Kaohsiung Journal of Medical Sciences (2013) 29, 484–487

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ORIGINAL ARTICLE

A comparison between succinylcholine and rocuronium on the recovery profile of the laryngeal muscles during intraoperative neuromonitoring of the recurrent laryngeal nerve: A prospective porcine model

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Received 12 April 2012; accepted 6 September 2012
Available online 6 April 2013

KEYWORDS
Intraoperative neuromonitoring;
Neuromuscular blocking agent;
Porcine model;
Recurrent laryngeal nerve;
Thyroid surgery

Abstract The use of succinylcholine and rocuronium are reportedly feasible during intraoperative neuromonitoring (IONM) of the recurrent laryngeal nerve (RLN) in thyroid surgery. This study aimed to investigate and compare the recovery profiles of succinylcholine and rocuronium on the laryngeal muscle during IONM of the RLN in a porcine model. Nine male Duroc-Landrace piglets were anesthetized with thiamylal and underwent tracheal intubation without neuromuscular blocking agents (NMBAs). Needle electrodes were inserted into the vocalis muscles through the cricothyroid ligament. The RLN was exposed and stimulated. Electromyographic (EMG) signals were obtained before and after the intravenous administration of a NMBA. The EMG amplitudes were measured before and after (at 1-minute intervals) the administration of the study drug until complete recovery. The study NMBA regimen included

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http://dx.doi.org/10.1016/j.kjms.2013.01.002

succinylcholine (1 mg/kg), low-dose rocuronium (0.3 mg/kg), and standard dose rocuronium (0.6 mg/kg). The maximal neuromuscular blockade and 80% recovery (i.e., duration) of the control responses were recorded and analyzed. The 80% recovery of the control response for succinylcholine (1 mg/kg) was 19.7 ± 1.5 minutes; low-dose rocuronium (0.3 mg/kg), 16.3 ± 2.5 minutes; and standard dose rocuronium (0.6 mg/kg), 29.3 ± 5.7 minutes. Succinylcholine (1 mg/kg) and low-dose rocuronium (0.3 mg/kg) had significantly shorter durations than standard dose rocuronium (0.6 mg/kg). The EMG signal recovery returned to baseline within 30 minutes in the succinylcholine and low-dose rocuronium groups, but it did not return to baseline until 1 hour after surgery in the rocuronium (0.6 mg/kg) group. In this study, succinylcholine (1 mg/kg) and low-dose rocuronium (0.3 mg/kg) had favorable recovery profiles on the laryngeal muscle. It is recommended that low-dose rocuronium may replace succinylcholine for the induction of general anesthesia during IONM of the RLN in thyroid surgery.

Introduction

Intraoperative neuromonitoring (IONM) of the recurrent laryngeal nerve (RLN) is commonly used in thyroid operations to prevent RLN injury [1–4]. However, troubleshooting IONM problems is persistently reported in the literature. The misuse of neuromuscular blocking agents (NMBAs) is a potential cause of unsuccessful IONM. To achieve muscle relaxation for tracheal intubation and operating conditions, administering a NMBA is usually mandatory. However, a NMBA can reduce the electromyographic (EMG) amplitude and make monitoring less sensitive to impending neural injury. When using a NMBA to induce general anesthesia, it is best to allow all neuromuscular blockade drugs to wear off and a full return of muscular activity as soon as possible after the intubation. The use of depolarizing NMBAs (e.g., succinylcholine) or nondepolarizing NMBAs (e.g., rocuronium) are reportedly feasible during IONM of the RLN in thyroid surgery [5–7]. However, it is impossible to obtain the continuous recovery profile of each NMBA in human subjects because of repeated nerve stimulation at 1-minute intervals. Furthermore, the dose of a NMBA and the timepoint of nerve stimulation are critical for successful IONM. Therefore, it is necessary to understand the recovery profile of different NMBAs at different doses. This study used an established porcine model with the aim of comparing the recovery profile of the laryngeal muscle to succinylcholine and rocuronium (at a low dose and the standard dose) and to find a relatively optimal NMBA for IONM.

Materials and methods

Animals and anesthesia

Duroc-Landrace male piglets (n = 9) weighing 18–20 kg were obtained through the Kaohsiung Medical University, Laboratory Animal Center (Kaohsiung, Taiwan). The piglets were allocated into one of three groups, based on the delivered NMBA regimen (each group had 3 piglets). The animal use protocol was approved by the Institutional Animal Care and Use Committee of the Kaohsiung Medical University (Kaohsiung, Taiwan) (protocol number 97146). The piglets were fasted for 8 hours, but were allowed water before the experiment. The piglets were anesthetized with 4% sevoflurane in pure oxygen at a flow rate of 4 L/min and were administered intravenous thiamylal (5 mg/kg). An endotracheal tube (size #6) was then inserted without the administration of a NMBA. General anesthesia was maintained with 1–3% sevoflurane and the piglets were controlled ventilated. They were continuously monitored through physiological monitors such as electrocardiography (EKG), oximetry, end-tidal CO_2, and airway pressure.

Equipment setting and experimental design

After surgical disinfection, a midline vertical cervical incision was created to expose the animal's neck and larynx. The RLN was identified and dissected free from the overlying soft tissue and fascia. Needle electrodes (Medtronic Xomed, Jacksonville, FL) were inserted into the vocalis muscles through the cricothyroid ligament. The channel leads from

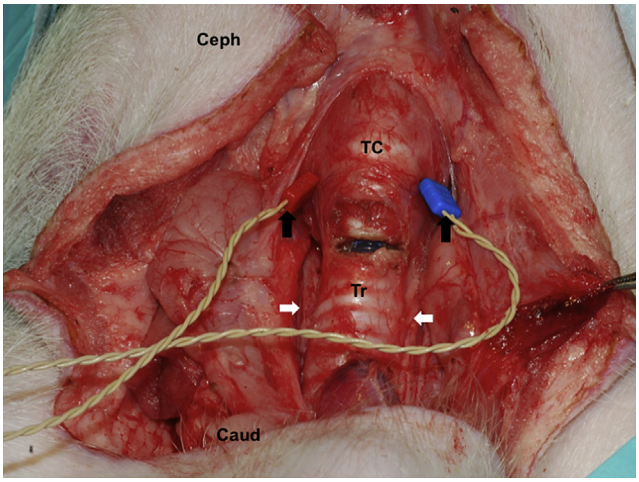

Figure 1. The neuromonitoring setup of the recurrent laryngeal nerve in a porcine model. The bilateral recurrent laryngeal nerve (white arrows) is exposed and stimulated. A pair of needle electrodes (black arrows) is inserted into the vocalis muscles. Caud = caudal; Ceph = cephalad; TC = thyroid cartilage; Tr = trachea.