of position before and after advancing the ETT. If the fiberoptic bronchoscope accidently slips out of the trachea during the maneuvering, it allows immediate recognition and institution of attempts to reestablish the airway.

We believe that this technique has application when difficulty in reintubation can be anticipated and where one would expect an ETT to pass over a suitably placed fiberoptic bronchoscope into the trachea. It may also be found to be useful in replacing endotracheal tubes in very ill patients who may not tolerate the stress of prolonged apnea, direct laryngoscopy, or anesthetic agents.

Anesthesiology
64:517–519, 1986

Pulmonary Aspiration after a Priming Dose of Vecuronium

JAMES MUSICH, M.D., PH.D.,* AND LEONARD F. WALTZ, M.D.†

Patients in danger of aspiration of gastric contents during induction of anesthesia require special techniques to protect their airway. If awake tracheal intubation cannot be safely accomplished, a rapid sequence of anesthesia induction–endotracheal intubation technique is used. A muscle relaxant with a rapid onset of paralysis is important because tracheal intubation should be performed as expeditiously as possible to minimize the period of vulnerability to aspiration. Succinylcholine is often used for this purpose. However, there are several conditions in which the side effects of succinylcholine might render it undesirable or contraindicated.1–3

Recently, several investigators have suggested using a medium-duration, nondepolarizing neuromuscular blocking drug, vecuronium or atracurium, to provide relaxation. To overcome the longer onset time of these muscle relaxants, they have suggested the drugs be given in two stages. First, a small, nonparalyzing dose is given. After a suitable period of time, anesthesia is induced, and the remainder of the muscle relaxant is given. Following the second administration of the muscle relaxant, the paralyzing dose, adequate relaxation can be obtained in one-half to two-thirds the time required when the full dose is administered as a single bolus. This practice has been popularized as the "priming principle."4–6

We report the use of the priming principle for rapid sequence induction of anesthesia and tracheal intubation in a patient with a full stomach and open eye injury to illustrate a possible complication of this technique.

REPORT OF A CASE

A 49-yr-old, 102-kg man was scheduled for repair of a ruptured eye. He had consumed an unknown quantity of alcohol 1 h before an auto accident. His past medical history was significant for hypertension, a 40 pack yr smoking history, and consumption of four to five drinks of alcohol daily. He was taking triamterene and hydrochlorothiazide for hypertension. Arterial blood pressure was 120/80 mmHg. Except for swelling and ecchymosis over the left periorbital region and tenderness to palpation over the lateral left lower rib cage, the physical examination, including cardiac, pulmonary, and nervous system, was within normal limits. Chest roentgenogram showed mild cardiomegaly and increased interstitial markings. His hematocrit was 44%, potassium was 3.1 mEq/l, and creatinine was 1 mg/dl.

On admission to the ward, an iv infusion was begun. Gentamicin 110 mg, vancomycin 500 mg, and potassium chloride 20 mEq then were given iv 4 h before the operation. Metoclopramide 10 mg orally and cimetidine 300 mg iv were given 3 h before the operation. Meperidine 100 mg and hydroxyzine 50 mg were administered im 2 h later. The patient was considered at risk for aspiration of stomach contents, and a rapid sequence induction–intubation employing cricoid pressure was planned, using vecuronium and the priming principle.

After 4 min of breathing oxygen, vecuronium 2 mg (0.02 mg/kg) was given iv. In less than 1 min the patient became agitated and complained of weakness and difficulty breathing. Cricoid pressure was applied; thiopental 500 mg and vecuronium 8 mg were given iv in rapid sequence. Stimulation of the ulnar nerve revealed a single, weak twitch response. Direct laryngoscopy and endotracheal intubation were performed, the endotracheal cuff was inflated, and the cricoid pressure was released. The pharynx was noted to be clear during laryngoscopy.

