A comparative study of the orbicularis oculi muscle to the adductor pollicis muscle during vecuronium neuromuscular blockade

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Independence, Missouri

This study compared the orbicularis oculi muscle to the adductor pollicis muscle during vecuronium blockade. The orbicularis oculi muscle was found to be more resistant to and recovered from vecuronium neuromuscular blockade faster than the adductor pollicis muscle. Thus, caution should be utilized when assessing neuromuscular block with the orbicularis oculi muscle.

The purpose of this study was to compare the evoked neuromuscular response of the orbicularis oculi muscle with that of the adductor pollicis muscle in patients who have received vecuronium bromide.

The sample used for this study included 13 ASA class I and II patients. Patients were randomized as follows: Group 1 received vecuronium 0.1 mg/kg (n=7), and Group 2 received vecuronium 0.1 mg/kg (n=6).

A Professional Instruments Nerve Stimulator Model NS-3A was applied to each patient with NDM Corporation (NDM) Plia-Cell electrodes over the facial nerve and over the ulnar nerve. Two minutes following intubation, the two muscle groups were stimulated with the train-of-four modality every two minutes until one muscle group demonstrated evidence of recovery. At that point, both muscle groups were monitored at more frequent intervals until reappearance of the train-of-four response in both groups.

Analysis of the data obtained was performed using analysis of variance with repeated measures design. The results were statistically significant at every time interval for Group 1 and at time 4, 14, and 20 for Group 2 (p < 0.01).

This study found the train-of-four response may have completely recovered in the orbicularis oculi muscle while the adductor pollicis muscle still has significant neuromuscular block.

Introduction

Monitoring neuromuscular function is vital in safe anesthesia practice. The standard muscle/nerve complex monitored is the adductor pollicis/ulnar nerve complex. However, the ulnar nerve is not always accessible. The orbicularis oculi/facial nerve complex is an alternative site. The purpose of this study was to compare the evoked response of the orbicularis oculi muscle with that of the adductor pollicis muscle in patients who have received vecuronium bromide.

The hypothesis of this study was that there would be no difference in the evoked response between the orbicularis oculi muscle and the adductor pollicis muscle in patients who have received vecuronium bromide.

Methods

The University of Kansas Medical Center provided the setting for this investigation. Approval from the Human Subjects Committee was obtained.
The sample consisted of male and female patients, ages 18 to 54, who were nonobese, free from neuromuscular disease, and who presented for surgery not involving the upper extremities or face. Only ASA class I or II patients were included in the study.

Each unpremedicated patient was taken into the operating room and appropriate monitoring devices were applied, including a blood pressure cuff, precordial stethoscope and electrocardiogram. A Professional Instruments Nerve Stimulator Model NS-3A was applied to each patient with NDM PliaCell electrodes over the facial nerve (2 cm lateral to and 2 cm above the lateral canthus of the eyes) and over the ulnar nerve (2 cm and 9 cm proximal and distal to the end of the ulna) as indicated by Stiffel. Cardboard templates were employed to standardize electrode placements in all patients.

After 2-5 minutes of preoxygenation with 100% oxygen via face mask, each patient was induced with fentanyl 2 μg/kg and thiopental 3-5 mg/kg. Patients were randomized to one of two groups: Group 1 received vecuronium 0.1 mg/kg (n=7), and Group 2 received vecuronium 0.05 mg/kg (n=6). Fifty percent nitrous oxide in oxygen, along with sufficient isoflurane (0.5-1.5% inspired concentration), was administered via a semi-closed circle system to provide for amnesia and blood pressure control.

After administration of the barbiturate and just prior to the administration of vecuronium, the train-of-four response was observed and recorded at each monitoring site so that each patient served as his or her own control. Two trained observers evaluated the evoked response (visual determination) and if discrepancy was encountered, an average of the two responses was made. Both muscle groups were observed continuously employing a twitch frequency of 0.1 Hz until complete obliteration of response from the neuromuscular blocking drug had occurred. This was evidenced by the absence of visually discernible response to train-of-four stimulation, with these times being recorded.

A specially designed dual cable peripheral nerve stimulator was employed so that simultaneous, supramaximal stimulation was accomplished in both muscle groups. The trachea was intubated and breath sounds were auscultated to determine proper placement of the endotracheal tube. Two minutes following intubation, the two muscle groups were stimulated with the train-of-four modality every two minutes until one muscle group demonstrated evidence of recovery. At that point, both muscle groups were monitored with the train-of-four response at more frequent intervals until reappearance of the train-of-four response in both muscle groups. No additional vecuronium was administered to patients after the initial bolus was injected.

Recovery characteristics were observed (time to appearance of first, second, third and fourth twitch, as well as train-of-four ratio) and recorded. At the completion of the surgical procedure, the intensity of the response was evaluated, and the residual neuromuscular block was reversed with glycopyrrolate 0.01 mg/kg in combination with pyridostigmine 0.24 mg/kg.

