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Monitoring Neuromuscular Block May be Unreliable in Patients with Upper-motor-neuron Lesions

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Monitoring the degree of neuromuscular block during anesthesia has become a routine and valuable practice in the last few years.[1] Three recent cases have demonstrated that monitoring with the peripheral-nerve stimulator may be unreliable and misleading in patients with upper-motor-neuron lesions.

REPORT OF THREE CASES

Patient 1. A 73-year-old man was scheduled for elective cataract extraction. The patient weighed 68 kg. He had suffered a stroke three months prior to admission and had residual weakness of his left arm and leg. He took no medication. He had a grade II/VI right carotid bruit and a left femoral bruit. Blood pressure was 130/85 torr. The electrocardiogram showed frequent premature ventricular contractions and nonspecific S-T sagging. Random blood sugar was 195 mg/dl.

Anesthesia was induced with fentanyl, .075 mg, and droperidol, 3.75 mg, followed by pancuronium, 5 mg, and thiopental, 250 mg. The trachea was intubated and controlled ventilation instituted. Anesthesia was maintained with nitrous oxide, 60 per cent, and oxygen. Twenty-five minutes later, a peripheral-nerve stimulator† was used to test the neuromuscular blockade in the left arm. An apparently normal response was seen with twitch, tetanus and train-of-four stimulation. There was no fade discernible, and no posttetanic facilitation. A further 2 mg pancuronium were given.

Five minutes later, on testing the left ulnar nerve, there was still no apparent effect of the muscle relaxant. A fresh ampule of pancuronium was obtained and a further 2 mg were given. Again, no change was seen in the left arm. Twenty-five minutes after the last dose of pancuronium, the procedure was completed. Testing of the right arm now revealed complete neuromuscular block. Atropine, 1.2 mg, and pyridostigmine, 20 mg, were given in divided doses. Reversal was inadequate, as judged by respiratory difficulty and fade with twitch and train-of-four stimulation of the right arm. The patient needed assisted ventilation for 30 min in the recovery room. Further recovery was uneventful.

Patient 2. A 49-year-old man weighing 80 kg underwent a right temporal craniotomy for removal of a large clivus meningioma. He had had progressive weakness of his right arm and leg for four years. He was found to have right lower facial weakness, mild right hemiparesis, and some ataxia on the right side. Results of the general physical examination and laboratory screening tests were unremarkable.

Premedication was with atropine, 0.6 mg. Anesthesia was induced with meperidine, 40 mg, thiopental, 350 mg and pancuronium, 7 mg. Hyperventilation was induced manually and the trachea was intubated 8 min later. Ventilation was controlled using a circle absorber system and 40 per cent oxygen in nitrous oxide. Halothane 0–1 per cent, was used to keep the blood pressure in the normal range.

Neuromuscular block was monitored by stimulating the posterior tibial nerve and observing plantar flexion of the toes. There was a considerable difference between the apparent degrees of neuromuscular block in the right and left legs. Forty minutes after the initial dose of pancuronium, fade was prominent on the left side. Only the first two twitches of a train-of-four were appreciable. On the right side, all four twitches were seen, and the ratio of the fourth to first twitch was estimated to be more than 80 per cent. Further doses of pancuronium were given according to the response seen in the left leg. A walnut-sized tumor was incompletely excised from the area between the optic nerves and the right internal carotid artery. The neuromuscular block was reversed with atropine, 1.2 mg, and pyridostigmine, 15 mg, in divided doses. Reversal was adequate as judged by sustained tetanus at 50 Hz in both feet and by clinically normal ventilation.

Patient 3. A 20-year-old girl weighing about 40 kg was scheduled for insertion of a ventriculo-peritoneal shunt. A year prior to admission she had had a massive hemorrhage from a posterior fossa arteriovenous malformation. She had severe spastic quadriplegia.

