Successful Use of a 20% Lipid Emulsion to Resuscitate a Patient after a Presumed Bupivacaine-related Cardiac Arrest

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The infusion of a lipid emulsion has been shown to increase the survival rates of both rats and dogs that have been resuscitated after an overdose of bupivacaine.1–5 We report the first successful use of a 20% lipid infusion to resuscitate a patient from a prolonged cardiac arrest that immediately followed the placement of an interscalene block with bupivacaine and mepivacaine.

Case Report

The patient was a 58-yr-old, 82-kg, 170-cm male who presented for arthroscopic repair of a torn rotator cuff in the right shoulder. His medical history was significant for coronary artery bypass graft surgery at age 43 yr. He gave a history of angina upon exertion and occasionally at rest. He declined further preoperative cardiac workup but was considered by his cardiologist to be stable on medical therapy. This included nitroglycerine as needed, lisinopril, atenolol isosorbide mononitrate, and clopidogrel and enteric-coated aspirin, both of which had been discontinued 1 week previously. His preoperative electrocardiogram revealed a right bundle-branch block, a left anterior hemiblock, and evidence of an old anterior myocardial infarction.

The patient arrived at the operating room holding area, where standard monitors were applied. Blood pressure was 120/80 mmHg, room air oxygen saturation measured by pulse oximetry was 98%, and heart rate was 60 beats/min. Supplemental oxygen was delivered at 3 l/min via a nasal cannula. A 20-gauge intravenous catheter was placed in the dorsum of his left hand, through which 2 mg midazolam and 50 µg fentanyl were administered. A 50-mm, 22-gauge Stimuplex™ insulated needle was connected to a Stimuplex™-DIG nerve stimulator (both B. Braun, Inc., Bethlehem, PA), and the interscalene groove was identified at the level of C6. The brachial plexus was identified by eliciting biceps stimulation (0.1-ms duration, 2 Hz) at 0.34 mA, following which 40 ml local anesthetic solution (20 ml bupivacaine, 0.5%, and 20 ml mepivacaine, 1.5%) were injected slowly (over approximately 2.5 min) in 5-ml increments with gentle aspiration between doses. The patient was awake and conversant during the performance of the block. At no time was any blood aspirated, nor did he report pain or paresthesias.

Approximately 50 s after removal of the block needle, the patient became incoherent and then developed a tonic–clonic seizure. Oxygen was delivered by a facemask attached to a self-inflating resuscitation bag while 50 mg propofol was injected intravenously. The seizure stopped, and spontaneous respirations resumed. Approximately 90 s later, the patient began to seize again; this time, 100 mg intravenous propofol was administered. The electrocardiogram showed asystole, and no pulse, by carotid or femoral palpation, or blood pressure was detectable. Advanced cardiac life support was immediately started. The trachea was intubated, and end-tidal carbon dioxide was detected with an EasyCap™-II (Nellcor Inc., Hayward, CA). Pulse wave was confirmed by auscultation, after which chest compressions were immediately resumed. During the first 20 min of advanced cardiac life support, a total of 3 mg epinephrine, given in divided doses, 2 mg atropine, 300 mg amiodarone, and 40 U arginine vasopressin were administered. In addition, monophasic defibrillation was used at escalating energy levels—200, 300, 360, and 360 J, according to the advanced cardiac life support protocol. Cardiac rhythms included ventricular tachycardia with a pulse, pulseless ventricular tachycardia that momentarily became ventricular fibrillation, and eventually asystole. The arrhythmias observed during most of the resuscitation period were pulseless ventricular tachycardia and asystole.

After 20 min, at which time plans were being made to institute cardiopulmonary bypass, the administration of a lipid emulsion was suggested, and 100 ml of 20% Intralipid (for Baxter Pharmaceuticals by Fresenius Kabi, Upplands, Sweden) was given through the peripheral intravenous catheter. Cardiac compressions continued, and a defibrillation shock at 360 J was given. Within seconds, a single sinus beat appeared on the electrocardiogram, and 1 mg epinephrine and 1 mg epinephrine were administered. Within 15 s, while external chest compressions were continued, the cardiac rhythm returned to sinus at a rate of 90 beats/min. The blood pressure and pulse became detectable. An infusion of lipid emulsion was started and continued at 0.5 ml · kg⁻¹ · min⁻¹ over the following 2 h and then discontinued. The patient remained in sinus rhythm. He was weaned from mechanical ventilation, and his trachea was extubated, approximately 2.5 h later. He was awake and responsive, and had right upper extremity weakness consistent with a brachial plexus block. No neurologic sequelae were sustained, and he was subsequently transferred to a monitored setting for overnight observation. There was no evidence of complications secondary to the administration of intralipid (i.e., pancreatitis) during the following 2 weeks.

