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Airway and Respiration

AIRWAY AND RESPIRATION

Deep neuromuscular block improves the surgical conditions for laryngeal microsurgery

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Abstract

Background: Adequate neuromuscular block is required throughout laryngeal microsurgery. We hypothesized that the surgical conditions would improve under a deeper level of rocuronium-induced neuromuscular block.

Methods: Seventy-two patients undergoing laryngeal microsurgery were randomly allocated to either the 'post-tetanic counts 1-2' (PTC1-2) group or the 'train-of-four counts 1-2' (TOFcount1-2) group according to the level of neuromuscular block used. Two different doses of rocuronium (1.2 or 0.5 mg kg^{-1}) were used after anaesthetic induction, and two respective targets of neuromuscular block (post-tetanic counts ≤2 or train-of-four count of 1 or 2) were used. Surgical conditions were assessed by the surgeon using a five-point rating scale (extremely poor/poor/acceptable/good/optimal), and clinically acceptable surgical conditions were defined as those which were rated acceptable, good, or optimal. The occurrence of vocal cord movement and postoperative adverse events was assessed.

Results: The surgical conditions were significantly different between the PTC1-2 and TOFcount1-2 groups (extremely poor/poor/acceptable/good/optimal: 0/2/1/7/26 and 3/10/2/14/7, respectively, $P<0.001$). The incidence of clinically acceptable surgical conditions was significantly higher in the PTC1-2 group than in the TOFcount1-2 group (94 *vs* 64%, $P=0.003$). The percentage of patients who exhibited vocal cord movement was significantly lower in the PTC1-2 group than in the TOFcount1-2 group (3 *vs* 39%, $P<0.001$). The incidence of postoperative adverse events was not significantly different except for the less frequent occurrence of mouth dryness in the PTC1-2 group ($P=0.035$).

Conclusions: Deep neuromuscular block (post-tetanic count of 1-2) surgical conditions in patients undergoing laryngeal microsurgery improves.

Clinical trial registration: NCT01980069.

Key words: larynx; neuromuscular blockade; neuromuscular monitoring

Adequate muscle relaxation is required throughout laryngeal microsurgery because the larynx must be directly visualized using a rigid laryngoscope. The laryngeal muscle requires deep neuromuscular block (NMB) because it is more resistant to neuromuscular blocking agents than other muscles.[1 2] Moreover, unexpected intraoperative patient movements and laryngeal responses can provoke cardiovascular instability and respiratory compromise.[3] Therefore, during laryngeal microsurgery, the

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Editor's key points

- Operating conditions for several surgical procedures are improved when deep neuromuscular block is provided
- However, this practice risks residual postoperative weakness if surgery is brief
- In this study, deep neuromuscular block with rocuronium improved conditions for short-duration laryngeal microsurgery
- Deep neuromuscular block was antagonisable quickly using sugammadex 4 or 8 mg kg^{-1}
- However the study was not blinded and more data are required to confirm these findings

maintenance of deep NMB until the end of surgery appears to be desirable for achieving clear and quiet laryngoscopic conditions.

However, the maintenance of deep NMB during surgery is likely to lead to postoperative residual muscle relaxation, which has been reported to occur in 33–64% of patients after admission to the recovery room. Additionally, postoperative residual muscle relaxation contributes to the occurrence of pulmonary complications, such as airway obstruction, aspiration, and hypoxia, and of delayed discharge.[4–6] The risk of residual muscle relaxation inevitably increases after laryngeal microsurgery, because most procedures are completed in less than 30 min, which does not allow the patient time to spontaneously recover from the muscle relaxation, before an acetylcholinesterase inhibitor is used. Therefore, in clinical practice, a single reduced dose of an intermediate-acting, non-depolarizing neuromuscular blocking agent is typically administered at the time of anaesthetic induction to facilitate rapid recovery of the protective airway reflexes and to prevent delayed discharge, even though moderate NMB is not ideal for laryngeal microsurgery.[1 3] However, previous reports have demonstrated that the maintenance of deep NMB during laparoscopic surgery, including cholecystectomy, hysterectomy, and prostatectomy, provided better surgical conditions than moderate NMB[7–11] and that the risk of delayed discharge as a result of deep NMB was avoided using sugammadex.[12–15] However, to the best of our knowledge, no study has evaluated the effect of deep NMB on surgical conditions during laryngeal microsurgery.

Therefore, based on the hypothesis that deep NMB would improve the surgical conditions during laryngeal microsurgery, we compared the effect of deep NMB with that of moderate NMB on surgical conditions during laryngeal microsurgery.

