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Original contribution

Visual evaluation of fade in response to facial nerve stimulation at the eyelid

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Abstract

Study Objective: The aim of this study is to investigate the probability of visual detection of fade in response to train-of-four (TOF) stimulation, double-burst stimulation$_{3,3}$ ($DBS_{3,3}$), or $DBS_{3,2}$ at the eyelid in comparison to that at the thumb.

Design: This is a randomized single-blinded study.

Setting: The study took place at the University hospital.

Patients and Measurements: Sixty adult patients underwent general anesthesia.

Interventions and Measurements: Patients were randomly divided into either the eyelid group (n = 30) or the thumb group (n = 30). In the eyelid group, at the varying degrees of neuromuscular block caused by vecuronium, TOF, $DBS_{3,3}$, or $DBS_{3,2}$ were given at the temporal branch of the facial nerve, and the probability of visual detection of fade in response to TOF, $DBS_{3,3}$, or $DBS_{3,2}$ was determined at the eyelid. Similarly, in the thumb group, the probability of visual detection of fade in response to TOF, $DBS_{3,3}$, or $DBS_{3,2}$ was examined at the thumb.

Main Results: When the true TOF ratios were 0 to 0.60, the probability of detection of TOF fade in the eyelid group was significantly lower than in the thumb group ($P < .05$). At the true TOF ratios of 0.31 to 0.70, the probability of visual detection of $DBS_{3,3}$ fade in the eyelid group was significantly less than in the thumb group ($P < .05$). When the true TOF ratios were 0.81 to 1.00, the probability of detection of $DBS_{3,2}$ fade in the eyelid group was significantly higher than in the thumb group ($P < .05$).

Conclusion: The probability of visual detection of fade in response to TOF or $DBS_{3,3}$ is lower at the eyelid than the thumb. In contrast, $DBS_{3,2}$ fade tends to be seen more frequently at the eyelid than at the thumb.

1. Introduction

The depth of neuromuscular block is commonly monitored at the thumb. Monitoring of neuromuscular block at the eyelid has also been studied [1-8]. Recovery from neuromuscular block assessed at the eyelid is rapid [1-7]. To assess profound neuromuscular block, monitoring of neuromuscular block at the eyelid is of clinical use. It is thought to be related to the fact that the orbicularis oculi muscle is more resistant to neuromuscular relaxant than is the adductor pollicis muscle [1-7]. However, a previous study

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recently showed that the orbicularis oculi and adductor pollicis muscles had the same sensitivity to neuromuscular relaxant, and that the corrugator supercilii muscle was more resistant to neuromuscular relaxant than either the orbicularis oculi or adductor pollicis muscle [8].

The relationship between the probability of visual detection of fade in response to the train-of-four (TOF) or double-burst stimulation (DBS) and the true depth of neuromuscular block has already been investigated at the thumb, index finger, and great toe [9-13]. However, to date, no studies have examined the probability of fade in response to facial nerve stimulation at the eyelid. The present study was undertaken to document the probability of visual detection of fade in response to TOF, $DBS_{3,3}$, or $DBS_{3,2}$ in anesthetized patients receiving vecuronium at varying degrees of neuromuscular block, in comparison to that at the thumb.

2. Materials and methods

The protocol was approved by the local ethics committee of the Fukushima Medical University School of Medicine, and informed consent was obtained from each patient. Sixty American Society of Anesthesiologists physical status I and II adult patients undergoing elective surgical procedures with general anesthesia were enrolled in this study. All patients were free of neuromuscular, hepatic, and renal disorders and were not receiving any drugs known to affect the action of neuromuscular relaxants. The sixty patients were randomly divided into 2 groups: eyelid group (n = 30) and thumb group (n = 30).