Because the patient had a cardiac arrest after which he had increased levels of cardiac enzymes, he agreed to undergo cardiac catheterization. This revealed total occlusion of the right coronary artery and a left ventricular ejection fraction of 32%. As a consequence, an automatic implantable cardiac defibrillator was inserted without any complications, and the patient was discharged home.

Discussion

Bupivacaine was first synthesized in 1963 and since that time has had many applications, including infiltration anesthesia, regional nerve blocks, and neuraxial anesthesia. In addition to its local anesthetic effects, it is a potent depressant of electrical conduction, which predisposes the heart to reentry types of arrhythmias.4 Weinberg et al.1 made the observation that intravenous

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lipid infusions not only increase the dose of bupivacaine required to produce asystole in rats but also improve survival in rats resuscitated after receiving intravenous bolus doses of bupivacaine. They then applied this observation to dogs, as a model of a species closer in size to humans, and found that lipid infusions during resuscitation from bupivacaine-induced cardiac arrests improved survival. Specifically, 12 dogs were given 10 mg/kg bupivacaine. All of the dogs developed circulatory collapse, and internal cardiac massage was delivered. Six of these dogs received 20% lipid infusion and 6 received saline as a 4-ml/kg bolus given over 2 min, followed by a continuous infusion of 0.5 ml · kg⁻¹ · min⁻¹. All of the dogs treated with the intralipid solution were successfully resuscitated, whereas none of the saline-treated animals survived.² Weinberg et al. offered two possible hypotheses for their findings. Either the lipid emulsion creates a lipid phase that extracts the lipid-soluble bupivacaine molecules from the aqueous plasma phase (and therefore out of the tissue), or alternatively, the lipid infusion diffuses directly into tissue and interacts with bupivacaine at that level.² Although the potential utility of lipid emulsions for cardiac resuscitation after a bupivacaine-induced cardiac arrest in humans has been discussed in the literature, its actual use has not been previously described.

When conventional algorithms for cardiopulmonary resuscitation were unsuccessful, a member of the code team suggested the use of a lipid emulsion, and arranged for the pharmacy to immediately dispatch a dose, through the pneumatic tube system at our institution. While it would have been preferable to infuse the lipid via a central venous catheter, the initial absence of such access necessitated the use of the peripheral intravenous line. Although recommendations for specific doses of intralipid have been suggested, we chose to administer 100 ml of a 20% lipid emulsion. While this is in excess of the suggested initial bolus of 1 ml/kg,⁵ we wanted to ensure that an adequate volume of lipid would reach the central circulation during cardiac compressions. Immediately after this administration, 1 mg each of atropine and epinephrine were administered, and sinus rhythm returned, where similar efforts had been unsuccessful before infusion of the lipid emulsion. Our maintenance infusion of 0.5 ml · kg⁻¹ · min⁻¹ was consistent with those used in the canine experiments but likely excessive. The specific recommendations of Weinberg et al. entail the use of a bolus infusion of 20% lipid emulsion, 1 ml/kg over 1 min while continuing chest compressions. This dose could be repeated every 3–5 min to a maximum of 3 ml/kg. At the point of conversion to sinus rhythm, Weinberg⁶ recommends that an infusion of 20% intralipid, at a rate of 0.25 ml · kg⁻¹ · min⁻¹, should be continued until hemodynamic recovery. Fortunately, there was no deleterious effect from this dose of intralipid. Since this event, a 100-ml bag of 20% lipid emulsion has been made immediately available in all areas in which peripheral nerve blocks are performed at our institution.

Levsky and Miller⁷ recently reported cardiovascular collapse from a bupivacaine dose of less than 1.1 mg/kg administered during a lumbar sympathetic ganglion radiofrequency ablation in a patient who previously sustained non-Q-wave myocardial infarction and whose preoperative electrocardiogram showed first-degree atrioventricular block. Although our patient had significant cardiac risk factors, he had been evaluated preoperatively by his cardiologist, who deemed him to be medically optimized to undergo this surgical procedure. His preoperative electrocardiogram revealed both a right bundle-branch block and a left anterior hemiblock. A significant preoperative conduction deficit may predispose to the development of local anesthetic induced cardiac toxicity at lower mg/kg basis than expected, and although no recommendations currently exist, in this group of patients, the use of levo-isomeric local anesthetics may offer some advantage. We have added ropivacaine to our hospital formulary specifically for the use in patients with significant cardiac histories who are undergoing peripheral plexus blockade.

We report the first use of a lipid emulsion as part of the successful resuscitation efforts in a patient who most likely sustained a local anesthetic-induced cardiac arrest. We concur with Picard,⁸ who considers a lipid emulsion, like dantrolene, a “crucial antidote” (which is both inexpensive and has a long shelf life) that should be routinely kept in areas in which peripheral nerve blocks are being performed.

References