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ORIGINAL ARTICLE

Monitoring of vecuronium-induced neuromuscular block at the sternocleidomastoid muscle in anesthetized patients

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Abstract

Purpose To assess the degree of neuromuscular block acceleromyographically at the sternocleidomastoid muscle.

Methods Eighteen adult patients scheduled for air–oxygen–sevoflurane–fentanyl and epidural anesthesia were studied. In the patients, the right accessory nerve and the sternocleidomastoid muscle were stimulated and the contraction of the sternocleidomastoid muscle was evaluated acceleromyographically. Simultaneously, the response of the adductor pollicis muscle was measured electromyographically. Supramaximal stimulating current, degree of maximum neuromuscular block after vecuronium 0.1 mg/kg, and onset of or recovery from vecuronium-induced neuromuscular block were compared between the two muscles.

Results The supramaximal stimulating current at the sternocleidomastoid muscle was significantly higher than that at the adductor pollicis muscle (54.8 ± 7.1 vs. 33.7 ± 10.3 mA, mean ± SD, $P < 0.001$). The onset of neuromuscular block at the sternocleidomastoid muscle did not significantly differ from that at the adductor pollicis muscle (214 ± 117 vs. 161 ± 87 s, $P = 0.131$). The degree of maximum neuromuscular block at the sternocleidomastoid muscle was significantly less than that at the adductor pollicis muscle (93.6 ± 3.1 vs. $99.2 \pm 2.5\%$, $P < 0.001$). During recovery from neuromuscular block, T1/control and train-of-four ratio measured at the sternocleidomastoid muscle were significantly higher than those at the adductor pollicis muscle 10–30 and 40–120 min after vecuronium, respectively ($P < 0.05$).

Conclusion The sternocleidomastoid muscle is more resistant to vecuronium than the adductor pollicis muscle. Recovery from neuromuscular block is faster at the sternocleidomastoid muscle than at the adductor pollicis muscle.

Keywords Sternocleidomastoid muscle · Adductor pollicis muscle · Vecuronium

Introduction

The level of neuromuscular block is commonly assessed at the adductor pollicis muscle. However, the degree of neuromuscular block can be evaluated at several parts of anesthetized patients other than the adductor pollicis muscle; i.e., great toe [1, 2], gastrocnemius muscle [3], corrugator supercilii or orbicularis oculi muscle [4, 5], and the inferomedial part of the thigh [6, 7].

In patients with airway obstruction and hyperinflation of the lungs, the sternocleidomastoid muscle raises the sternum and expands the upper thorax [8], and takes an active part in the inspiration [9]. The sternocleidomastoid muscle is prone to fatigue [10]. The force of the contraction of the sternocleidomastoid muscle can be evaluated mechanomyographically in humans [10, 11]. Further, especially when the patients' arms lie alongside the trunk, the acceleromyographic monitoring of neuromuscular block

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cannot be performed at the adductor pollicis muscle. In such cases, the assessment of the degree of neuromuscular block at the facial muscles may be of clinical use. Nowadays, to evaluate the depth of neuromuscular block at the facial muscles, an acceleromyographic transducer is usually attached over the corrugator supercilii muscle [4, 5, 12]. To assess the level of neuromuscular block over the muscle, a transducer needs to be placed over the forehead of the patient. However, the corrugator supercilii muscle is so small that concomitant monitoring of the orbicularis oculi and production of a mixed signal cannot be avoided [4, 5, 12]. For this reason, it is suggested that the monitoring of neuromuscular block over the corrugator supercilii muscle may be impractical. In addition, a probe for monitoring the degree of hypnosis (i.e., the bispectral index) is routinely attached to the forehead of any patient undergoing general anesthesia, so we proposed that monitoring neuromuscular block at the sternocleidomastoid muscle would be of greater use. This study was undertaken to examine whether the depth of neuromuscular block could be assessed at the sternocleidomastoid muscle acceleromyographically. In addition, we compared the monitoring of neuromuscular block at the sternocleidomastoid muscle with that at the adductor pollicis muscle in anesthetized patients receiving vecuronium.

