5. Wilkinson PL, Ham J, Mill RD: Clinical Anesthesia Case Selections From the University of California—San Francisco. St. Louis, The C. V. Mosby Co., 1980, pp 294–295
6. Weiss HD: The physiology of human penile erection. Annl Intern Med 76:793–799, 1972
7. Roy R: Cardiovascular effects of ketamine given to relieve penile turgescence after high dose of fentanyl. ANESTHESIOLOGY 61: 610–613, 1984
8. Benson HT, Leventhal JB, Ovasapian A: Ketamine treatment for penile erection in the operating room. Anesth Analg 62:457–461, 1981
9. Nieder RM: Ketamine treatment of priapism. JAMA 221:195, 1972
10. Benson GS: Penile erection: In search of a neurotransmitter. World J Urol 1:209–212, 1983
11. Brindley GS: Cavernosal alpha-blockade: A new technique for investigating and treating erectile impotence. Br J Psychiatry 143: 332–337, 1983
12. Ravindran RS, Grate DE, Somerville G: Treatment of priapism with ketamine and physostigmine. Anesth Analg 61:705–707, 1982
13. Brindley GS: New treatment of priapism. Lancet 2:220–224, 1984
14. Walthor JP, Meyer FA, Woodworth BE: Intraoperative management of penile erection with intracorporal phenylephrine during endoscopic surgery. J Urol 137:738–739, 1987
15. Lue FT: Editorial comment. J Urol 139:737, 1988
16. Goldstein AM, Meehan JP, Zakhary R, Buckley PA, Rogers FA: New observations on the microarchitecture of the corpora cavernosa in man and their possible relationship to the mechanism of erection. Urol 20:259–266, 1982

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Air Embolism Removal from Both Pulmonary Artery and Right Atrium during Sitting Craniotomy Using a New Catheter: Report of a Case

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Numerous authors have recommended insertion of central venous catheters for aspiration of venous air embolism (VAE). Others[1,2] have recommended insertion of pulmonary artery (PA) catheters for detection of hemodynamically significant VAE. Unfortunately, the lumens of commercially available PA catheters are small, making them "poorly suited for efficient air aspiration."[3] This leaves the clinician in the awkward position of having a catheter well suited for either detection or treatment of VAE, but not both. Furthermore, since significant amounts of air may enter the right ventricular outflow tract and PA,[1,2,4,5] a means to effectively detect and treat significant VAE in either PA or right atrium-superior vena cava (RA-SVC) is needed.

The author has developed a catheter to address this need (fig. 1, 2). Its balloon tip and 70-cm length permit insertion into the PA. The ECG bushing allows accurate RA-SVC positioning without adapters. Multiple side holes, an end hole, and 7 French size allow rapid removal of embolized air. If used with an introducer with an external sterile sleeve, the catheter can be repositioned during surgery, allowing repeated aspiration of air from multiple sites. The introducer side port will also provide an independent central port for drug injection. The catheter is available on request from Arrow International (PO Box 6306, Hill and George Avenues, Reading, Pennsylvania 19610). Its use is illustrated by the following case.

REPORT OF A CASE

A previously healthy 47-kg, 175-cm, 22-yr-old woman with a large midline tumor obstructing the outlet of the fourth ventricle, hydrocephalus, and brain stem compression was brought to the operating room for urgent decompression.

A prototype of the catheter described above was inserted 4 cm into the PA *via* the left subclavian vein, with the depth of insertion at RA-SVC determined by intravascular ECG monitoring during catheter passage. The introducer and sterile sleeve assembly were left in place to allow later catheter manipulation.

Induction of anesthesia with 200 μg of fentanyl and 800 mg of thiopental was followed by 8 mg of vecuronium and tracheal intubation with a 7.5-mm endotracheal tube. Following intubation, anesthesia was maintained with 70% nitrous oxide and oxygen. The patient was placed in the sitting position.

A burr hole and ventriculostomy were placed in the right parieto-occipital area. A midline suboccipital incision was then made. As this incision was being carried down to the bone, the end-tidal CO_2 decreased rapidly to 14 mmHg, followed rapidly by an increase in PA pressure to 39/24 mmHg and a decrease in arterial pressure to an eventual nadir of 20 mmHg systolic. In rapid sequence, the surgeons were notified of air embolism, 10 mg of ephedrine was given iv, and the catheter was aspirated. Nitrous oxide was discontinued and 5 cm H_2O PEEP was instituted. After inspecting both wounds, the surgeons located an open vein in the burr hole, which was then packed. A total of 25 ml of air was removed from the PA, then the catheter was withdrawn to the RA-SVC position where an additional 10 ml of air was removed. The arterial pressure rapidly recovered to normal. Ten to fifteen minutes were required for PA pressures and end-tidal CO_2 to return to normal, after which the catheter balloon was inflated and the catheter repositioned in the PA. Anesthesia was then maintained with isoflurane in oxygen. Later, there were two similar, but less severe, episodes. Following the operation, the patient recovered fully without apparent sequelae.

