

## CASE REPORTS

2. Kavanagh BP, Katz J, Sandler AN: Pain control after thoracic surgery: A review of current techniques. *ANESTHESIOLOGY* 81:737-759, 1994
3. Usubiaga JE: Neurological complications following epidural anesthesia. *Int Anesthesiol Clin* 13:1-153, 1975
4. Kane RE: Neurologic deficits following epidural or spinal anesthesia. *Anesth Analg* 60:150-161, 1981
5. Dawkins CJ: An analysis of the complications of extradural and caudal block. *Anaesthesia* 24:554-563, 1969
6. Shenaq SA, Svensson LG: Paraplegia following aortic surgery. *J Cardiothorac Vasc Anesth* 7:81-94, 1993
7. Gelman S, Reves JG, Fowler K, Samuelson PN, Lell WA, Smith LR: Regional blood flow during cross-clamping of the thoracic aorta and infusion of sodium nitroprusside. *J Thorac Cardiovasc Surg* 85:287-291, 1983
8. Crawford ES, Crawford JL, Safi HJ, Coselli JS, Hess KR, Brooks B, Norton HJ, Glaeser DH: Thoracoabdominal aortic aneurysms: Preoperative and intraoperative factors determining immediate and long-term results of operations in 605 patients. *J Vasc Surg* 3:389-404, 1986
9. Hollier LH, Symmonds JB, Pairolero PC, Cherry KJ, Hallett JW, Gloviczki P: Thoracoabdominal aortic aneurysm repair: Analysis of postoperative morbidity. *Arch Surg* 123:871-875, 1988
10. Crawford ES, Mizrahi EM, Hess KR, Coselli JS, Safi HJ, Patel VM: The impact of distal aortic perfusion and somatosensory evoked

potential monitoring on prevention of paraplegia after aortic aneurysm operation. *J Thorac Cardiovasc Surg* 95:357-367, 1988

11. Moore WMJ, Hollier LH: The influence of severity of spinal cord ischemia in the etiology of delayed-onset paraplegia. *Ann Surg* 213:427-431, 1991
12. Yuh WT, Marsh EE, Wang AK, Russell JW, Chiang F, Koci TM, Ryals TJ: MR imaging of spinal cord and vertebral body infarction. *Am J Neuroradiol* 13:145-154, 1992
13. Mizukami M, Kawase T, Usami T, Tazawa T: Prevention of vasospasm by early operation with removal of subarachnoid blood. *Neurosurgery* 10:301-307, 1982
14. Ready LB, Plumer MH, Haschke RH, Austin E, Sumi SM: Neurotoxicity of intrathecal local anesthetics in rabbits. *ANESTHESIOLOGY* 63:364-370, 1985
15. Kozody R, Swartz J, Palahniuk RJ, Biehl DR, Wade JG: Spinal cord blood flow following sub-arachnoid lidocaine. *Can Anaesth Soc J* 32:472-478, 1985
16. Dohi S, Matsumiya N, Takeshima R, Naito H: The effects of subarachnoid lidocaine and phenylephrine on spinal cord and cerebral blood flow in dogs. *ANESTHESIOLOGY* 61:238-244, 1984
17. Shah JL: Influence of cerebrospinal fluid on epidural pressure. *Anaesthesia* 36:627-631, 1981
18. Thomas PS, Gerson JI, Strong G: Analysis of human epidural pressures. *Reg Anesth* 17:212-215, 1992
19. Paul DL, Wildsmith JA: Extradural pressure following the injection of two volumes of bupivacaine. *Br J Anaesth* 62:368-372, 1989

*Anesthesiology*  
83:1359-1361, 1995  
© 1995 American Society of Anesthesiologists, Inc.  
Lippincott-Raven Publishers