Methods

The protocol of the present study was approved by our local ethics committee, and written informed consent was obtained from each patient. Eighteen adult patients (11 males and 7 females) with an ASA physical status of 1 or 2 who were scheduled for elective colonic surgery during general anesthesia combined with epidural anesthesia were studied. No patient had any neuromuscular, cardiac, hepatic, renal, or metabolic disorder, nor was any patient taking any drug known to affect neuromuscular transmission.

In the present study, sample sizes were based upon an ability to detect a difference of $\geq$0.2 in the mean T1 [first stimulation in train-of-four (TOF)]/control value or the TOF ratio (T4/T1), with a standard deviation of approximately 0.2. Assuming an α of 5% and a power of 90%, 18 patients were required [13]. Accordingly, a total of 18 patients were enrolled in the present study.

No premedication was given to the patients. After arrival in the operating room, an epidural catheter was placed through the Th10/11 intervertebral space, and a test dose of 60 mg lidocaine 2% (3 mL) was given. Thereafter, the patients lay on the operating bed in a supine position, and the patients' heads were simply placed on a headrest. The patients received a continuous infusion of lidocaine 2% at a rate of 6–8 mL/h via the epidural catheter.

The devices for monitoring of neuromuscular block were attached in the patients. As shown in Fig. 1, to monitor neuromuscular block at the sternocleidomastoid muscle, a surface-stimulating electrode (the cathode) was placed over the midpoint of the right side of the sternocleidomastoid muscle where the muscle received its motor innervation from the accessory nerve. Another electrode (the anode) was positioned over the upper sternum. This way of positioning the stimulating electrodes was in accordance with that reported previously [11]. Once the two electrodes had been placed, an acceleromyographic transducer was attached between the two electrodes with an adhesive tape. Additionally, two stimulating electrodes were positioned over the left ulnar nerve at the wrist. The anode was placed proximal to the cathode. Two recording electrodes were also attached over the adductor pollicis muscle. One ground electrode was positioned between the stimulating and recording electrodes. These electrodes were connected to a neuromuscular transmission module as described below.

Anesthesia was induced with propofol 2.5 mg/kg and fentanyl 2 μg/kg. After the loss of the eyelid reflex, a laryngeal mask airway (LMA Proseal, LMA International Services UK, Wooburn Green, UK) was inserted and the lungs were ventilated with air 3 L/min, oxygen 1 L/min, and sevoflurane 1.7% of end-tidal concentration. Laryngeal mask airways of #5 and #4 were inserted in male and female patients, respectively. To determine the supramaximal stimulating current at the sternocleidomastoid muscle, square-wave single-twitch stimuli of duration 0.2 ms were delivered at 1 Hz. At first, the single twitch stimuli were started at 60 mA, and the stimulating current was decreased in steps of 5 (60, 55, 50, 45,… 20) mA. When a decrease of 10% or more was detected in the acceleromyographic

Fig. 1 Two surface-stimulating electrodes are attached over the accessory nerve and sternocleidomastoid muscle. An acceleromyographic transducer and a surface thermometer probe are placed over the sternocleidomastoid muscle

transducer signal in response to the single-twitch stimuli, the current at which the supramaximal muscular response could be elicited was defined as the stimulation current for the previous stimulation. Thereafter, the current level that was 110% of that which yielded the supramaximal response was regarded as the "supramaximal stimulating current." Simultaneously, the ulnar nerve of the left forearm was stimulated using an electrical nerve stimulator of a neuromuscular transmission module (M-NMT Module, Datex-Ohmeda Inc., Helsinki, Finland). For each patient, the monitoring system searched automatically for the stimulus current needed to achieve the maximal response of the adductor pollicis muscle. The search began with 10 mA square-wave single-twitch stimuli of duration 0.2 ms applied every 1 s. The stimulating current was increased in steps of 5 mA until increasing the current no longer increased the electromyographic response. The stimulating current was then automatically increased by 15% to produce a supramaximal current. If the supramaximal current was not found or the response was too weak to determine the current, the current was set at 70 mA. Once the supramaximal current had been established, the electromyographic amplitude of single-twitch stimulation was considered to be the control value, and the mode of the nerve stimuli was changed to TOF stimuli. For TOF stimuli, four single-twitch stimuli consisting of square waves 0.2 ms in duration were delivered at 2 Hz every 15 s. The corresponding electromyographic amplitudes were quantified using the neuromuscular transmission module, and were displayed on an anesthetic monitoring system (Anaesthetic Monitoring System A/S3, Datex-Ohmeda Inc.). The control value was again determined 10 min after starting TOF stimuli, which were applied every 15 s, as recommended previously [14].