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Key words: Embolism: air. Equipment, catheters: central venous; pulmonary artery. Position: seated.

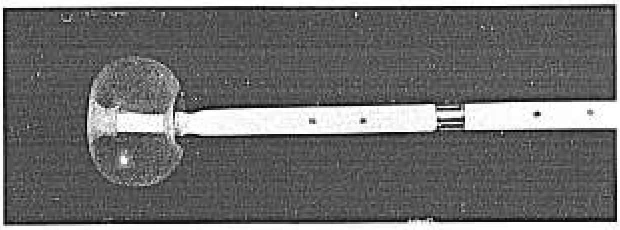

FIG. 1. Distal end of prototype air aspiration catheter showing balloon tip, multiple side holes, and ECG electrode.

DISCUSSION

Despite unequivocal evidence that air emboli lodge in both RA-SVC and PA,[1,2,4,5] and evidence that removing air from the PA or RV is beneficial,[2,4,5] attention has largely been focused on removal of air from the RA-SVC. If substantial amounts of air pass into the PA, aspiration of the RA-SVC will not improve the hemodynamic consequences of PA air. The same holds true for RA-SVC air if only the PA is aspirated. As seen in this case and reported by Marshall and Bedford,[2] air can readily be recovered from both sites, allowing a more complete treatment for the hemodynamic consequences of VAE than aspiration from a single site.

The catheter described allows easy positioning into the RA-SVC or PA with commonly available introducer kits. In the PA position, it can function as a sensitive monitor for hemodynamically significant VAE.[2] With its large bore, end hole, and multiple side holes, it can then be used for effective removal of VAE in the PA. Once the air has been removed from the PA, the catheter tip can be withdrawn to the RA-SVC and remove air trapped there. When cardiac output is restored, the catheter can be repositioned in the PA. The opposite sequence is unlikely to work, since in massive VAE cardiac output may remain too depressed to permit the catheter to be positioned in the PA until air is removed from both sites.

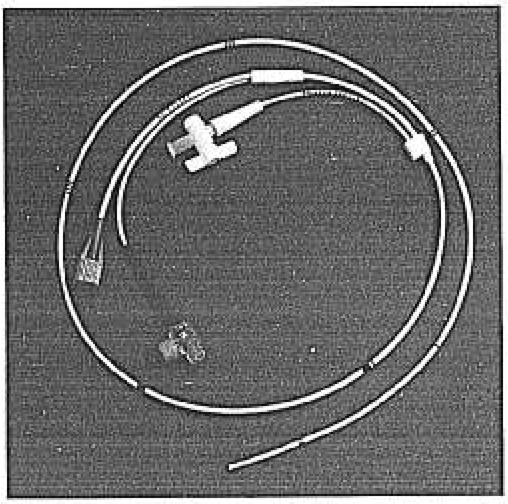

FIG. 2. Prototype of air aspiration catheter showing balloon tip, multiple side holes, ECG electrode, and proximal tail with ECG connector button and Luer connections for lumens.

In this case, the ability to position the catheter in the PA was very important for both monitoring and aspiration. The ability to reposition the catheter proved crucial, since substantial amounts of air were removed from both the PA and RA-SVC, with more air being removed from the PA than RA-SVC in every episode.

Other authors[3,6] have recovered the majority of experimental VAE from the RA-SVC position, contrary to what was observed in this case. It may be that air that would have lodged in the PA was recovered in transit, in which case the catheter described above, being more effective than prior catheters in the PA,[3] would also recover the air. Alternatively, the design of the experiments may have not in fact accurately reflected the clinical setting; or this case may be an exception for reasons that are not apparent.

In conclusion, a case has been presented demonstrating removal of large VAE from both PA and RA-SVC using a new catheter. Special advantages of the catheter include positioning in multiple sites using ECG or pressure guidance, ready intraoperative repositioning, PA pressure monitoring, and rapid air removal.

REFERENCES

1. Munson ED, Paul WL, Perry JC, DePadua CB, Rhoton AL: Early detection of venous air embolism using a Swan-Ganz catheter. ANESTHESIOLOGY 42:223–226, 1975
2. Marshall WK, Bedford RF: Use of a pulmonary artery catheter for detection and treatment of venous air embolism: A prospective study in man. ANESTHESIOLOGY 52:131–134, 1980
3. Bowdle TA, Artru AA: Treatment of air embolism with a special pulmonary artery catheter introducer sheath in sitting dogs. ANESTHESIOLOGY 68:107–110, 1988
4. Sato S, Toya S, Ohira T, Mine T, Greig NH: Echocardiographic detection and treatment of intraoperative air embolism. J Neurosurg 64:440–444, 1986
5. Furuya H, Okumura F: Detection of paradoxical air embolism by transesophageal echocardiography. ANESTHESIOLOGY 60:374–377, 1984
6. Colley PS, Artru AA: Bunegin-Albin catheter improves air retrieval and resuscitation from lethal air embolism in dogs. Anesth Analg 66:991–994, 1987

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