Anesthesiology
73:365, 1990

Paralysis after Long-Term Administration of Vecuronium: II

To the Editor:—Segredo *et al.*[1] described two cases of prolonged paralysis after long-term administration of vecuronium. There are numerous reports of prolonged weakness (tetraplegia) after prolonged use of neuromuscular blocking agents.[2-7] A variety of etiologies have been suggested to explain these cases.

Smith *et al.* reported seven patients with combined renal and respiratory failure who received vecuronium infusions[8]; the mean infusion time was 20.5 h (range 6.75–32.0 h). Neuromuscular function return was delayed 6–37 h after the infusions were stopped in these patients. The dose requirements for vecuronium were assessed with peripheral nerve stimulator. Marked variations in dose requirements were noted among patients. Metronidazole was the only identifiable association for reduced dose requirements, in two patients.

The laboratory data and some of the clinical findings suggest metabolites of vecuronium as the etiology in the cases reported by Segredo *et al.* However, the electromyographic (EMG) findings of fibrillation and positive waves suggest chronic denervation in patient 1. It would be worthwhile to know if, in addition to the EMG, detailed nerve conduction studies were performed, since these would allow better definition of the paresis. The authors do not comment on this aspect of their clinical data and its contribution to the paresis of patient 1.

KENNETH L. BACHENBERG, M.D.
Department of Anesthesiology
University of Washington, School of Medicine
Seattle, Washington 98108

REFERENCES

1. Segredo V, Matthay MA, Sharma ML, Gruenke LD, Caldwell JE, Miller RD: Prolonged neuromuscular blockade after long-term administration of vecuronium in two critically ill patients. ANESTHESIOLOGY 72:566–570, 1990
2. Op de Coul AAW, Lambregts PCLA, Koeman J: Neuromuscular complications in patients given Pavulon during artificial ventilation. Clin Neurol Neurosurg 87:17–21, 1985
3. Kupfer Y, Okrent DG, Twersky R: Disuse atrophy in a ventilated patient with status asthmaticus receiving neuromuscular blockade. Crit Care Med 15:795, 1987
4. Bachmann P, Gaussorgues P, Piperno D: Hydrocortisone and pancuronium bromide: Acute myopathy during status asthmatius (letter to editor). Crit Care Med 16:731, 1988
5. Brun-Buisson C, Gherardi R: Case report (letter to editor). Crit Care Med 16:731, 1988
6. Panacek EA, Sherman B: Case report (letter to editor). Crit Care Med 16:732, 1988
7. Picado C, Monteserrat J, Agusti-Vida A: Muscle atrophy in severe exacerbation of asthma requiring mechanical ventilation. Respiration 53:201–203, 1988
8. Smith CL, Hunter JM, Jones RS: Vecuronium infusions in patients with renal failure in an ITU. Anaesthesia 42:387–393, 1987

(Accepted for publication May 21, 1990.)

Anesthesiology
73:365–366, 1990

In Reply:—Dr. Bachenberg asks a clinically important question. Our investigation included both nerve conduction and EMG studies.[1] The sensory nerve conduction study showed normal sensory nerve action potentials. However, motor nerve conduction study was abnormal: no muscle compound action potential was obtained after single or repetitive stimulation (at 50 Hz for 3 s). The EMG study showed fibrillation and positive waves in at least two muscles in each of the four extremities, and the inability to recruit motor units. These findings have a pathologic significance. However, fibrillation potentials and positive waves are not in themselves diagnostic of denervation, because they can also be seen in primary muscle disease and diseases of the neuromuscular junction.[2]

We concluded that the observed flaccid paralysis was due to myonecrosis, inflammatory motor neuropathy, or neuromuscular blockade, or a combination of these. Myonecrosis was unlikely because the creatine phosphokinase (CPK) plasma levels were increased to only 1.5 times their normal value. An inflammatory motor neuropathy also was unlikely because of the transient recovery of a twitch response after neostigmine administration. Therefore, we concluded that the unexplained paralysis in our critically ill patient was due to neuromuscular blockade. Once we made this determination, we looked for the etiology of the neuromuscular blockade and found that none of the classic causes applied (pharmacologic potentiation of the blockade, acidosis, hypokalemia, *etc.*). We, therefore, questioned whether residual concentrations of neuromuscular blocking drug (vecuronium, in this case) might be responsible. We found that throughout the 7-day period of unexplained neuromuscular blockade, our patient consistently had high concentrations of 3-desacetylvecuronium. This metabolite has 50% the neuromuscular blocking potency of vecuronium in cats and was present in our patient in concentrations sufficient to produce 100% blockade (assuming the same neuromuscular blocking potency in humans as in cats). We believe the significant residual presence of the metabolite to be responsible for prolonging the neuromuscular blockade in our patient beyond termination of vecuronium administration.