## Placement of a Right Atrial Air Aspiration Catheter Guided by Transesophageal Echocardiography

Steven Roth, M.D.,\* Solomon Aronson, M.D.†

ONE of the principal risks of the sitting position for neurosurgical patients is the possibility of life-threat-

ening air embolism. Use of a multiorificed central venous catheter is highly recommended as a means for aspirating air from the circulation should embolism occur.<sup>1</sup> The junction of the superior vena cava (SVC) and right atrium (RA) is the optimal position for maximal efficacy in aspirating air.<sup>2</sup> Conventional methods for placement of the catheter include the use of x-ray, fluoroscopy, or pressure waveform monitoring. These methods are time consuming, require additional personnel, and may not precisely localize the catheter at the RA-SVC junction. In addition, chest x-ray and fluoroscopy may expose personnel to radiation. Accordingly, the catheter is typically placed by interposing a stopcock with a metal connector into the fluid path of the catheter and connecting the stopcock to an ECG machine. The P wave is transduced as the catheter is

\* Associate Professor of Anesthesia and Critical Care; Chief, Neuroanesthesia.

† Associate Professor of Anesthesia and Critical Care; Chief, Cardiovascular and Thoracic Anesthesia.

Received from the Department of Anesthesia and Critical Care, University of Chicago, Chicago, Illinois. Submitted for publication April 13, 1995. Accepted for publication July 24, 1995.

Address reprint requests to Dr. Roth: Department of Anesthesia and Critical Care, University of Chicago, 5841 South Maryland, Box MC-4028, Chicago, Illinois 60637.

Key words: Embolism, air; right atrial catheter. Measurement technique: transesophageal echocardiography. Monitoring: central venous pressure.

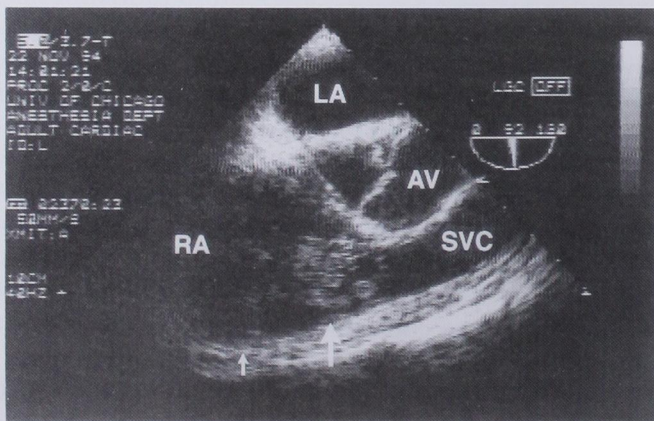


## CASE REPORTS

advanced through the SVC. The point at which the P wave changes direction is the RA-SVC junction. Because we were not able to locate the metal stopcock that we usually used for this procedure, and transesophageal echocardiography (TEE) was available in our operating room, we used TEE to guide the proper placement of the catheter.

### Case Report

The patient, a 38-yr-old man, was scheduled for resection of an acoustic neuroma to be performed with the patient in the sitting position. After induction of general anesthesia and tracheal intubation, a 5-mHz omniplane TEE probe (Hewlett-Packard, Andover, MA) was inserted, and a Hewlett-Packard Sonos 1500 OR echocardiography machine was used to obtain views of the heart. First, the patient was evaluated for the presence of a patent foramen ovale by imaging the intraatrial septum. Color flow imaging and hand-agitated saline injections with and without sustained continuous positive airway pressure (5–10 mmHg) did not reveal a right-to-left intraatrial shunt. Next, a Bunegin-Albin multiorificed air aspiration catheter (CVAE-580; Cook Critical Care, Inc., Bloomington, IN) was sterilely placed *via* the left subclavian vein, and advanced until its position in the midright atrium was visible in a short-axis view at the base of the heart. The catheter was withdrawn to the RA-SVC junction. To provide additional confirmation of proper catheter placement, hand-agitated saline microbubbles were flushed through the catheter. Microbubbles were produced by forcibly injecting approximately 10 ml of a blood-saline mixture alternately for about 1 min between two syringes connected by a stopcock. Any macroscopic air bubbles were discharged before injection of the mixture into the catheter. This contrast material could be visualized as it left the catheter and entered the RA (fig. 1). We then secured the catheter in place, and the operation proceeded uneventfully without the occurrence of significant air embolism.