* Assistant Professor of Anesthesiology.
† Professor of Anesthesiology.
Received from the Department of Anesthesiology, University of California, Los Angeles, CA 90024. Accepted for publication November 11, 1985.
Address reprint requests to Dr. Waltz.
Key words: Complications: aspiration. Neuromuscular relaxants: vecuronium.
Auscultation of the lung fields after intubation revealed scattered, course rhonchi. Anesthesia was maintained with enflurane, nitrous oxide, and oxygen. Mechanical, controlled ventilation was instituted. To provide an adequate tidal volume, peak inspiratory pressures of 35 to 40 cm of water were required. With a fractional inspired O\textsubscript{2} concentration (F\textsubscript{I}O\textsubscript{2}) of 0.4 we found the pH\textsubscript{a} 7.40, Pa\textsubscript{CO\textsubscript{2}} 42 mmHg, and Pa\textsubscript{O\textsubscript{2}} 59 mmHg. The F\textsubscript{I}O\textsubscript{2} was increased to 1.0. The pH\textsubscript{a} then was 7.35, Pa\textsubscript{CO\textsubscript{2}} 51 mmHg, and Pa\textsubscript{O\textsubscript{2}} 84 mmHg. PEEP was instituted after a 20 cm peak inspiratory pressure, the Pa\textsubscript{O\textsubscript{2}} was 351 mmHg. PEEP was maintained for the remainder of the procedure. The operation took 7 h to perform.

Because of the respiratory abnormalities during surgery, endotracheal intubation and controlled ventilation were maintained postoperatively. A recovery room chest roentgenograph showed bilateral, fluffy pulmonary infiltrates, small bilateral pleural effusions, and evidence of pulmonary vascular congestion. The presumptive diagnosis was aspiration of gastric contents. After transfer to an intensive care unit, the patient became febrile and developed a cough productive of brownish sputum. He was treated for pneumonia with antibiotics, and his respiratory status improved. His trachea was extubated on the second postoperative day, and he was discharged on the 15th postoperative day.

**DISCUSSION**

Emergency management of patients with an open eye injury requires two major considerations. Airway protection must be taken to prevent aspiration of gastric contents that could occur with the loss of consciousness. At the same time, the anesthesiologist wishes to avoid an increase in intraocular pressure, which might result in the avulsion of ocular contents and permanent eye damage. While succinylcholine has a short latency period that makes it ideally suited for achieving rapid paralysis and facilitating early tracheal intubation, its effect on intraocular pressure is a theoretical objection to its use in patients with an open eye injury.\textsuperscript{7,8}

Giving a small dose of a nondepolarizing neuromuscular blocking drug before giving succinylcholine has been employed in order to minimize the succinylcholine effect on intraocular pressure. Although the efficacy of this pretreatment technique is debatable, this method has been widely and successfully used.\textsuperscript{8,9} The successful use of a succinylcholine infusion, without prior pretreatment, to facilitate intubation in children undergoing open eye surgery has also been reported.\textsuperscript{9}

Another strategy used to manage these patients has been to induce anesthesia rapidly and intubate the trachea employing thiopental and a single, relatively large dose of nondepolarizing neuromuscular blocking drug.\textsuperscript{10} The introduction of atracurium and vecuronium has overcome some of the objections to this technique, such as long duration of paralysis and cardiovascular side effects. However, the latency of drug effect, up to 3 min for conditions suitable to facilitate tracheal intubation, makes these drugs not ideally suited for this purpose. The latter disadvantage can be lessened if priming doses of the neuromuscular blocking drug are given before the induction of anesthesia. The priming dose, because it is small, is not expected to cause weakness or paralysis, thus ensuring the preservation of protective reflexes until anesthesia is induced. The second dose, larger in size, provides sufficient relaxation and, because many receptors have been exposed to the relaxant, the latency of action may be as short as 1 min.\textsuperscript{4} The use of the priming principle was chosen in our patient because of the excellent results reported by others. In fact, the trachea of our patient was intubated in less than 1 min after the second dose of vecuronium was given. The patient had no hypotension, and the effect of the relaxant used for intubation had waned in 45 min. The use of the priming principle in our patient, however, demonstrated a potential shortcoming of the technique. The patient complained of weakness and respiratory difficulty within 1 min after receiving the priming dose. The size of our priming dose, 0.02 mg/kg, was larger than the often recommended 0.01 to 0.015 mg/kg and may have contributed to this complication.