VERONICA SEGREDO, M.D.
Visiting Research Fellow

RONALD D. MILLER, M.D.
Professor and Chairman of Anesthesia
Professor of Pharmacology

Department of Anesthesia
C-450, Box 0648
University of California, San Francisco
School of Medicine
San Francisco, California 94143-0648

References

1. Segredo V, Matthey MA, Sharma ML, Gruenke LD, Caldwell JE, Miller RD: Prolonged neuromuscular blockade after long-term administration of vecuronium in two critically ill patients. ANESTHESIOLOGY 72:566–570, 1990
2. Aminoff MJ: Electrodiagnosis in Clinical Neurology, New York, Churchill Livingston, 1986, pp 231–332

(Accepted for publication May 21, 1990.)

Anesthesiology
73:366, 1990

Safety of Transesophageal Echocardiography Is Still Unclear

To the Editor:—Recently Urbanowicz *et al.*[1] described the potential for esophageal damage with transesophageal echocardiography (TEE). We have two questions and related comments that pertain to this study: 1) Does esophageal surface pressure (ESP) as measured by the modified probe accurately reflect the pressure produced by contact between a conventional TEE probe and the esophagus? 2) What is the clinical significance of ESP? Urbanowicz *et al.* studied six patients and three dogs with a modified TEE probe designed to measure ESP generated by probe flexion. The transducer tip of the modified probe was fitted with a water-filled Silastic balloon connected to an external pressure monitor. The balloon tip disperses the force generated by probe flexion onto a larger surface area of the esophagus with a resultant decrease in esophageal surface pressure. Therefore, this study may significantly underestimate the force generated by a conventional TEE probe, and hence may underestimate risk of esophageal injury.

Urbanowicz *et al.* attempted to simulate the worst clinical scenario with continuous probe flexion and could not demonstrate esophageal injury, either histologically (animals) or symptomatically (humans). None of the animals sustained "abnormally" high ESP, but one of the patients did, despite no history of preexisting esophageal disease. It would be informative to know if the investigators noticed any resistance to probe flexion in this patient.

The clinical significance of ESP is appreciated by gastroenterologists who use esophageal tamponade and dilatation. To minimize injury during esophageal tamponade, inflation pressures are limited to 35–45 mmHg.[2,3] Perhaps an animal model can be developed to establish a relationship between elevated ESP during TEE and esophageal injury. If elevated surface pressure was associated with esophageal injury, then this measurement may have significant clinical implications in patients undergoing TEE.

Ultrasound transducers not only produce pressure at the site of contact but also generate heat and place the patient at risk for thermal injury. The water-filled balloon on the modified probe used in this study may function as an insulator and protect the esophageal mucosa from injury. If maximum power output was maintained for up to 8 h in the animal studied with the conventional TEE probe (*i.e.*, without a balloon), it is of interest that no evidence of thermal injury was detected on histologic examination of the esophageal mucosa. Most TEE instruments designed for intraoperative use have a thermocouple to monitor transducer tip temperature and possess an automatic shutdown mechanism if a preset threshold (42° C) is reached. Thermal monitoring is clinically relevant only when the instrument is used for extended periods or when adjacent structures are deliberately cooled (*e.g.*, posterior left ventricle with cold cardioplegia).

Urbanowicz *et al.* should be applauded in addressing this issue. Their study confirms previous animal studies that reported no evidence of esophageal injury after TEE.[4] Although continuous compression of tissue blood supply may result in ischemia and necrosis, the consequences of a routine TEE evaluation with intermittent compression are poorly understood and are unlikely to be associated with significant injury. However, we believe that the approach used in this study significantly underestimates the force that is transmitted onto the esophageal wall by a conventional TEE probe.

JOSEPH S. SAVINO, M.D.
Assistant Professor

STUART WEISS, M.D., Ph.D.
Cardiothoracic Anesthesia Fellow

Department of Anesthesia
University of Pennsylvania
3400 Spruce Street
Philadelphia, Pennsylvania 19104-4283

References

1. Urbanowicz J, Kernoff RS, Oppenheim G, Parnagian E, Billingham ME, Popp RL: Transesophageal echocardiography and its potential for esophageal damage. ANESTHESIOLOGY 72:40–43, 1990
2. Gossat D, Bolin TD: An unusual complication of balloon tamponade in the treatment of esophageal varices: A case report and brief review of the literature. Am J Gastroenterol 80:600–601, 1985
3. Nickell MD, Schwitzer GA, Gremillion DE: Overdistension of the gastric balloon: Complication with the Sengstaken-Blakemore tube. JAMA 240:1172–1173, 1978
4. O'Shea JP, D'Ambra MN, Magro C, Guerrero JL, Marshall JE, Vlahakes GJ, Jacobs M, Levine RA: Transesophageal echocardiography: Is it safe to the esophagus? An *in vivo* study (abstract). Circulation(suppl)78:1756, 1988

(Accepted for publication May 22, 1990.)

Anesthesiology
73:366–367, 1990

In Reply:—We believe that the pressure transducer accurately records the contact pressure between the esophagus and the ultrasonic probe, since the esophagus is sufficiently malleable that the whole face of the ultrasonic probe stays in contact with the esophagus both in animals and in humans during these experiments. This pressure transducer accurately records pressure when as little as 25% of its surface is in