After the stabilization period of the TOF stimuli at the sternocleidomastoid and adductor pollicis muscles, vecuronium 0.1 mg/kg was administered intravenously. After the administration of vecuronium, TOF stimuli were continuously applied every 15 s. Times from the administration of vecuronium to the onset of neuromuscular block were compared between the sternocleidomastoid and adductor pollicis muscles. The onset of neuromuscular block was regarded as the time when the acceleromyographic or electromyographic value of T1/control decreased to the minimum level. Once the time from vecuronium administration to the onset of neuromuscular block had been determined, the time interval for TOF stimuli was changed to 10 min at the two muscles. In other words, from the time when vecuronium was administered, TOF stimuli were applied every 10 min, and T1/control values or TOF ratios were recorded at the two muscles. In this way, T1/control or the TOF ratio was compared every 10 min between the two muscles.

When the level of neuromuscular block was assessed at the sternocleidomastoid muscle, the number of patients in whom the abdomen or right upper limb moved was recorded. Also, the degree of movement of the abdomen or right upper limb was graded as severe, slight, or none. Movement of the abdomen or right upper limb that hindered the surgical procedure was regarded as "severe." If the abdomen or right upper limb moved but the movement did not interfere with the surgical procedure, it was graded as "slight." When no movement of the abdomen and right upper limb was observed, the movement was classified as "none."

Anesthesia was maintained with air 3 L/min, oxygen 1 L/min, and sevoflurane 1.7% end-tidal concentration, and 2% lidocaine was administered continuously via the epidural catheter. A bolus dose of fentanyl 2 μg/kg was administered intravenously before skin incision. When the patients exhibited systolic hypertension (systolic arterial pressure >150 mmHg) or tachycardia (heart rate >100 bpm), a supplemental bolus of fentanyl 2 μg/kg was administered. Ventilation was controlled to maintain normocapnia ($P_{ET}CO_2$ 32–37 mmHg). The end-tidal concentrations of anesthetic and $P_{ET}CO_2$ were measured continuously using a multiple gas monitor belonging to the anesthetic monitoring system. Esophageal temperature was monitored throughout the surgical procedure. Also, the surface skin temperatures over the sternocleidomastoid and adductor pollicis muscles were measured using a thermometer probe.

The supramaximal stimulating currents, times to the onset of neuromuscular block, and the minimum acceleromyographic or electromyographic values of T1/control were compared between the sternocleidomastoid and adductor pollicis muscles using the unpaired *t* test. The comparison of T1/control or the TOF ratio during recovery from neuromuscular block between the sternocleidomastoid and adductor pollicis muscles was done using analysis of variance (ANOVA) and the unpaired *t* test with Bonferroni's adjustment. All results were expressed as numbers or mean ± SD. $P < 0.05$ was considered statistically significant. Statistical analyses were performed using a statistical package (SPSS 15.0J for Windows, SPSS Inc., Chicago, IL, USA) running on a personal computer.

Results

The mean age, weight, and height of the patients studied were 67.7 ± 12.2 years, 58.7 ± 10.0 kg, and 160.6 ± 8.2 cm, respectively. Eight and 10 patients were ASA grade 1 and 2, respectively.