In each patient in the 2 groups, premedication consisting of atropine 0.01 mg/kg and midazolam 0.05 mg/kg was administered intramuscularly 30 minutes before induction of anesthesia. On arrival at the operating room, electrocardiographic and noninvasive blood pressure monitors were attached. Two surface-stimulating electrodes and 2 surface-recording electrodes were applied to the ulnar nerve at the wrist of the forearm and above the adductor pollicis muscle, respectively. A ground electrode was placed between the stimulating electrodes and the recording electrodes. These 5 electrodes were connected to a neuromuscular transmission analyzer (Relaxograph; Datex Inc, Helsinki, Finland).

In the eyelid group, 2 surface-stimulating electrodes were also positioned over the temporal branch of the right facial nerve. The negative and the positive stimulating electrodes, respectively, were placed 2 cm lateral to the lateral canthus of the eye and 1.5 cm superior and inferior to this point, as recommended previously [1,2]. The stimulating electrodes were connected to another neuromuscular transmission analyzer (TOF guard; Biometer Inc, Odense, Denmark). In the thumb group, 2 surface-stimulating electrodes connected to the neuromuscular transmission analyzer (TOF guard) were placed over the ulnar nerve of the forearm opposite the electromyography (EMG). As noted below, after induction of anesthesia, facial and ulnar nerves were stimulated in the eyelid and thumb groups, respectively.

In the 2 groups, anesthesia was induced with thiopental sodium 3 to 4 mg/kg and fentanyl 2 μg/kg IV. After loss of eyelash reflex was confirmed, neuromuscular function was evaluated via EMG at the adductor pollicis muscle using the neuromuscular transmission analyzer (Relaxograph). For TOF stimulation, 4 square-waves single twitch stimuli (pulse width 0.2 milliseconds) were delivered every 0.5 seconds. Train-of-four stimuli were applied at the ulnar nerve every 20 seconds at a supramaximal current.

In each group, after the administration of thiopental and fentanyl, TOF stimuli were delivered every 20 seconds for 5 to 10 minutes. Patients' lungs were ventilated via a facemask with oxygen 6 L/min and isoflurane 1%. Once the EMG amplitude of T1 (first response in TOF) was stabilized, the magnitude of T1 was recorded as the control value. Thereafter, vecuronium 0.1 mg/kg was administered to facilitate tracheal intubation. Anesthesia was maintained with 66% nitrous oxide, 33% oxygen, and 0.5% to 1.0% of end-tidal isoflurane. When the level of anesthesia was thought to be insufficient, a bolus dose of fentanyl 2 μg/kg was administered. Ventilation was controlled to maintain normocapnia ($P_{ET}CO_2$, 32-37 mm Hg). The concentrations of anesthetics and $P_{ET}CO_2$ were measured continuously using a multiple gas monitor (AS/3 ADU Anesthetic Work Station; Datex Inc).

In the eyelid group, as described above, the temporal branches of the facial nerve were stimulated. The stimulation pattern for TOF delivered over the facial nerve was equal to that given over the ulnar nerve. However, when the facial nerve was stimulated, the supramaximality of the stimulating current was not examined, and the stimulating current for TOF applied over the facial nerve was settled at 60 mA. In addition, in the thumb group, the ulnar nerve of the forearm opposite the EMG assessment of the level of neuromuscular block was stimulated at 60 mA using the neuromuscular transmission analyzer (TOF guard). Train-of-four, $DBS_{3,3}$, or $DBS_{3,2}$ was applied at the facial or ulnar nerve when the presence or absence of fade in response to facial or ulnar nerve stimulation was examined visually at the eyelid and thumb.

One of 20 observers, all anesthetists, who were blinded as to the true TOF ratio measured at the adductor pollicis muscle and the pattern of nerve stimulation, visually assessed the presence or absence of fade in response to TOF, $DBS_{3,3}$, or $DBS_{3,2}$ at the eyelid and at the thumb in the eyelid and thumb groups,, respectively. Each observer took part in evaluation of the presence or absence of fade in the same patient at most 4 times. When one observer assessed the presence or absence of fade twice, the second visual assessment of fade was performed more than 30 minutes after the first assessment of fade. In some patients, a bolus dose of vecuronium 0.01 to 0.02 mg/kg was given to achieve a more intense level of neuromuscular block. Once