Methods

This prospective, randomized study was approved by the Institutional Review Board of Severance Hospital (ref: 4-2013-0451) in Seoul, Republic of Korea, and was registered at ClinicalTrials.gov (ref: NCT01980069, November 1, 2013). Written informed consent was obtained from all patients. The participants included adults aged 20–80 yr who exhibited an ASA physical status of I, II or III and were undergoing elective laryngeal microsurgery requiring tracheal intubation under general anaesthesia. Patients with a known neuromuscular disease, a history of difficult intubation, cervical spine injury or pathology, acute or chronic renal failure, liver cirrhosis, liver failure, or an allergic reaction to non-depolarizing neuromuscular blocking agents were excluded.

The patients were randomly assigned to two groups using a computer-generated randomization table: the 'post-tetanic counts 1-2' (PTC1-2) group or the 'train-of-four counts 1-2' (TOFcount1-2) group. The dose of rocuronium administered at anaesthesia induction, the degree of intraoperative NMB, and the selection of drugs for NMB antagonism differed according to the group assignment.

Preoperative airway assessments, including the modified Mallampati classification, the thyromental distance, and the interincisor gap, were conducted before anaesthesia induction by one of the investigators (H.J.K.), who was unaware of the group assignment. A bispectral index sensor (BIS™ sensor; Covidien, Boulder, CO, USA) was attached to the patient's forehead. Two electrodes were placed on the skin above the ulnar nerve and were connected to an acceleromyograph (TOF-Watch® SX, Roganon Ireland Ltd., a subsidiary of Merck and Co., Swords, Co. Dublin, Ireland).

Propofol and remifentanil were administered via continuous i.v. infusion. After loss of consciousness was confirmed, neuromuscular activity monitoring via acceleromyography was initiated. The acceleromyograph was calibrated with 50 Hz tetanic stimulation for 5 s and train-of-four (TOF) stimulation for 3 min.[12 13] The ulnar nerve was stimulated, and the movement of the adductor pollicis muscle was monitored. After the calibration was completed, repetitive TOF stimulation was initiated. Rocuronium was administered intravenously at the dose determined by the group assignment (1.2 mg kg^{-1} for the PTC1-2 group or 0.5 mg kg^{-1} for the TOFcount1-2 group). Tracheal intubation was performed after a TOF count of 0 was confirmed by a single anaesthetist (B.R.L.), who was unaware of the group assignment. The Cormack and Lehane grade of the laryngeal view was recorded.[16] Anaesthesia was maintained via continuous i.v. infusion of propofol and remifentanil, targeting a bispectral index of 40–60. Neuromuscular activity monitoring was performed repeatedly using TOF stimulation or post-tetanic count (PTC) stimulation, until the TOF ratio was greater than 0.9. TOF stimulation and PTC stimulation were repeated every 15 s and two min, respectively. PTC stimulation at 1 Hz for 15 s was performed three s after tetanic stimulation at 50 Hz for five s.[17] Additional rocuronium was administered intravenously according to the group assignment. Rocuronium 0.15 mg kg^{-1} was administered to maintain the PTC at less than two or the TOF count at one or two based on acceleromyography in the PTC1-2 group and the TOFcount1-2 group, respectively. Additionally, if the surgeon asked the anaesthetist for deeper NMB to achieve an adequate surgical field, rocuronium 0.15 mg kg^{-1} was administered. The peripheral temperature was measured continuously at the axilla on the same side as neuromuscular activity was monitored, with the shoulder completely adducted and at a constant temperature of 35°C or greater using a forced air warmer.[18]

At the end of surgery, the degree of NMB was assessed using TOF stimulation. If the TOF response was absent, the PTC was observed. Patients received either sugammadex (Bridion®, Merck Sharp and Dohme (MSD), Oss, The Netherlands) at different doses or neostigmine at 50 μg kg^{-1} according to their group assignment. Sugammadex at eight or four mg kg^{-1} was administered to patients in the PTC1-2 group if the PTC was ≤2 or >2, respectively. Neostigmine was administered with glycopyrrolate 10 μg kg^{-1} to the TOFcount1-2 group if a second twitch appeared upon TOF stimulation. Anaesthesia was maintained until the TOF ratio recovered to 0.9.

The surgeon (W.S.K.), who was blinded to the group assignment, performed the laryngeal microsurgery. The surgeon evaluated the resistance of the rigid laryngoscope, the movement of the vocal cords, and the position of the vocal cords, immediately upon the placement of the rigid laryngoscope, to expose the vocal cords. The surgeon also scored the difficulty of exposing the vocal cords using a rigid laryngoscope, using a three-point scale: difficult, acceptable, or easy. The duration of vocal cord exposure was recorded from the insertion of the rigid laryngoscope into the patient's mouth to the fixation of suspension. The surgeon