

Cardiac Arrest upon Induction of General Anesthesia: Transesophageal Echocardiography-assisted Diagnosis of Impending Paradoxical Embolus

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CARDIAC arrest occurring upon the induction of general anesthesia in an otherwise healthy patient is distinctly rare. It is even more unusual to discover its etiology to be an impending paradoxical embolus (IPE). We present a case in which the timely use of transesophageal echocardiography (TEE), implemented during the course of cardiopulmonary resuscitation, revealed a large transatrial thromboembolus which had been trapped in transit through a patent foramen ovale.

Case Report

A 46-yr-old 6'5", 280-lb, previously healthy man presented for surgical correction of a C4-C5 herniated nucleus pulposus. His presenting complaints were mild upper extremity weakness and neck pain; he could reproduce his symptoms only with extreme neck extension. Preoperatively, he was designated as American Society of Anesthesiologists Class 2.

In the surgical suite, he moved himself to the operating table. Five minutes after the initiation of preoxygenation, his vital signs were as follows: Blood pressure 105/55 mmHg, heart rate regular and 85 beats/min, SaO_2 100%. Induction of general anesthesia was accomplished using 2 mg midazolam IV, 100 mcg fentanyl IV, 10 mg ketamine IV, 500 mg thiopental IV incrementally, and sevoflurane up to 2% expired concentration. The airway was easily managed without an appliance of any kind. Succinylcholine 80 mg IV was administered to facilitate tracheal intubation. With his neck in the neutral position, the vocal cords were fully visualized with a #2 Miller laryngoscope blade (Heine Corporation, Herrsching, Germany). An Eschmann introducer (SunMed Healthcare, Largo, FL) was inserted between the vocal cords and an 8.0 oral endotracheal tube was then passed over it into the trachea. Successful intubation was confirmed by the presence of bilateral breath sounds; the end-tidal carbon dioxide remained stable at 30 mmHg over several respiratory cycles, and the SaO_2 remained 100%.

As the endotracheal tube was being secured, the heart rate unexpectedly decreased from 100 beats/min to 75 beats/min, while the electrocardiogram continued to display a sinus mechanism. The blood pressure decreased from 110/70 mmHg to 85/50 mmHg; the SaO_2 remained 100%, and the end-tidal carbon dioxide was stable at 25 mmHg. Atropine 0.4 IV was administered with no effect on the heart

rate. The blood pressure, heart rate, and end-tidal carbon dioxide continued to rapidly decrease; the SaO_2 remained at 100%. On the presumption that the endotracheal tube had slipped out of the trachea while it was being secured, a second laryngoscopy was performed. The endotracheal tube was seen to be appropriately positioned between the vocal cords. However, the laryngoscopist (DY) noted that the patient's tongue was gray in color. At this point, the heart rate had decreased to 45 beats/min, the end-tidal carbon dioxide had decreased to 9 mmHg and the SaO_2 had decreased to 88%. No carotid pulse was felt. Sevoflurane administration was discontinued, assistance was summoned, and the attendant neurosurgeons initiated cardiopulmonary resuscitation, following the Advanced Cardiac Life Support protocol for pulseless electrical activity.

Rapid fiberoptic bronchoscopy performed during ongoing cardiopulmonary resuscitation confirmed the position of the endotracheal tube within the trachea; no obstructive lesions were found in the trachea or mainstem bronchi. A TEE probe was then passed and an attempt was made to obtain a simple midesophageal four-chamber view of the heart. Large echogenic densities were found within both atria. A few minutes later, spontaneous myocardial contraction resumed. At this point, these densities were seen to be the respective ends of a single large Y-shaped mass, which apparently straddled the interatrial septum through a patent foramen ovale (fig. 1). Cardiothoracic surgery consultation was sought and the diagnosis of impending paradoxical embolus was made. Shortly thereafter, the patient began to demonstrate both purposeful movement and a vigorous spontaneous respiratory pattern. He was sedated with propofol 15 mcg · kg · min propofol and relaxed with 10 mg vecuronium IV. Right radial arterial and right femoral vein catheters were inserted. An arterial blood gas obtained on a fractional inspired oxygen tension 0.94 and 0 cm H_2O positive end-expiratory pressure at 16 min after the initial arrest revealed the following: PaCO_2 286 mmHg, PaO_2 32.2 mmHg, pH 7.28, HCO_3^- 14.7 meq, hematocrit 36.2%, glucose 186 mg%, K^+ 3.3 meq/L, Na^+ 138 meq/L, ionized Ca^{2+} 1.4 mm.

The patient was transferred to the intensive care unit. A bedside duplex scan revealed deep vein thrombosis in the left femoral vein, and computerized axial tomography of the head revealed no evidence of intracranial infarction. Intravenous heparin therapy was initiated. The patient was admitted once again to the operating room, where general anesthesia was induced for anticipated intracardiac and possible pulmonary embolectomy. During the course of continuous TEE monitoring, the echocardiographer (JRV) noted that the trapped embolus periodically obstructed flow from the atria into both ventricles. The presumptive diagnosis of both acute and chronic pulmonary emboli was also made at this time, based on the presence of the IPE and the echocardiographic findings of a grossly dilated right ventricle and pulmonary artery. The surgeon extracted the transatrial embolus, which measured 15 cm in length (fig. 2). He also removed multiple fragments of old, resolving thromboemboli from the distal pulmonary arteries. A filter was inserted into the inferior vena cava to reduce the risk of additional embolization. At the conclusion of the procedure the patient was taken to the intensive care unit, where he was extubated successfully on postoperative day 7. He had no gross neurologic deficits and was capable of self-care with some assistance. Further investigations have yielded no definitive evidence for either an inherited or acquired thrombophilic disorder.

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Fig. 1. A transesophageal four-chamber view obtained during resuscitation. The proximal portion of the impending paradoxical embolus (IPE) can be seen to extend from the right atrium (RA) through a patent foramen ovale (PFO) into the left atrium (LA).

Discussion

The presence of an IPE suggests that the right atrial pressures in this patient at one time were high enough to force open a foramen ovale, allowing for the migra-



Fig. 2. The intact paradoxical embolus, once it had been extracted from the heart. The Y-shaped end had been wedged into the right atrial side of the patent foramen ovale, preventing the embolus from freely migrating into the left atrium.

tion and entrapment of an embolus. Using contrast echocardiography, Kasper *et al.*¹ have demonstrated that such a condition may exist in up to 39% of patients with hemodynamically significant acute pulmonary emboli. However, the surgical findings, as well as the magnitude of the right ventricular and right atrial enlargement, suggest a more chronic process in this patient, one which was complicated by an acute embolic event occurring around the time of induction of anesthesia.

The natural history and management of free-floating right atrial emboli have been the subject of several reviews.²⁻⁵ This patient had a mobile, or Type A, embolus, which is associated with a very high mortality.⁶ An IPE represents a variation of the Type A embolus, one which has been trapped across the atrial septum during migration through a patent foramen ovale. This rare embolic event was first demonstrated by TEE in 1985.⁷ However, demonstration of the presence of an IPE during cardiac arrest at the time of induction of general anesthesia in a previously asymptomatic patient is a rare event, the frequency of which has yet to be quantified. TEE certainly played a pivotal role in the initial management of the patient described above, even though ongoing cardiopulmonary resuscitation severely limited echocardiographic technique. Without question, prompt TEE-assisted diagnosis and rapid institution of an effective therapeutic plan contributed to the favorable patient outcome.

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