The supramaximal stimulating current at the sternocleidomastoid muscle was significantly higher than that at

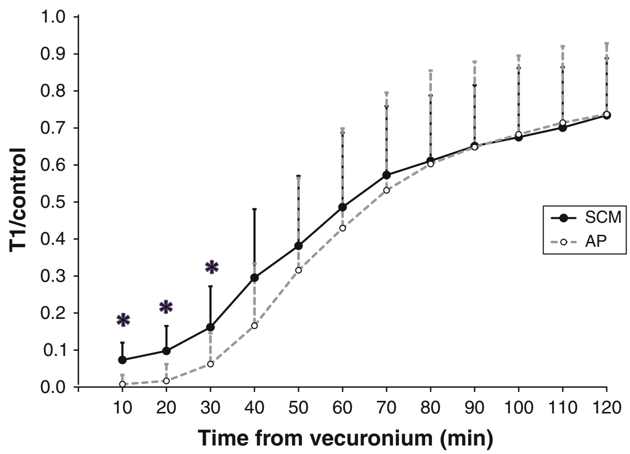

Fig. 2 T1/control values obtained at the sternocleidomastoid muscle (*filled circles*) and at the adductor pollicis muscle (*open circles*) after the administration of vecuronium 0.1 mg/kg. $^{*}P < 0.05$ between groups. *SCM* sternocleidomastoid muscle, *AP* adductor pollicis muscle

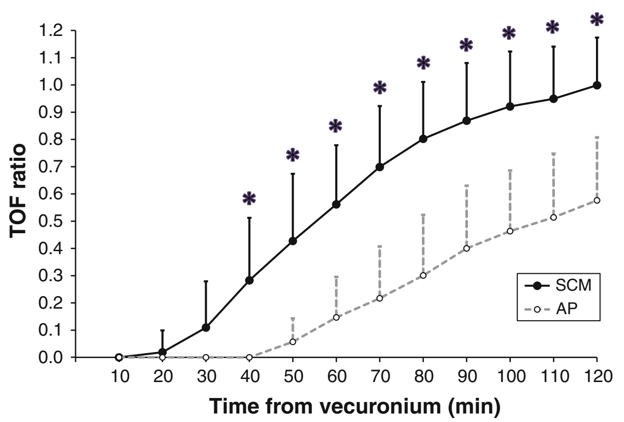

Fig. 3 TOF ratios obtained at the sternocleidomastoid muscle (*filled circles*) and adductor pollicis muscle (*open circles*) after the administration of vecuronium 0.1 mg/kg. $^{*}P < 0.05$ between groups. *TOF* train-of-four, *SCM* sternocleidomastoid muscle, *AP* adductor pollicis muscle

the adductor pollicis muscle (54.8 ± 7.1 vs. 33.7 ± 10.3 mA, $P < 0.001$). The time from vecuronium administration to the onset of neuromuscular block did not differ significantly at the sternocleidomastoid and adductor pollicis muscles (214 ± 117 vs. 161 ± 87 s, $P = 0.131$). The degree of maximum neuromuscular block at the sternocleidomastoid muscle was significantly less than that at the adductor pollicis muscle (93.6 ± 3.1 vs. 99.2 ± 2.5%, $P < 0.001$).

As shown in Figs. 2 and 3, during recovery from neuromuscular block, T1/control and the TOF ratio at the sternocleidomastoid muscle were significantly higher than those at the adductor pollicis muscle 10–30 and 40–120 min after vecuronium, respectively ($P < 0.05$).

When the level of neuromuscular block was monitored at the sternocleidomastoid muscle, the movement of the abdomen was severe in 2 patients. The movement of the upper limb was also severe in 2 patients. The movements of the abdomen and that of the upper limb were slight in 4 and 3 patients, respectively. In the remaining 7 patients, the movement of the abdomen or upper limb was classified as "none." In the patients in whom the abdomen or upper limb moved during the accessory nerve stimuli, the movement became apparent when T1/control returned to a value of more than about 0.1.

