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Neuromuscular Blockade in a Patient with Nemaline Myopathy

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Nemaline myopathy is characterized by a nonprogressive, symmetrical muscle weakness affecting primarily proximal muscles but not causing marked atrophy. Other musculoskeletal abnormalities including severe kyphosis can be present. Although smooth muscle is not usually involved, cardiac failure has been described in two patients and a "swallowing abnormality" has been noted in another.[1]

The diagnosis is confirmed by histologic examination of the muscle. Rods of 0.5–3.0-μ diameter are seen between normal myofibrils in 2–40% of muscle fibers. The disease is thought to be autosomally dominant with incomplete penetrance.[1]

Because there are no published reports of the anesthetic management of, or action of, neuromuscular blocking drugs in patients with nemaline myopathy, we describe the responses of a patient with nemaline myopathy to anesthesia with the muscle relaxants succinylcholine and pancuronium. This study was undertaken with the patient's informed consent.

Report of a Case

An 18-year-old woman was admitted for repair of a prognathic malocclusion. She had been admitted previously at the age of 4.5 years because of weakness, uncoordination, and prognathia. An electromyogram was consistent with a myopathy and a gluteal muscle biopsy obtained under local anesthesia revealed nemaline myopathy.

In 1969, at the age of 5 years, she received halothane anesthesia for bilateral myringotomies without difficulties. A cardiac echogram in 1975 revealed mitral valve prolapse. In 1976, her palate and mandible were reconstructed at another medical center. Information regarding the use of muscle relaxants was not available. The postoperative course was complicated by pneumonia, from which she fully recovered. In 1977, a Risser cast was applied during succinylcholine and halothane anesthesia to correct scoliosis. One month later, a C7-T7 posterior spinal fusion with Harrington rods was accomplished under anesthesia with nitrous oxide, oxygen, fentanyl, morphine sulfate, succinylcholine, and pancuronium. Both procedures were without complications; no unusual reactions to muscle relaxants were observed.

Before the repair of her prognathic malocclusion, another electromyogram revealed a myopathy. Pulmonary function testing was consistent with a severe extrinsic restrictive defect. This correlated with her chest roentgenogram, which showed severe scoliotic changes. The lung fields were clear. Analysis of arterial blood gases with an FI_{O_2} of 0.21 revealed a pH_a of 7.35, Pa_{O_2} 82 mmHg, Pa_{CO_2} 55 mmHg, HCO_3 29.5 mEq/l, and base excess +4 mEq/l, which is most consistent with a chronic respiratory acidosis. The electrocardiogram (ECG) was normal. Preoperative electrolyte determinations including serum calcium were normal. She was taking no medications.

Preoperative medication consisted of morphine sulfate, 3 mg; promethazine hydrochloride, 25 mg; atropine, 0.4 mg; and procaine penicillin, 600,000 units im. Anesthesia was induced with fentanyl, 1 μg/kg iv; thiopental, 4 mg/kg iv; nitrous oxide 66%; and oxygen, 34%. Neuromuscular blockade was assessed by response of thumb adduction to supramaximal square wave stimuli (0.2 ms duration every 10 sec) delivered to the ulnar nerve at the wrist via electrode pads. The strength of the thumb response was measured with a Grass FT03 force displacement transducer and recorded. The transducer was applied to the hand as described by Walts *et al.*[2] The cardiac rate and rhythm were recorded continuously with an ECG (Lead II). Arterial blood pressure was recorded using a catheter inserted into a dorsalis pedis artery. When a consistent baseline twitch height was achieved, succinylcholine (1 mg/kg) was administered iv. The trachea was intubated nasally, ventilation controlled, and anesthesia maintained with nitrous oxide/oxygen and fentanyl. Serum samples for potassium determinations were obtained before succinylcholine was administered and 12 and 28 minutes after injection, the times of maximum neuromuscular blockade and complete recovery, respectively. Twenty minutes after recovery from the succinylcholine, four incremental doses of 0.02 mg/kg of pancuronium were administered.[3] Ninety-five per cent (95%) depression of twitch height was achieved after a total dose of 0.08 mg/kg. Deliberate hypotension then was induced with nitroprusside, and anesthesia was maintained with nitrous oxide/oxygen and enflurane (1.0% end-tidal concentration by mass spectrometry) supplemented with fentanyl. In order to maintain optimal surgical conditions, intermittent doses of pancuronium (total dose 0.18 mg/kg) were given over the next 6 h. Spontaneous recovery of twitch height from 95–50% twitch height depression was allowed. The rectal temperature varied from 35–36° C during this period. After 7 h, the neuromuscular blockade was reversed with atropine, 0.02 mg/kg, and neostigmine, 0.06 mg/kg iv. The remainder of the case proceeded without the use of neuromuscular blocking agents and was uneventful. Total operative time was 18 h. Since the patient had severe respiratory compromise preoperatively, the trachea was not extubated and controlled ventilation was continued postoperatively. Her trachea was extubated 19 h after the procedure and she was discharged from the hospital 5 days later.

