Acta Neurochir (Wien) (1993) 125: 181–183

Acta Neurochirurgica

Massive Cerebral Air Embolism Following Cardiopulmonary Resuscitation. Report of Two Cases

G. Shiina[1], **Y. Shimosegawa**[1], **M. Kameyama**[2], and **T. Onuma**[1]

[1] Department of Neurosurgery, Sendai City Hospital, and [2] Department of Emergency and Critical Care Medicine, Tohoku University, Miyagi, Japan

Summary

Cerebral air embolism can occur in a number of situations. We report two cases of massive cerebral arterial air embolism following cardiopulmonary resuscitation, and its mechanism is discussed.

Keywords: Head injury; cardiopulmonary resuscitation; cerebral air embolism; computerized tomography.

Introduction

Cerebral air embolism can occur in a number of situations, such as head trauma[3], chest trauma, cervical trauma, Caisson's disease, scuba diving[6], neurosurgical operations (especially in the sitting position), gynaecological surgery[4], pulmonary barotrauma, pneumothorax, percutaneous biopsy of the lung[2, 11, 24], lung cancer, arterial or venous catheterization[13], cardiothoracic trauma or surgery[18, 22], mechanical positive pressure ventilation[1, 5, 17], oesophagoatrial fistula[19], intraaortic balloon pumping catheter insertion[7, 8], angiography[20, 23], haemodilution, intravenous transfusion, and other diagnostic or therapeutic procedures.

Two cases of massive cerebral arterial air embolism associated with posttraumatic cardiopulmonary resuscitation[25] are reported and its possible mechanism is discussed.

Case Reports

Case 1

A 40-year-old male received a head injury when falling from his bicycle on December 27, 1989. On admission, he was in cardiorespiratory arrest. Cardiopulmonary resuscitation was performed; however, he died 1 hour after admission. A CT scan of the head half an hour after admission showed multiple skull fractures of the frontal bone and the skull base, pneumocephalus in the frontal region, and scattered massive air embolism in the cerebral arteries (Fig. 1).

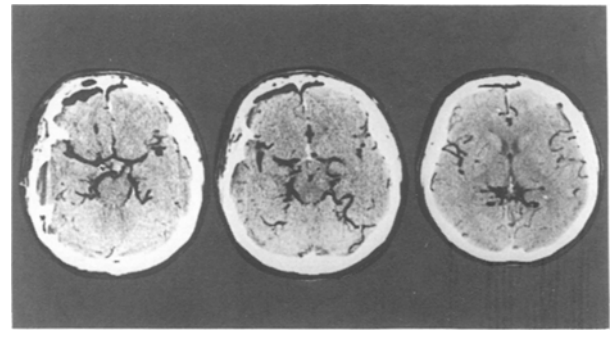


Fig. 1. Case 1. A CT scan of the head half an hour after admission showed multiple skull fractures in the frontal bone and the skull base, pneumocephalus in the frontal region and scattered massive air in the cerebral arteries

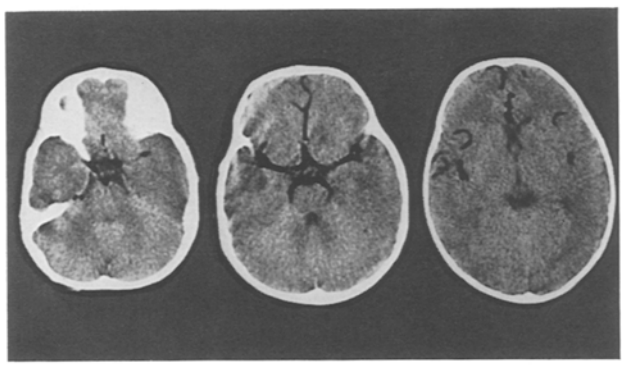
Case 2

A 11-month-old girl received minor head trauma on June 10, 1991, and her mother brought her to our neurosurgical department on the June 11 in the morning. Clinical examination and skull X-ray revealed no abnormal findings. After returning home, she drunk tea and slept. While sleeping, she vomited and suffocated. When she was transported to our hospital by an ambulance, she was in cardiorespiratory arrest. She was intubated and vigorously ventilated by a manual bag. Cardiac resuscitation was also performed. But she died 1 hour after admission. A chest X-ray half an hour after admission showed pneumothorax and a CT scan of the head showed air-filled cerebral vessels (Fig. 2 a and b).

Discussion

Cerebral air embolism is often produced either accidentally or iatrogenically. Cerebral air embolism may occur in two ways: one as a part of decompression sickness[6] and the other as a complication of various medical procedures[12, 14, 15]. It is pointed out that po-

a



b

Fig. 2. (a, b) Case 2. A CT scan of the head half an hour after admission showed diffusely air-filled main trunks of the anterior and middle cerebral arteries

sitive pressure ventilation may produce pulmonary barotrauma and can cause cerebral air embolism[1, 5, 17]. It is very rare that air bubbles are detected by skull X-ray[21] and computerized tomography[9, 10, 12, 16] in the case of cerebral air embolism.