In no patient did the esophageal or peripheral temperature decrease below 35.5 or 32.0°C, respectively. Also, in no patient did SpO_2 decrease to <98% at any time during anesthetic management.

Discussion

The present study indicates that the depth of neuromuscular block can be monitored acceleromyographically at the sternocleidomastoid muscle by stimulating the accessory nerve and sternocleidomastoid muscle. To evaluate the degree of neuromuscular block at the sternocleidomastoid muscle, a higher supramaximal stimulating current is needed. The onset of vecuronium 0.1 mg/kg-induced neuromuscular block measured at the sternocleidomastoid muscle does not differ from that at the adductor pollicis muscle. During recovery from neuromuscular block, T1/control and the TOF ratio evaluated at the sternocleidomastoid muscle is higher than those assessed at the adductor pollicis muscle. When the degree of neuromuscular block is monitored at the sternocleidomastoid muscle, the abdomen or upper limb often moves markedly.

To monitor the level of neuromuscular block at the adductor pollicis muscle, a current of 30 mA produces maximal muscular contraction in most patients [15, 16]. Also, in this study, the mean stimulating current needed to yield the maximal electromyographic response of the adductor pollicis muscle was 33.7 mA. In contrast, it has been reported that the supramaximal stimulating currents needed to elicit the maximal response at the orbicularis oculi muscle [17] and the orbicularis oris muscle [18] are 55 and 55.3 mA, respectively. From this viewpoint, a higher current is thought to be needed to yield the maximal response of the facial muscles or the sternocleidomastoid muscle. However, the difference in the neuromuscular monitoring device between the two muscles should be taken into consideration. As described in "Methods," to determine the supramaximal stimulating current acceleromyographically at the sternocleidomastoid muscle, single-twitch stimuli were started at 60 mA, and the stimulating current was decreased in steps of 5 (60, 55, 50, 45,… 20) mA.

On the other hand, at the adductor pollicis muscle, the search for the supramaximal stimulating current began with 10 mA single-twitch stimuli, and the stimulating current was increased in steps of 5 (10, 15, 20, 25,… 70) mA until the increase in current no longer increased the electromyographic response. If the degree of neuromuscular block at the adductor pollicis muscle had been monitored acceleromyographically, the supramaximal stimulating current may have differed from the present result.

In this study, the onset of neuromuscular block at the sternocleidomastoid muscle did not significantly differ from that at the adductor pollicis muscle. In a previous study, the onset of neuromuscular block evaluated at several muscles other than the adductor pollicis muscle was investigated. Hemmerling et al. [19] reported that the onset of mivacurium 0.2 mg/kg-induced neuromuscular block at the corrugator supercilii muscle was faster than that at the adductor pollicis muscle. They also showed that the time to the onset of neuromuscular block caused by mivacurium at the orbicularis oculi muscle did not significantly differ from that at the adductor pollicis muscle [19]. Accordingly, the onset of neuromuscular block assessed at muscles other than the adductor pollicis muscle may occur more quickly than or at a similar speed to that at the adductor pollicis muscle. Strictly speaking, to compare the onset of neuromuscular block at the sternocleidomastoid and adductor pollicis muscles, we cannot ignore the difference in the monitoring devices used. The minimum level of T1/control at the sternocleidomastoid muscle assessed acceleromyographically was 0.03 or 0.04, but that at the adductor pollicis muscle evaluated electromyographically was 0.01 in this study. Based on this, during the onset of neuromuscular block, T1/control at the sternocleidomastoid muscle was regarded as zero when it decreased to a value of less than 0.03 or 0.04. In contrast, T1/control at the adductor pollicis muscle was regarded as "present" until T1/control decreased to a value of <0.01. Thus, the onset of neuromuscular block measured electromyographically may be slower than that evaluated acceleromyographically. Further, the difference in blood flow at the skeletal muscles may influence the onset of neuromuscular block. However, Abdulatif and El-Sanabary [20] showed that although the blood flow at the orbicularis oculi muscle was much less than that at the adductor pollicis muscle during general anesthesia, the onset of mivacurium-induced neuromuscular block at the orbicularis oculi muscle was faster than that at the adductor pollicis muscle. They noted that the muscular blood flow was not the main mechanism for the difference in the onset of neuromuscular block at the different muscles. In this study, the blood flows at the two muscles were not evaluated, but the difference in the two muscles may not have affected the onset of neuromuscular block.