**Fig. 1.** Contrast (gray dots) is visible entering the RA (small arrow). A large bolus of contrast (gray dots) is visible at the RA-SVC junction, having just exited at either the catheter tip or another catheter orifice (large arrow). RA = right atrium; SVC = superior vena cava; AV = aortic valve; LA = left atrium.

### Discussion

Transesophageal echocardiography has been used in both children and adults to guide the proper placement of pulmonary artery catheters.<sup>3,4</sup> The tip of the catheter and the balloon were visible during advancement into the pulmonary artery.<sup>5</sup> Transesophageal echocardiography has also been used to localize the tip of a ventriculoatrial shunt.<sup>6</sup> In our case, it was easy to visualize the RA-SVC junction, the ideal site for placement of the air-aspiration catheter. Flushing saline microbubbles through the catheter confirmed its correct positioning. Our method is advantageous when a TEE machine is readily available, and it eliminates the need for x-ray equipment. Although not confirmed by our case, our belief is that, if the TEE probe is positioned properly, this method is as efficient as placing the catheter using ECG monitoring. A theoretic advantage of placement guided by TEE rather than ECG is that ECG changes may be recorded not from the tip, but, rather from the more proximally located lumen orifices; therefore, the tip may not truly be at the RA-SVC junction.<sup>7</sup>

Limitations of using TEE are: 1) settings for gain and ultrasound transmission must be adjusted properly, and 2) the operator must be experienced in recognizing the anatomic correlations and structures of the heart and great vessels. When contrast injection is used to localize the catheter, contrast may flow from both the catheter tip and proximal orifices; this flow may decrease its usefulness for locating the tip of the catheter. In summary, we believe that this method is an efficient means for placing the air aspiration catheter when an ultrasound system is available. This example is another potential application of intraoperative echocardiography by the anesthesiologist.

### References

1. Michenfelder JD: Central venous catheters in the management of air embolism: Whether as well as where (editorial). *ANESTHESIOLOGY* 55:339–341, 1981
2. Bunegin L, Albin MS, Helsel PE, Hoffman A, Hung T-K: Positioning the right atrial catheter: A model for reappraisal. *ANESTHESIOLOGY* 55:343–348, 1981
3. Turnage WS, Fontanet H: Transesophageal echocardiography-guided pulmonary artery catheter placement. *Anesth Analg* 77:858–859, 1993
4. Yoshizato T, Hagler DJ: Pulmonary artery catheter placement with two-dimensional echocardiographic guidance: A technique applicable in critically ill neonates. *Mayo Clin Proc* 64:387–391, 1989



## CASE REPORTS

5. Tuggle DW, Pryor R, Ward K, Tunell WP: Real-time echocardiography: A new technique to facilitate Swan-Ganz catheter insertion. *J Pediatr Surg* 22:1169-1170, 1987

6. McGrail KM, Muzzi DA, Losasso TJ, Meyer FB: Ventriculoatrial

shunt distal catheter placement using transesophageal echocardiography: Technical note. *Neurosurgery* 30:747-749, 1992

7. Mongan P, Peterson RE, Culling RD: Pressure monitoring can accurately position catheters for air embolism aspiration. *J Clin Monit* 8:121-125, 1992

## Anesthesiology

83:1361-1364, 1995

© 1995 American Society of Anesthesiologists, Inc.  
Lippincott-Raven Publishers

## Suspected Isoflurane Hepatitis in an Obese Patient with a History of Halothane Hepatitis

Naresh T. Gunaratnam, M.D.,\* Jay Benson, M.D.,† A. Jay Gandolfi, Ph.D.,‡ Mingli Chen, B.S.§

VOLATILE halogenated anesthetics are known to produce a sporadic low incidence of hepatotoxicity. Halothane is the principal agent associated with hepatotoxicity, as documented by numerous case reports and laboratory investigations. The hepatotoxicity varies from a mild, acute, self-limited injury, which is seen in 20% of patients, to an often fatal, idiosyncratic fulminant hepatocellular necrosis, which occurs in 1 of 30,000 patients.<sup>1,2</sup> Isoflurane has also been associated with hepatitis in a few case reports.<sup>3-6</sup> We describe the case of a patient with a history of halothane hepatitis, who showed similar hypersensitivity toward isoflurane.