Because two independent groups were being compared using several measures over time, analysis of variance (ANOVA) with repeated measures design was utilized. A level of significance of p<0.01 was established prior to initiating the study.

### Results

In Group 1, the times 2 (T1), 14 (T2), 20 (T3), 26 (T4) and 36 (T5) minutes were statistically analyzed as these represented milestones in terms of the recovery of the evoked response (Table I). At time T1, all the hand responses showed 100% neuromuscular block while the face demonstrated all four responses.

<table>
<thead>
<tr>
<th>Table I</th>
<th>Vecuronium 0.1 mg/kg</th>
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<tr>
<td>Number of evoked responses present</td>
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<td>Pt. #</td>
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<td>1</td>
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*p < 0.01
to the train-of-four. At T2, 14 minutes after administration of vecuronium, the face began demonstrating a return of train-of-four and at T5, 36 minutes, all four twitches had returned to the face. The average time of onset of neuromuscular blockade was 2 minutes for the hand and 4 minutes for the face. The average time of duration of neuromuscular blockade was 42 minutes for the hand and 25 minutes for the face.

In Group 2, the times 4 (T1), 14 (T2), 20 (T3) and 26 (T4) were analyzed (Table II). Only four times were analyzed in this group because the smaller dose of vecuronium resulted in a shorter duration of action. The time for complete depression of the adductor pollicis muscle was longer in this group; thus, the time before adequate intubation conditions were present was longer. Also, the patient recovery of neuromuscular function was faster in this group. Three patients in this group never experienced complete loss of the train-of-four response in the face while their hands demonstrated complete absence of the train-of-four response. The average onset and duration of neuromuscular blockade was unable to be determined due to patients never losing all four twitches in the face.

<table>
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<th>Table II</th>
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<td>Group 2—Vecuronium 0.5 mg/kg</td>
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<td>Number of evoked responses present</td>
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*p < 0.01

Discussion

From analyzing the data, it can obviously be seen that the hypothesis was rejected. This study found that the facial nerve and orbicularis oculi muscle complex recovered more quickly than the ulnar nerve and adductor pollicis. In fact, the facial muscle demonstrated resistance to neuromuscular block in three cases. These findings support other studies done by Stiffel et al. and Caffery et al. Smith and associates have recently shown that the effects of succinylchloine at the diaphragm and adductor pollicis muscle are different. The degree of adductor pollicis blockade might overestimate the intensity of the diaphragmatic paralysis. Also, Sopher and associates found variability between the hand and foot muscles with vecuronium induced neuromuscular blockade.

The reason for this difference remains uncertain. Possible explanations would include both physiological and pharmacological variables. A different type of innervation is present in the facial muscles. These muscles have a proportionately greater number of neuromuscular junctions compared with other muscles in the body. This may contribute to their more rapid return to functioning and greater difficulty in ablating the evoked response. There may be some yet unknown factors which account for differences seen in the muscle groups (e.g., alteration in blood flow to the muscle groups, idiosyncratic sensitivity of one muscle group to one of the anesthetic drugs, etc.). Additionally, the relative contribution of Type I large muscle fibers and Type II small muscle fibers are known to vary depending on the muscle group.

Muscle relaxants vary in their pre- and post-junctional sites of action. These differences in action complicate the assessment of muscle function after drug administration, and may impact significantly upon the resultant evoked response in divergent muscle groups. Pathak et al. have discussed the clinical implications of receiving differing information from divergent muscle groups.

Equipment variability could also be a source for difference. Care needs to be taken in the placement of electrodes. The muscle itself can be directly stimulated if not properly positioned, thus, leading to erroneous interpretation. As stated previously, the nerve/muscle complex should be isolated from one another during stimulation to foster correct interpretation. Stiffel found surface electrodes tended to overestimate the degree of blockade compared with needle electrodes.

In conclusion, the facial muscle is more resistant to and recovers from vecuronium neuromuscular block faster than does the adductor pollicis mus-
Caution should be utilized with using the facial nerve stimulation to assess reversal of vecuronium neuromuscular block. The train-of-four may have completely recovered in the facial muscle while the adductor pollicis muscle indicates significant neuromuscular block. Thus, if the anesthetist relies exclusively on the facial muscle for neuromuscular monitoring, the patient could be overdosed on muscle relaxant during the case and an overestimation of the degree of recovery might occur at the end of the procedure.

REFERENCES

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Kristi Koch Campbell, CRNA, MS, graduated from the University of Kansas with a BSN degree. She received her MS degree from the University of Kansas School of Nurse Anesthesia, Kansas City, Kansas, in 1987. She is a staff nurse anesthetist at Independence Anesthesia, Inc., Independence, Missouri.

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