Premedication was with atropine, 0.6 mg. Anesthesia was induced with meperidine, 25 mg, diazepam, 5 mg, thiopental, 250 mg, and pancuronium, 4 mg. After 5 min, relaxation of the chest and jaw appeared complete, and the trachea was intubated, with no response. Ventilation was controlled with oxygen in 60 per cent nitrous oxide by use of a circle absorber system. Halothane, 0.5 per cent inspired, was added for maintenance of anesthesia. Testing neuromuscular function with the peripheral-nerve stimulator showed no apparent relaxant effect. There was no fade on twitch, tetanus, or train-of-four stimulation, and no evidence of posttetanic facilitation (50 Hz) was found. The result was the same for the ulnar, median and posterior tibial nerves bilaterally. No further relaxant was given. One hundred and twenty minutes later, the anesthesia was lightened, and spontaneous ventilation resumed.

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† Professional Instruments Co., Model NS 3A, 30 volts maximum voltage into 1 kilohm, tetanus frequency 50 Hz.

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The inspiratory force[2] after 1 min of airway occlusion was −6 cm H_2O. The patient was given atropine, 0.6 mg, and pyridostigmine, 10 mg. Five minutes later, inspiratory force was −22 cm H_2O. The trachea was extubated, and recovery was uncomplicated.

Discussion

From the clinical picture seen with these three cases, it is apparent that testing neuromuscular function in paralyzed limbs is an unreliable guide to the use of nondepolarizing relaxants. All three patients had upper-motor-neuron lesions. In each case, a supramaximal stimulus was delivered via subcutaneous electrodes. Care was taken to place the negative electrode distally over the nerve being stimulated.[3]

In the second case, the train-of-four response in the right leg corresponded to twitch depression of less than 5 per cent, while, in the left leg, the train-of-four response corresponded to twitch depression of more than 80 per cent.[4] In the third case, the conditions for intubation indicated a block of approximately 95 per cent.[5] At the same time, the patient showed apparently normal responses to testing with the nerve stimulator in both arms and both legs. These patients demonstrated resistance to the relaxant effect of pancuronium in all limbs affected by an upper-motor-neuron lesion. When the elicited response in an involved limb is used as a guide to dosages of nondepolarizing relaxants, such patients will be given excessive doses of relaxants.

A recent review of the subject of monitoring neuromuscular block during anesthesia is very complete and most helpful.[1] However, Ali and Savarese do not mention the effects of upper-motor-neuron lesions on the clinical use of relaxant drugs. They stress the usefulness of a peripheral-nerve stimulator in abnormal circumstances. It has not been observed previously that the nerve stimulator may be misleading by showing apparent resistance to nondepolarizing relaxants.

The mechanism of this effect is not clear. In peripheral nerve section, there may be a spread of cholinergic receptors.[6] However, in the patients described here, the motor neuron was intact. Temperature and blood flow differences between limbs were most unlikely.

The synthesis and degradation of acetylcholine receptors have been reviewed by Fambrough, Devroates and Card.[7] Extrajunctional chemosensitivity is increased by blockade of neuromuscular transmission by botulinum toxin, *d*-tubocurarine, and α-bungarotoxin, and by blockade of nerve and muscle activity by application of local anesthetics to nerves. Application of tetrodotoxin or procaine leads to an increase in the number of acetylcholine receptors in cultures of spontaneously active muscle fibers. Drastically decreasing muscle usage by spinal-cord section or immobilization of limbs results in a modest increase in extrajunctional chemosensitivity. According to Fambrough and his colleagues,[7] the experimental evidence constitutes a strong argument for the involvement of muscle activity in the regulation of extrajunctional chemosensitivity.

The responses seen in the patients described are consistent with a decrease in threshold of muscles previously affected by upper-motor-neuron lesions. This may be due to an increase in acetylcholine receptors. With a decreased threshold, the fade normally seen with tetanic and train-of-four stimulation after clinically useful doses of nondepolarizing relaxants would require larger doses of relaxant on the abnormal side.

In summary, there may be differences in responses to muscle relaxants between muscles affected by upper-motor-neuron lesions and normal muscles. The peripheral-nerve stimulator may be an unreliable guide to relaxant dosages in patients who have upper-motor-neuron lesions.

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