In our adult case, it seemed that massive air entered the venous circulation via a traumatic shunt within the lung due to the traffic accident, then to the arterial circulation by the mechanical force of cardiopulmonary resuscitation. In our baby case, on the other hand, it seemed that the mechanical impact of cardiopulmonary resuscitation resulted in pulmonary barotrauma and pushed massive air into the arterial circulation and thus the intracerebral arteries. Some artificial force in cardiopulmonary resuscitation seems necessary to push air into the intracerebral arteries to the extent of being detectable on a skull X-ray.

Massive air embolism may be fatal. However, in our two cases, air embolism did not seem to be the direct cause of death, since there was already cardio-respiratory arrest on admission. We would rather make a point that the massive air embolism to the extent of being detectable even by skull X-ray can be caused by the mechanical force during cardiopulmonary resuscitation.

References

1. Banagale RC (1980) Massive intracranial air embolism: a complication of mechanical ventilation. Am J Dis Child 134: 799–800
2. Bradley KB, Eric EA (1988) Case report. Computed tomography of fatal cerebral air embolism following percutaneous aspiration biopsy of the lung. J Comput Assist Tomogr 12: 1082–1083
3. Butler BD, Hills BA (1985) Transpulmonary passage of venous air emboli. J Appl Physiol 59: 543–547
4. Davis FM, Glover PW, Maycock E (1990) Hyperbaric oxygen for arterial air embolism occurring during Caeserian section. Anest Intens Care 18: 403–405
5. David BU, James AJ, Ronald VT, Lislie HG (1991) Cerebral arterial air embolism associated with coughing on a continuous positive airway pressure circuit. Crit Care Med 19: 985–987
6. Dick APK, Massey EW (1985) Neurologic presentation of decompression sickness and air embolism in sport divers. Neurology 35: 667–671
7. Hani AH, Ayming W (1987) CT diagnosis of delayed cerebral air embolism following intraaortic balloon pump catheter insertion. Comput Radiol 10: 307–309
8. Haykal HA, Wang A (1986) CT diagnosis of delayed cerebral air embolism following intraaortic balloon pump catheter insertion. Comput Radiol 10: 307–309
9. Hirabuki N, Miura T, Mitomo K, *et al* (1988) Changes of cerebral air embolism shown by computed tomography. Br J Radiol 61: 252–255
10. Hwang T, Fremax R, Sears ES, MacFadyen B, Hills B, Mader JT, Peters B (1983) Confirmation of cerebral air embolism with computerized tomography. Ann Neurol 13: 214–215
11. Jack LW (1973) Air embolism complicating percutaneous needle-biopsy of the lung. Chest 63: 108–110
12. Jensen ME, Lipper MH (1986) CT in iatrogenic cerebral air embolism. AJNR 7: 823–827
13. Kearns PJ, Haulk AA, McDonald TW (1984) Homonymous hemianopsia due to cerebral air embolism from central venous catheter. West J Med 140: 615–617
14. Marquez J, Sladen A, Gendell H, Boehnke M, Mendelow H (1981) Paradoxical cerebral air embolism without an intracardiac septal defect. J Neurosurg 55: 997–1000
15. Mary EJ, Maurice HL (1986) CT in iatrogenic cerebral air embolism. AJNR 7: 823–827
16. Matz S, Segal A, Nemesh L, Spitzer S, Atsmon A (1980) Diagnosis of air embolism to the brain by computerized axial tomography. Comput Tomogr 4: 107–110

17. Michael AM, Milton LP, Ronald BP (1981) Detection of pneumoencephaly secondary to mechanical ventilation in neonates. J Comput Tomogr 5: 328–332
18. Mills NL, Ochsner JL (1980) Massive air embolism during cardiopulmonary bypass. J Thorac Cardiovasc Surg 80: 708–717
19. Nadjmi M, Schaffer R, Wordartz R (1979) Cerebral arterial air embolism due to an esophago-atrial fistura seen on CT. Neuroradiology 18: 103–106
20. Rand MV, Richard ARF (1984) Cerebral air embolism occurring at angiography and diagnosed by computerized tomography. J Neurosurg 60: 177–178
21. Taylor JD (1952) Post-mortem diagnosis of air embolism by radiography. BMJ 1: 890–892
22. Toscano M, Chiavarelli R, Ruvolo G, Macchiarelli A, Sciblia G, Marino B (1983) Management of massive air embolism during openheart surgery with retrograde perfusion of the cerebral vessels and hypervaric oxygenation. Thorac Cardiovasc Surg 31: 183–184
23. Voorhies RM, Fraser RAR (1984) Cerebral air embolism occurring at angiography and diagnosed by computerized tomography. J Neurosurg 60: 177–178
24. Wescott JL (1973) Air embolism complicating percutaneous needle biopsy of the lung. Chest 63: 108–110
25. Yamaki T, Ando S, Ohta K, Kubota T, Kawasaki K, Hirama M (1989) Case report. CT demonstration of massive cerebral air embolism from pulmonary barotrauma due to cardiopulmonary resuscitation. J Comput Assist Tomogr 13: 313–315

Correspondence: Genzou Shiina, M.D., Department of Neurosurgery, Sendai City Hospital, 3-1 Shimizukouji, Wakabayashi-ku, Sendai-shi, Miyagi 980, Japan.