Clinical Reports

Failure to awaken after general anaesthesia secondary to paradoxical venous embolus

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A patient is presented who failed to regain consciousness after an apparently uneventful nine-hour revision of a total hip replacement. There were no clinically important haemodynamic changes during the operation, and oxygen saturation, capnography and acid base balance were normal throughout. Postop CT of the head showed a large left MCA infarct with midline shift. At autopsy, the patient was found to have a previously unsuspected patent foramen ovale, and a venous embolus in the left internal carotid artery, which probably had originated from the periprostatic venous plexus with a large infarct in the distribution of the left anterior and middle cerebral arteries. The authors conclude that massive paradoxical venous emboli can occur during surgery with minimal haemodynamic changes.

Un patient qui ne s'est pas réveillé après une révision d'un remplacement total de la hanche de neuf heures sans complication apparente est présenté. Il n'y avait aucune altération hémodynamique clinique importante durant l'opération et la saturation d'oxygène, la capnographie et l'équilibre acide base furent normaux à travers la procédure. Un CT scan cérébral en postop a démontré un grand infarctus de l'artère cérébrale moyenne gauche avec un déplacement de la ligne médiane. À l'autopsie, on trouva un foramen oval non suspecté et une embolie veineuse dans l'artère carotide interne gauche probablement provenant du plexus veineux périprostatique avec un large infarctus dans le territoire de distribution des artères cérébrales

Key words

COMPLICATIONS: embolism;

EMBOLISM: cerebral, thromboembolism.

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moyenne et antérieure gauche. Les auteurs concluent qu'une embolie veineuse paradoxale massive peut survenir lors de la chirurgie avec des altérations hémodynamiques minimales.

Prolonged or failed emergence from anaesthesia has been reported from anaesthetic medications, metabolic abnormalities, and neurological causes.¹ Neurological complications include hypoxia, intracranial haemorrhage, cerebral ischaemia and cerebral embolism.² There are several reports of paradoxical air embolism (PAE), causing death or delayed awakening from anaesthesia.³⁻⁵ We report a patient who failed to awaken after an apparently uneventful general anaesthetic, caused by a thrombotic cerebral embolus through a previously unsuspected patent foramen ovale.

Case report

A 63-yr-old man presented for revision of a left total hip replacement. He previously had two right and one left hip replacements under general anaesthesia without complications. History revealed no known drug allergies, no abnormal cardio-pulmonary or neurological signs or symptoms, and his only medication was flurbiprofen for arthritis. Non-invasive peripheral vascular impedance plethysmography studies were normal.

He received 350 mg thiopentone for induction of anaesthesia, 8 mg pancuronium for muscle relaxation, and 0.5–1.25% isoflurane with 50% nitrous oxide, 250 µg fentanyl, and 10 mg morphine for anaesthetic maintenance for an apparently uneventful nine-hour procedure. Intraoperative monitors included ECG, non-invasive sphygmo-manometer, oesophageal thermometer, oesophageal stethoscope, mass spectrometry and peripheral oximeter. The patient was placed in the right lateral position with the head aligned with the torso and not rotated.

Blood pressures ranged from 98–140/60–65 mmHg. The pulse rate, which was 60–80 bpm minute during the

first four hours, increased to 90–100 bpm as the patient warmed from the heating blanket and blood warmer. The highest nasopharyngeal temperature was 38.4° C. After the heating blanket and blood warmer were turned off, the temperature decreased and the heart rate returned to normal.

The peripheral oxygen saturation of the patient in the operating room and recovery room was 97% or higher, and the $P_{ET}CO_2$ was 34–42 mmHg. All blood gases analyzes in the OR showed normal acid base balance and a PO_2 of at least 120 mmHg while breathing 50% oxygen.

During the last two hours of the procedure 10 mg morphine sulphate was given *iv* in divided doses in an attempt to lessen postoperative pain. At the conclusion of surgery the patient was taken to the recovery room with stable vital signs breathing 40% oxygen spontaneously through a Briggs adapter with the tracheal tube in place. Estimated blood loss was 1000 ml. Intraoperative fluid replacement consisted of 6000 ml crystalloid with 100 g dextrose; urine output was 1000 ml.