Results

Response to Succinylcholine. The maximal depression of twitch height was 5% of control within 6 min after succinylcholine (1 mg/kg). The twitch never was abolished completely; no fasciculations were noted. Laryngoscopy and tracheal intubation were accomplished easily. Re-

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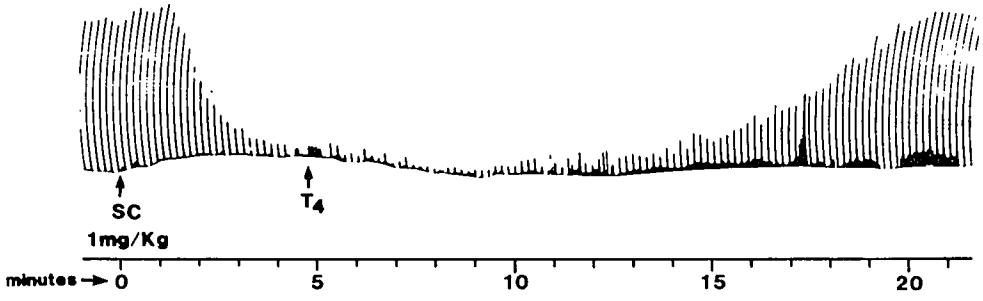

FIG. 1. Twitch trace demonstrating the response to succinylcholine, 1 mg/kg. The twitch never is abolished. The train of four demonstrates a Phase I block. (Train-of-four ratio > 0.7.)[4,5] Recovery time from 5–100% of control is 11 min.

covery of the twitch height from 5–100% of control occurred within 11 min (fig. 1). A train-of-four stimulation showed no evidence of Phase II block, the train-of-four ratio being greater than 0.7.[4,5] Serum potassium levels were 4.2, 3.8, and 3.9 mEq/l at 0, 12, and 28 min, respectively, after injection. Pseudocholinesterase 3 days after surgery was 4.5 u/l (normal 3–8) and dibucaine number was 71% (normal homozygotes 77–83%; heterozygotes 54–70%).

Response to Pancuronium. After total doses of 0.02 mg/kg, 0.04 mg/kg, and 0.08 mg/kg of pancuronium, the twitch was depressed 9, 47, and 95%, respectively. The single twitch response spontaneously returned from 5 to 25% and 50% of control within 57 and 83 min, respectively. These data were collected before enflurane was administered. Recovery of single twitch response from 25–90% of control after the administration of neostigmine, 0.06 mg/kg, and atropine, 0.02 mg/kg, occurred within 21 min. The reversal with neostigmine occurred during 1.0% end-tidal concentration of enflurane.

DISCUSSION

The failure of 1 mg/kg of succinylcholine to abolish the twitch completely is abnormal when compared with previous studies. Katz and Ryan[6] demonstrated that 0.5 mg/kg of succinylcholine abolished the twitch in all the patients they studied. The latency time of 6 min is also abnormal; succinylcholine (1 mg/kg iv) has a latency of 25–45 s.[7] Our patient's recovery time falls well within the normal range as determined by Katz and Ryan.[6] Although peak serum potassium levels occur 3–5 min after succinylcholine administration in denervated muscle, the serum potassium levels remain significantly elevated for at least 15 min.[8] The fact that there was no rise in serum potassium in our patient suggests a normal response of serum potassium to succinylcholine administration.