### Case Report

The patient, a 47-yr-old man, was exposed to halothane in 1970. At that time, he was 23 yr of age, obese (weight, 122 kg; height, 1.65 m), and healthy; while anesthetized with halothane, he underwent elective reduction of gynecomastia induced by obesity. Two days after surgery, the patient developed fever, arthralgias, and frank hepatitis. Detailed records were unavailable, but the patient's hepatitis required hospitalization for 3 weeks. On discharge, the patient was told by the treating physicians that the hepatitis was probably halothane induced, and he was instructed to avoid future halothane exposure. The initial episode of hepatitis resolved completely in that the patient became asymptomatic and results of his liver function were normal. In October, 1980, the patient was evaluated for irritable bowel syndrome and was noted to have slightly increased hepatic transaminases, with AST 46 U/l (normal, 0-35 U/l), ALT 108 U/l (normal, 0-35 U/l), and a total bilirubin of 1.4 mg/dl (normal 0.3-1.0 mg/dl). The patient worked as a school teacher and did not have a history of any blood transfusion, alcohol abuse, intravenous drug use, or exposure to other hepatotoxic chemicals or medications, and had no serologic evidence of hepatitis A or B. The patient did not manifest stigmata of chronic liver disease, and hepatocellular enzymes remained increased, but stable, over the next 2 yr. In May, 1982, liver biopsy revealed moderate diffuse fatty metamorphosis, slight focal chronic inflammation, and rare degenerated liver cells. The patient's physicians believed that the hepatic pathology was either a sequela of his episode of halothane hepatitis or secondary to his morbid obesity (weight, 122 kg). Liver function studies remained minimally abnormal on close follow up over the next 11 yr.

In August, 1993, the patient underwent endoscopic sinus surgery for removal of nasal polyps. He was in good health otherwise, and physical examination was only remarkable for obesity (weight, 134 kg). Laboratory examinations 1 day before surgery documented that results of his liver function tests were normal (AST 32, ALT 35). The patient was premedicated with 3 mg midazolam and anesthesia was induced with 3 ml (50 µg/ml) fentanyl and 20 ml propofol. General anesthesia was maintained with 1% isoflurane, N<sub>2</sub>O/O<sub>2</sub> 60:40 for 1 h. During anesthesia, the patient received succinylcholine, as well as ephedrine, topically for local hemostasis. There were no episodes

\* Fellow in Gastroenterology, University of Michigan Medical Center.

† Clinical Associate Professor of Medicine, University of Connecticut School of Medicine and St. Francis Hospital Medical Center.

‡ Professor of Anesthesiology, Pharmacology, and Toxicology, University of Arizona.

§ Graduate Assistant, Department of Anesthesiology, University of Arizona.

Received from the University of Michigan Medical Center, Department of Medicine, Division of Gastroenterology, Ann Arbor, Michigan; the University of Connecticut School of Medicine and St. Francis Hospital Medical Center, Hartford, Connecticut; and the Department of Anesthesiology, College of Medicine, University of Arizona, Tucson, Arizona. Submitted for publication February 17, 1995. Accepted for publication August 3, 1995.

Address reprint requests to Dr. Gunaratnam: University of Michigan Medical Center, Department of Medicine, Division of Gastroenterology, Ann Arbor, Michigan 48109-0362.

Key words: Anesthetics, volatile: isoflurane. Antibodies: TFA-albumin. Liver: injury.