In the recovery room the patient did not awaken from anaesthesia and responded only to deep pain. For the first hour the systolic blood pressure was 94–117 mmHg and the pulse rate was 96–109 bpm. The blood pressure then decreased to 84/65 mmHg. A one litre crystalloid fluid challenge was administered which increased the blood pressure but which only provided a $14 \text{ ml} \cdot \text{hr}^{-1}$ urine output compared with the previous $65 \text{ ml} \cdot \text{hr}^{-1}$. The patient was given nalbuphine 5 mg twice without response. When the heart rate increased to 124 bpm a pulmonary artery catheter was inserted. The pulmonary artery pressures were: wedge = 5 mmHg, pulmonary artery systolic = 36 mmHg and diastolic = 10 mmHg.

In the intensive care unit the patient was comatose with left gaze preference and roving eye movements but without papilloedema. Noxious stimulation produced movement only on the left. Hypotonia and depressed reflexes were present bilaterally. A CT brain scan demonstrated a large left middle cerebral artery infarction with effacement of the left lateral ventricle and mild shifting of the falx cerebri. The clinical diagnosis was carotid occlusion, most likely embolic in origin. During the next 24 hr, he became less responsive and, despite treatment with hyperventilation and mannitol, died.

An autopsy revealed a patent foramen ovale 1 cm in diameter, with no intracardiac thrombus. There was no evidence of acute or hyperacute myocardial infarction. An embolus was lodged in the left internal carotid artery extending to the origin of the left anterior and middle cerebral arteries. There was no evidence of pre-existing carotid artery thrombotic disease. He had a haemorrhagic infarct of the prostate with fibrin thrombi in the peripros-

tatic venous plexus, and the pathologist believed this was the most likely source of the embolus. There were small areas of fat emboli averaging 2–5 microns in about 10% of the lungs.

Discussion

Initially when the patient remained obtunded in the recovery room, morphine sulphate was considered to be the cause and attempts were made to reverse its effects with nalbuphine. The focal neurological changes did not fit the diffuse central nervous system damage seen with fat embolism.⁶ When the neurological examination and CT scan showed middle cerebral artery damage, a search for a cardiac or systemic source of emboli was initiated.

Paradoxical embolism is a well recognized entity often caused by a venous clot or entrained air (PAE). The cardiac defect allowing systemic embolisms is usually a patent foramen ovale or occult ASD.⁷ Paradoxical venous emboli (PVE) are the most frequently reported paradoxical cerebral emboli, and are associated with a mortality rate of about 50%.⁷ Suspicion of PVE should arise in any patient with cerebral emboli without a left-sided cardiac source with deep vein thrombosis, pulmonary embolus, or right to left shunt. The risk of stroke in unselected patients undergoing elective surgery is small. Ropper *et al.*,⁸ in a prospective study, found an incidence of 0.7% with or without an audible carotid bruit, all of whom underwent coronary artery bypass grafting – a procedure known to carry an increased risk of perioperative stroke.⁹ The risk of perioperative stroke in general surgical patients is estimated to be 0.3%.⁹ In younger individuals embolic phenomena account for a substantial number of cerebral infarctions in nonsurgical patients, though their sources are not always evident and may remain undefined in approximately one-third of cases despite extensive investigation.^{10,11} Paradoxical embolism occurs when a thrombus crosses an intracardiac defect, enters the systemic circulation and produces an arterial infarction. Cerebral infarctions caused by this process remained largely undetected in life until recently. Improved cardiac imaging and awareness of the syndrome make the diagnosis not only more frequent, but suggest that it may be a more common mechanism of embolic infarction than previously suspected. Intracardiac defects capable of permitting right- to left-sided shunting are more prevalent in young stroke patients than in age-matched controls,^{10,12} and the incidence of patent foramen ovale at autopsy may be as high as 35%.¹³

Despite this apparent high frequency of intracardiac defects, cerebral infarction due to paradoxical embolism is uncommon. However, when right-sided circulatory pressures increase, this pathophysiological mechanism

may become important. Meister *et al.*¹⁴ suggested that the triad of venous thrombosis and/or pulmonary embolism, a right to left intracardiac shunt, and arterial embolism without evidence of a left-sided intracardiac source should suggest the possibility of this diagnosis. Other authors have noted that a Valsalva manoeuvre may be a precipitating factor because it transiently increases right to left shunting.^{7,15,16}