This resistance to succinylcholine in the presence of a normal pseudocholinesterase level and dibucaine number is difficult to explain. One can postulate that 1) muscle blood flow was decreased, 2) another plasma factor was metabolizing succinylcholine, or 3) an abnormality was occurring at the neuromuscular junction. There are no data, however, to support these theories. Other diseases such as myasthenia gravis have been reported to demonstrate a resistance to depolarizing muscle relaxants,[9] but the mechanism of the resistance is not clear.

The magnitude of twitch depression in our patient after incremental doses of pancuronium is consistent with normal competitive neuromuscular blockade as reported by Savarese *et al.*,[10] and Katz[11] reported the spontaneous recovery time for pancuronium from 0% to 25% of control to be from 43 to 133 min. Thus, our patient's recovery time was normal. Nitroprusside was administered during this time, but it does not prolong the neuromuscular blockade produced by pancuronium.[12]

Reversal of pancuronium by neostigmine occurred during 1.0% end-tidal enflurane administration. Enflurane antagonizes the reversal of pancuronium by neostigmine. The recovery from 10% of control to 90% of control of single twitch height occurs within 20 min.[13] The time of recovery to 90% of control for the single twitch in our patient is consistent with the data of Delisle and Bevan.[13] We conclude, therefore, that our patient's response to pancuronium and neostigmine was normal.

In conclusion, nemaline myopathy may be associated with an abnormal resistance to succinylcholine. However, direct laryngoscopy and tracheal intubation were performed easily with an iv dose of 1 mg/kg. Serum potassium did not increase after succinylcholine was administered. The patient's response to pancuronium and neostigmine were normal. As with any myopathy, we suggest administering muscle relaxants while assessing the muscle response to peripheral nerve stimulation.

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REFERENCES

1. Miller J, Lee C: Muscle diseases, Anesthesia and Uncommon Diseases, second edition. Edited by Katz J, Benumof J, Kadis LB. Philadelphia, WB Saunders, 1981, pp 543–544

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2. Walts LF, Lebowitz M, Dillon JB: A means of recording force of thumb adduction. ANESTHESIOLOGY 29:1054–1055, 1968
3. Donlon JV, Ali HH, Savarese JJ: A new approach to the study of four nondepolarizing relaxants in man. Anesth Analg 53:934–939, 1974
4. Lee C: Dose relationships of phase II, tachyphylaxis, and train-of-four fade in suxamethonium-induced dual neuromuscular block in man. Br J Anaesth 47:841–845, 1975
5. Hassan HA, Savarese JJ: Monitoring of neuromuscular function. ANESTHESIOLOGY 45:216–249, 1976
6. Katz RL, Ryan JF: The neuromuscular effects of suxamethonium in man. Br J Anaesth 41:381–390, 1969
7. Walts LF: Studies on latency and duration of action of succinylcholine chloride. ANESTHESIOLOGY 27:229–230, 1966
8. Gronert GA, Lambert EH, Theye RA: The response of denervated skeletal muscle to succinylcholine. ANESTHESIOLOGY 39:13–22, 1973
9. Churchill-Davidson HC, Richardson AT: Neuromuscular function in myasthenia gravis. J Physiol (London) 122:252–263, 1953
10. Savarese JJ, Ali HH, Antonio RP: The clinical pharmacology of metocurine: Dimethyltubocurarine revisited. ANESTHESIOLOGY 47:277–284, 1977
11. Katz RL: Clinical neuromuscular pharmacology of pancuronium. ANESTHESIOLOGY 34:550–556, 1971
12. Graham CW, Walts LF: Nitroprusside and the duration of tubocurarine and pancuronium. Anaesthesia 34:1005–1009, 1979
13. Delisle S, Bevan DR: Impaired neostigmine antagonism of pancuronium during enflurane anesthesia in man. Br J Anaesth 54:441–445, 1982

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