluated the surgeon's satisfaction with the operating conditions.

Main results: Group LR showed significantly delayed onset time (group C: 87 ± 22 seconds, group LR: 127 ± 47 seconds, and group LM: 89 ± 32 seconds; $P = .001$) and maximal suppression than did other groups (group C: 102 ± 30 seconds, group LR: 155 ± 66 seconds, and group LM: 105 ± 36 seconds; $P = .002$). Duration of action of rocuronium was significantly longer in group C than in other groups (group C: 39 ± 7 minutes, group LR: 28 ± 8 minutes, group LRM: 31 ± 8 minutes; $P < .001$). Laryngoscope placement score ($P = .002$), surgeon's satisfaction ($P = .005$), and sore throat ($P = .035$) were significantly worse in group LR.

Conclusions: Magnesium sulfate 30 mg/kg accelerated the onset and improved operating conditions of low-dose rocuronium without prolongation of action.

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1. Introduction

Laryngeal microsurgery (LMS) is performed with diagnostic or therapeutic intent in patients with a vocal cord lesion or a voice disorder [1]. Smooth endotracheal intubation is necessary to minimize damage to the lesion during anesthetic induction. However, other factors such as involuntary contractions of the vocal cords might affect the surgical outcome. Therefore, deep neuromuscular blockade is required during surgery. On the one hand, because the lesion is usually small and of the benign nature, and the operation time is relatively short, deep neuromuscular blockade may prevent rapid reversal and emergence from

anesthesia. On the other hand, a low-dose neuromuscular blocking agent may exhibit a slower onset time and contribute to poor intubation and surgical conditions [2]. As a result, it is not easy for the anesthesiologist to choose the most adequate type and dosage of a neuromuscular blocking agent.

Succinylcholine had been considered a good neuromuscular blocking agent for LMS because it has not only a short onset time but also a short duration of action [3]. However, it has many adverse effects such as arrhythmia, myalgia, acute rhabdomyolysis, and hyperkalemia, which restrict its use in clinical settings [4]. Recently, rocuronium, which has a rapid onset time and an intermediate duration of action, has been emerging as the drug of choice [5]. Previous studies about intubation conditions have found that ketamine and alfentanil shorten the onset time of low-dose rocuronium, but such combinations were associated with delayed emergence from anesthesia [6,7].

Magnesium sulfate enhances the effect of nondepolarizing neuromuscular blocking agents [8–10]. However, to our knowledge, there are no reports of the effect of magnesium sulfate on low-dose rocuronium. The

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aim of this study was to evaluate the effects of magnesium sulfate on onset and duration of low-dose rocuronium, and on operating conditions during LMS.

2. Materials and methods

This double-blind randomized controlled study was approved by the Seoul National University Bundang Hospital Institutional Review Board and was registered at ClinicalTrials.gov (NCT02100293). After obtaining written informed consents, we enrolled patients aged 20–75 years with American Society of Anaesthesiologists physical status I or II, who were scheduled for LMS under general anesthesia. Exclusion criteria were as follows: underweight (body mass index <18.5 kg/m²) or overweight (body mass index >24.9 kg/m²), neuromuscular disease, hepatic disease, renal disease, Mallampati class 3 or 4, sore throat, and medication that could influence neuromuscular blockade. A total of 84 eligible patients were randomly allocated to 3 groups using a computer-generated list: the control group (group C) was given rocuronium 0.6 mg/kg; the low-dose rocuronium group (group LR) was given rocuronium 0.45 mg/kg; and the low-dose rocuronium plus magnesium sulfate group (group LM) was given magnesium sulfate 30 mg/kg before receiving rocuronium 0.45 mg/kg. An anesthesia nurse, who was not involved in the clinical care of patients, prepared the study drug according to the randomization list using a computer-generated random sequence (<http://www.randomization.com>).

Patients received midazolam 0.03 mg/kg as a premedication at the reception area of the operating theater. After arrival at the operating theater, patients were monitored with standard monitoring, including electrocardiography, noninvasive blood pressure, and pulse oximetry. Patients in group C and group LR received 100 mL of isotonic saline, and those in group LM received 100 mL of magnesium sulfate 30 mg/kg diluted with isotonic saline over 10 minutes. Anesthesia was induced in all patients with 4 µg/mL of propofol and 4 ng/mL of remifentanyl administered via target-controlled infusions using an Orchestra infusion pump system (Fresenius Vial, Brezins, France) and maintained with 2–6 µg/mL of propofol and 2–6 ng/mL remifentanyl with target-controlled infusion to maintain a bispectral index of 40–60 (measured with an A-2000 BISTM monitor; Aspect Medical Systems

Inc, Natick, MA). After endotracheal intubation, lung was mechanically ventilated and ventilation was controlled to maintain an end-tidal carbon dioxide tension of 30–35 mm Hg. The temperature was checked via skin temperature probe and was maintained at greater than 35°C.