Significant variability in sensitivity to nondepolarizing neuromuscular blocking drugs has been widely reported.\textsuperscript{11-15} The etiology of our patient's sensitivity to the priming dose is unclear. The patient had no known neuromuscular disease and, despite a history of chronic alcohol abuse, had no history of alcoholic myopathy or peripheral neuropathy. A factor that could possibly explain our patient's exaggerated response to the vecuronium was the administration of gentamicin 4 to 5 h before the operation. Gentamicin is one of several aminoglycoside antibiotics that have neuromuscular blocking activity. Its enhancement of nondepolarizing neuromuscular blocking drugs has been documented.\textsuperscript{14} However, clinical problems caused by interaction of antibiotics and neuromuscular blocking drugs generally occur when the antibiotic is given iv during the course of the anesthesia in which the neuromuscular blocking drug has been used. Preoperative prophylactic use of gentamicin in patients with normal renal function has not been reported to be a source of clinical interaction with the muscle relaxants.\textsuperscript{15} The preoperative use of gentamicin as administered in this case, however, does not preclude an interaction with the subsequently administered small dose of vecuronium.

Although the etiology of our patient's sensitivity to the priming dose of vecuronium is unclear, such sensitivity can adversely affect the patient and his anesthetic management. This is particularly true if the sensitivity and resulting exaggerated response are not expected and not detected early, or if preparation has not been made to intervene and respond appropriately and effectively. The patients may be harmed psychologically as well as physically, and the partial weakness and accompanying anxiety and physical agitation may adversely affect their cardio-
vascular and respiratory status. Unexpected rapid paralysis and loss of glottic reflexes can increase the risk of aspiration of gastric contents.

This case illustrates a problem that one could encounter following the use of a small dose of muscle relaxant. It points out that priming doses may not be innocuous and that further studies are needed to define the optimum, safe priming dose in awake patients. Patients who are to be given a priming dose should be monitored for unusual sensitivity to the relaxant and for the possible consequences of an unexpected paralysis. It would seem prudent to have patients breathe oxygen before a priming dose is administered and be prepared to induce general anesthesia and intubate the trachea, should one find evidence of muscle weakness or impending paralysis. In spite of our close observation and early intervention, our patient may have aspirated before the trachea was intubated and the airway was properly secured.

REFERENCES

Anesthesiology
64:519–521, 1986

Pulmonary Air Embolism in the Pediatric Patient Undergoing Central Catheter Placement: A Report of Two Cases

CRAIG H. LEICH, M.D., M.P.H.,* AND JORDAN WALDMAN, M.D.†

Pulmonary air embolism is a well known, potentially fatal complication of certain surgical procedures, especially neurosurgical procedures in the sitting position.

* Research Fellow in Obstetrical Anesthesia, University of California, San Francisco.
† Associate Clinical Professor of Anesthesiology, University of California, San Diego.

Received from the Departments of Anesthesiology and Clinical Investigation,* Naval Hospital, San Diego, California; and the Children’s Hospital and Health Center;† San Diego, California. Accepted for publication November 27, 1985.

The opinions or assertions expressed in this paper are those of the authors and are not construed as official or as necessarily reflecting the views of the Department of the Navy or the Naval Service at large.

Address reprint requests to C. H. Leicht, MC, USN: Anesthesiology Department, Naval Hospital, San Diego, California 92134–5000.

Key words: Embolism; air. Equipment: Broviac®/Hickman® catheter.

However, air embolism can occur in the nonneurosurgical, noncardiac pediatric patient.

We describe two cases of air embolism that occurred within 1 week of each other in pediatric patients undergoing central venous insertion of a Broviac® or Hickman® catheter.

REPORT OF TWO CASES

Case 1. A 7-month-old, 4 kg girl (born 34 weeks gestation), status-post patent ductus arteriosus ligation, with short gut syndrome secondary to necrotizing enterocolitis, was scheduled for Broviac® catheter insertion for hyperalimentation. The patient had been doing well with oral feedings until 7 days before admission, when she developed an upper respiratory infection with fever and decreased oral intake. A left external jugular iv was placed the evening before surgery for hydration. After premedication with 60 µg of atropine iv, anesthesia was induced with halothane, N2O, and O2 without incident.