The present study showed that T1/control and the TOF ratio assessed at the sternocleidomastoid muscle were significantly higher than those evaluated at the adductor pollicis muscle 10–30 and 40–120 min after vecuronium, respectively. Formerly it had been believed that if the percentage of type II muscle fibers was high, the skeletal muscle was resistant to neuromuscular blocking drugs [1, 3]. The percentages of type II muscle fibers of the sternocleidomastoid and adductor pollicis muscles are 64.8 and 19.6%, respectively [21], which may lead to quick recovery of T1/control or the TOF ratio at the sternocleidomastoid muscle. However, this work has shown that a high percentage of type II muscle fiber does not necessarily guarantee resistance to neuromuscular blocking drugs. For example, although the percentages of type II fibers of the corrugator supercilii and orbicularis oculi muscles are 49 and 89%, respectively [22], the corrugator supercilii muscle was more resistant to neuromuscular blocking drugs than the orbicularis oculi muscle [5].

On the other hand, it has been suggested that muscle sensitivity to neuromuscular blocking drugs increases with type I fiber diameter [23]. However, the type I fiber diameter of the sternocleidomastoid muscle is a little larger than that of the adductor pollicis muscle (50.2 vs. 47.7 μm) [24], which contradicts the present result that the sternocleidomastoid muscle was more resistant to vecuronium. The type I fiber diameter may not necessary be related to the sensitivity to neuromuscular blocking drugs.

We previously reported that recovery of T1/control assessed over the vastus medialis muscle was comparable with that at the adductor pollicis muscle after vecuronium [6]. We also demonstrated that recovery of T1/control measured at the orbicularis oris muscle was identical to that at the adductor pollicis muscle [18]. In contrast, in the current study, T1/control assessed at the sternocleidomastoid muscle was significantly higher than that at the adductor pollicis muscle 10–30 min after vecuronium, and the difference became insignificant 40–120 min after vecuronium. We cannot definitively explain this, but we presume that it may be attributed to the difference in the sensitivity to vecuronium between the two muscles. After administration of vecuronium 0.1 mg/kg, the degree of maximum neuromuscular block at the sternocleidomastoid muscle was significantly less than that at the adductor pollicis muscle (93.6 ± 3.1 vs. $99.2 \pm 2.5\%$). Subsequently, for a while after the administration of vecuronium (i.e., 10–30 min after vecuronium), T1/control at the sternocleidomastoid muscle would have been higher than that at the adductor pollicis muscle.

It has been reported that T1/control and the TOF ratio represent the degrees of neuromuscular block at the post-junctional and pre-junctional regions of the neuromuscular junction, respectively [25]. In the present study, both

T1/control and the TOF ratio at the sternocleidomastoid muscle were higher than those at the adductor pollicis muscle. Recovery from neuromuscular block at the sternocleidomastoid muscle is thought to be faster than that at the adductor pollicis muscle at the levels of the pre- and post-junctional regions of the neuromuscular junction.

In this study, the TOF ratio evaluated at the sternocleidomastoid muscle was significantly higher than that at the adductor pollicis muscle 40–120 min after vecuronium. This result is similar to that observed in our previous studies in which the recoveries of the TOF ratio were compared between the vastus medialis and adductor pollicis muscles [6], or the orbicularis oris and adductor pollicis muscles [18]. Thus, the recoveries of the TOF ratio measured at several muscles other than the adductor pollicis muscle are thought to be faster than that at the adductor pollicis muscle.