Neuromuscular blockade was monitored using acceleromyography (TOF-Watch SX; Organon Ltd, Swords, Ireland) according to recent clinical guidelines [11]. The acceleration transducer of the acceleromyograph was firmly fixed to the volar side of the distal phalanx of the thumb on a small elastic hand adapter (TOF-Watch Handadapter; Schering-Plow, Swords, Ireland). After calibration, the data obtained from the TOF-Watch SX were automatically collected on a computer using the TOF-Watch SX monitoring program (version 2.1; Organon Ltd).

After achieving a stable baseline, 0.6 mg/kg rocuronium was injected to group C and 0.45 mg/kg rocuronium was injected to group LR and group LM. Endotracheal intubation was performed by a blinded and skilled anesthesiologist when T1 was less than 5%. The intubation attempt was recorded as a failed one if the anesthesiologist could not intubate successfully within 20 seconds. If the anesthesiologist succeeded an endotracheal intubation, he or she scored the endotracheal intubation conditions according to the scoring method developed by Fuchs-Buder et al [11] (Supplementary Data, Table S1). The same scoring method was used to score the laryngoscope placement conditions. During surgery, maintenance doses of 0.15 mg/kg rocuronium were injected when the second twitch of the train-of-four (TOF) response appeared or when the surgeon requested further relaxation. When the surgical procedure was completed before achieving 25% recovery of the first twitch of TOF stimulation, the anesthesiologist waited until this mark was reached to inject 50 µg/kg of neostigmine with 10 µg/kg of glycopyrrolate. When the surgical procedure was completed after achieving 25% recovery of the first twitch of TOF stimulation, the anesthesiologist injected 50 µg/kg of neostigmine with 10 µg/kg of glycopyrrolate as soon as the surgery ended. Neuromuscular monitoring was continued until the TOF ratio reached 1.0. According to the above guidelines, we defined the time from injection of rocuronium (0.6 or 0.45 mg/kg) to 95% depression of the single twitch as onset time, the time from injection of rocuronium (0.6 or 0.45 mg/kg) to maximal depression of the single twitch as maximal suppression time, the time from injection of rocuronium (0.6 or 0.45 mg/kg) to 25% recovery

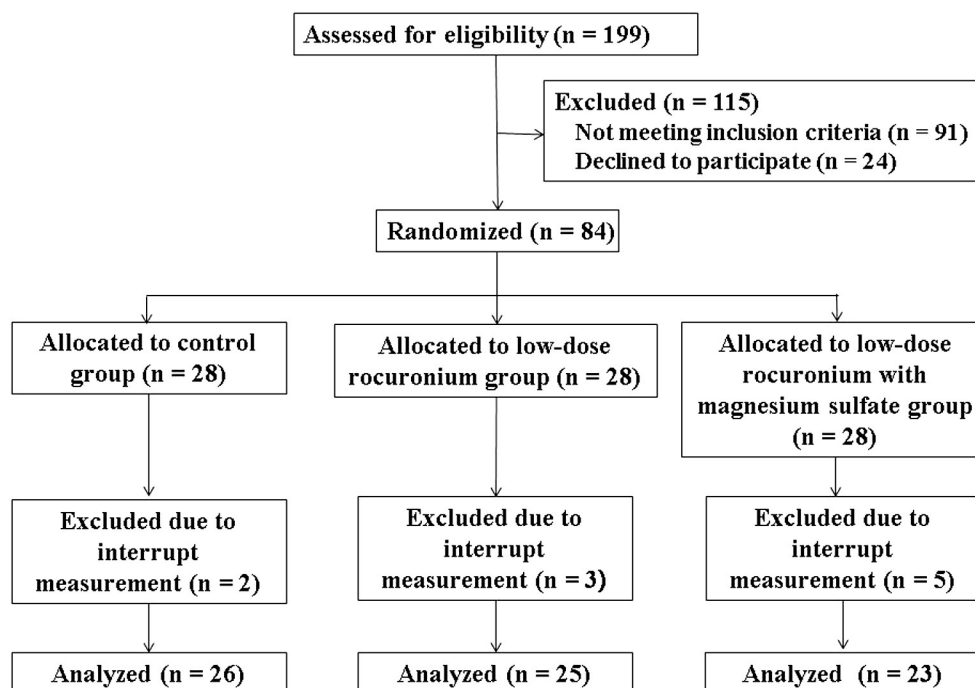


Fig. 1. CONSORT diagram.

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