Leg or pelvic veins are usually the source of embolic material in cases of cerebral infarctions due to paradoxical embolism, but current clinical and diagnostic tests for emboli are limited.¹⁷ The patient described in this case report was screened for venous thrombosis before surgery. His risk for thrombosis was predominately that of prolonged perioperative immobilization. Other potential risk factors such as obesity, preoperative immobilization, cancer, anovulatory agents or pregnancy, or preexisting coagulopathy were absent. He was not known to have cardiopulmonary disease which would predispose to elevated right-sided circulatory pressures.

In summary, we report a patient with paradoxical cerebral embolism who failed to emerge from anaesthesia. There are only a few previous reports of PAE despite the large population with patent foramen ovale and the large number of procedures with the risk of embolism. Previously reported cases of PAE during anaesthesia were all associated with profound haemodynamic changes. Although PVE is the most common type of cerebral embolus, it has not previously been reported during anaesthesia. This case is unique because the patient had no clinical symptoms during the procedure, and the first indication of neurological damage was failure to awaken after the end of the surgery.

References

- 1 Denlinger JK. Prolonged emergence and failure to regain consciousness. In: Orkin FK, Cooperman LH (Eds.). *Complications in Anesthesiology*. Philadelphia: J.B. Lippincott Company, 1983; 368–99.
- 2 Oliver SR, Cucchiara RF, Warner MA, Muir JJ. Unexpected focal neurological deficit on emergence from anesthesia: a report of three cases. *Anesthesiology* 1987; 67: 823–6.
- 3 Buckland RW, Manners JM. Venous air embolism during neurosurgery: a comparison of various methods of detection in man. *Anaesthesia* 1976; 31: 633–43.
- 4 Gronert GA, Messick JM, Cucchiara RF, Michenfelder JD. Paradoxical air embolism from a patent foramen ovale. *Anesthesiology* 1979; 50: 548–9.
- 5 Root B, Levy MN, Pollack S, Mortimer L, Kalindi P. Gas embolism death after laparoscopy delayed by “trapping” in portal circulation. *Anesth Analg* 1978; 57: 232–7.
- 6 Schwartz SI. *Principles of Surgery*. Singapore. McGraw Hill Book Co. 1989; 470–2.
- 7 Jones HR, Caplan LR, Come PL, Swinton Jr NW, Breslin DJ. Cerebral emboli of paradoxical origin. *Ann Neurol* 1983; 13: 314–9.
- 8 Ropper AH, Wechsler LR, Wilson LS. Carotid fruit and the risk of stroke in elective surgery. *N Engl J Med* 1982; 307: 1388–90.
- 9 Hart RG, Easton JD. Management of cervical bruits and carotid stenosis in preoperative patients. *Stroke* 1983; 14: 290–7.
- 10 Lechat P, Mas JL, Lascault G *et al.* Prevalence of patent foramen ovale in patients with stroke. *N Engl J Med* 1988; 318: 1148–53.
- 11 Mohr JP. Cryptogenic stroke. *N Engl J Med* 1988; 318: 1197–38.
- 12 Webster MWI, Chancellor AM, Smith HJ, Swift DL, Sharpe DN, Bass NM. Patent foramen ovale in young stroke patients. *Lancet* 1988; 2: 11–2.
- 13 Thompson T, Evans W. Paradoxical Embolism. *Q J Med* 1930; 23: 135–50.
- 14 Meister SG, Grossman W, Dexter L, Dalen JE. Paradoxical embolism: diagnosis during life. *Am J Med* 1972; 53: 292–8.
- 15 Biller J, Johnson MR, Adams Jr HP, Kerber RE, Toffol GJ, Butler MJ. Echocardiographic evaluation of young adults with nonhemorrhagic cerebral infarction. *Stroke* 1986; 17: 608–12.
- 16 Cheng T. Paradoxical Embolism. A diagnostic challenge and its detection during life. *Circulation* 1976; 53: 565–8.
- 17 Rosenow EC III, Osmundson PJ, Brown JL. Pulmonary embolism. *Mayo Clin Proc* 1981; 56: 161–78.