When the contraction of the adductor pollicis muscle in response to ulnar nerve stimulation at the wrist is quantified, in principle the skeletal muscle is not directly stimulated, because the ulnar nerve is separate from the adductor pollicis muscle. On the contrary, when the degree of neuromuscular block is evaluated at the sternocleidomastoid muscle, not only the accessory nerve but also the sternocleidomastoid muscle can be stimulated. If the skeletal muscle is directly stimulated via surface electrodes, the skeletal muscle sometimes contracts even when the level of neuromuscular block is very profound [26]. However, in this study, 10 min after vecuronium, mean T1/control decreased to a value of 0.07. As described above, in our previous study which examined the monitoring of neuromuscular block over the vastus medialis muscle [6], mean T1/control decreased to a value of 0.04 after vecuronium 0.1 mg/kg, and the recovery of T1/control over the vastus medialis muscle and that at the adductor pollicis muscle followed similar time courses. Thus, we presume that even if the skeletal muscle is stimulated directly, the degree of neuromuscular block can be fairly assessed.

When TOF stimuli were given over the accessory nerve and sternocleidomastoid muscle, the abdomen and the upper limb moved markedly in 2 and 2 patients, respectively. The movement of the abdomen and that of the upper limb were thought to be due to the stimulation of the phrenic nerve and brachial plexus, respectively. For this reason, we asked the surgeons to stop the surgical procedure when the level of neuromuscular block was assessed at the sternocleidomastoid muscle in the four patients. The fact that the abdomen or the upper limb often clearly moves is a shortcoming of monitoring neuromuscular block at the sternocleidomastoid muscle during the surgical procedure. The patients' heads were simply placed on a headrest, but in no patient did the head clearly move.

Again, we discuss the undesirable movement of the abdomen or the upper limb during the stimulation of the accessory nerve. It has been demonstrated that the degree of neuromuscular block can be evaluated at submaximal stimulating currents [16, 27]. For example, as noted above, the supramaximal stimulating current for the ulnar nerve stimulation is 30 mA [15, 16]. Nevertheless, the depth of neuromuscular block can be assessed at a current of 20 mA [16, 27]. In the present study, the monitoring of neuromuscular block at the sternocleidomastoid muscle at submaximal stimulating currents was not investigated. However, if the accessory nerve had been stimulated at submaximal currents, the undesirable movement of the abdomen or upper limb might have been attenuated.

In the present study, the level of neuromuscular block was monitored acceleromyographically and electromyographically at the sternocleidomastoid muscle and at the adductor pollicis muscle, respectively. As compared with the TOF ratio measured mechanomyographically using a force transducer—the gold standard of the neuromuscular monitoring device, the TOF ratio assessed acceleromyographically is prone to be higher when the TOF ratio evaluated mechanomyographically is more than 0.7 [28]. Additionally, Kopman [29] reported that even when recovery from neuromuscular block was significant, T1/control assessed electromyographically tended to return to only 0.8. Hence, in this study, changes in T1/control or the TOF ratio due to the neuromuscular monitoring device should be taken into consideration.

We conclude that the degree of neuromuscular block can be monitored acceleromyographically at the sternocleidomastoid muscle. A higher supramaximal stimulating current is needed to monitor neuromuscular block at the sternocleidomastoid muscle as compared to that at the adductor pollicis muscle. The onset of neuromuscular block caused by vecuronium at the sternocleidomastoid muscle does not differ from that at the adductor pollicis muscle. Recovery of T1/control or the TOF ratio at the sternocleidomastoid muscle is faster than that at the adductor pollicis muscle. Monitoring neuromuscular block at the sternocleidomastoid muscle is useful from a clinical perspective, especially when the patients' arms lie alongside the trunk and the neuromuscular block cannot be quantified at the adductor pollicis muscle. Moreover, a deeper level of neuromuscular block can be evaluated at the sternocleidomastoid muscle than at the adductor pollicis muscle. The disadvantage of monitoring neuromuscular block at the sternocleidomastoid muscle is that the abdomen or upper limb of the patient often clearly moves when the accessory nerve is stimulated.

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