Case report

Capgras syndrome: a clinical manifestation of watershed cerebral infarct complicating the use of extracorporeal membrane oxygenation

Jean Marc Dejode, François Antonini, Pierre Lagier and Claude Martin

Department of Anesthesia and Intensive Care, CHU Nord, Marseilles, France

Correspondence: Jean-Marc Dejode, jmdejode@ap-hm.fr

Received: 16 May 2000
Revisions requested: 20 November 2000
Revisions received: 23 May 2001
Accepted: 4 June 2001
Published: 13 July 2001

Critical Care 2001, **5**:232–235

(Print ISSN 1364-8535; Online ISSN 1466-609X)

Abstract

Ischaemic cerebral accidents are frequent following extracorporeal membrane oxygenation (ECMO), especially after fixing the reinjection cannula in the right primitive carotid artery, which leads to an interruption in downstream flow. We describe a rare and unusual symptom of cerebral ischaemic accident that is known as Capgras syndrome. This feature is interesting because it may be documented by computed tomography (CT) scan and particular electroencephalography signals. It appears that our observation represents the first documented case of Capgras syndrome complicating ECMO. This incident emphasizes the potential hazards associated with right common artery ligature for venoarterial extracorporeal membrane oxygenation (VAECMO). In addition, it shows that this psychiatric symptom (that has been interpreted psychodynamically for many years) can have an organic basis, which should be studied.

Keywords Capgras syndrome, cerebrovascular lesion, extracorporeal membrane oxygenation (ECMO), illusion of doubles, periodic lateralized epileptiform discharge (PLED)

Introduction

Watershed cerebral infarcts are very rare ischaemic lesions [1]. In the present report, we describe the case of a 24-year-old woman who developed border zone infarction after right primitive carotid artery occlusion for VAECMO.

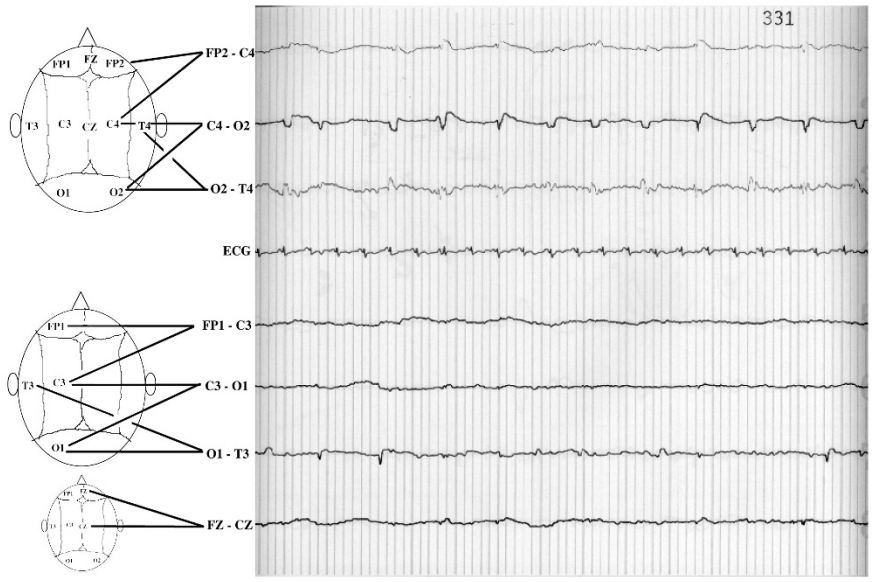
Case report

A 24-year-old-woman was admitted to the emergency service of our hospital with severe adult respiratory distress syndrome, complicating pneumococcal pneumonia. Body temperature was 41.7°C, and blood cultures and bronchial samples were positive for *Streptococcus pneumoniae*. The patient was intubated and ventilated because of serious hypoxaemia.

Mechanical ventilation parameters needed to be modified regularly, and pressures were gradually increased in order to combat hypoxaemia. This resulted in an aggressive assisted ventilation: fractional inspired oxygen 1; positive end-expiratory pressure 20 cmH_2O; mean airway pressure 40 cmH_2O; and inspiratory : expiratory ratio 2 : 1. Despite this aggressive approach, oxygenation remained insufficient: arterial oxygen saturation 65%; arterial oxygen tension 44 mmHg; arterial carbon dioxide tension 56 mmHg; and alveolar–arterial oxygen difference 600 mmHg. Nitric oxide inhalation (20 parts/million), in combination with almitrine adminstration, resulted in no improvement. Major air leak syndrome occurred, with pneumomediastinum, pneumoperitoneum and subcutaneous emphysema.

CT = computed tomography; ECMO = extracorporeal membrane oxygenation; ICA = internal carotid artery; PLED = periodic lateralized epileptiform discharge; VAECMO = venous arterial extracorporeal membrane oxygenation.

Figure 1



Periodic lateralized epileptiform discharges (C4-O2).

The patient was administered noradrenaline (norepinephrine; 0.4 μg/kg per min), dopamine (15 μg/kg per min) and dobutamine (10 μg/kg per min), and the following measures were obtained: mean arterial pressure 50 mmHg; cardiac index 2.26 l/min per m^2; systemic vascular resistance 659 dyne×s/cm^5 per m^2; central venous pressure 19 mmHg; mean pulmonary artery pressure 32 mmHg; pulmonary capillary wedge pressure 23 mmHg; and pulmonary vascular resistance 191 dyne×s/cm^5 per m^2.

Renal failure occurred, with anuria and fluid overload: natremia 129 mmol/l; total protein 34 g/l; blood nitrogen 21 mmol/l; and creatininaemia 350 μmol/l. Hepatic failure was present, with bilirubin at 120 μmol/l and a prothrombin time of 30 s.

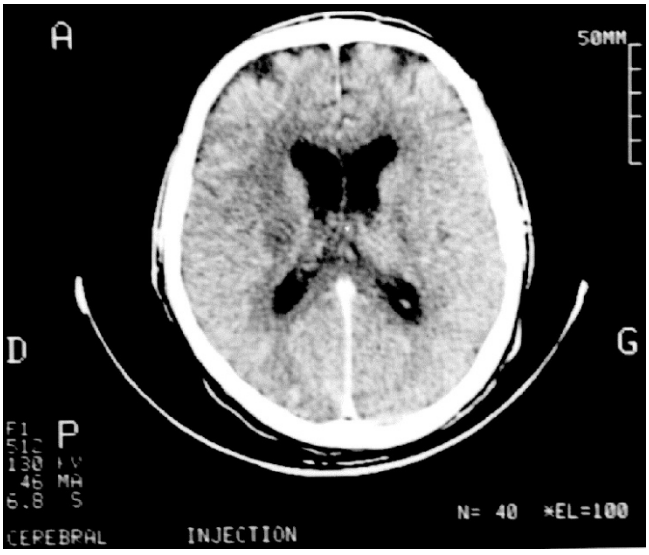
Confronted with this hypoxic multiple organ failure, we opted to initiate VAECMO treatment, which was started at 45 h after admission. Blood was collected from the right atrium by a drain CH24, and reinjected using a Harvey's cannula no 22 in the right primitive carotid artery following ligature of the downstream segment. The membrane used was a Ultrox I (3.5 m^2) (Avecoz Cardiovascular France, Voisins le Bretonneux, France), the rate of carbon dioxide removal was 160 ml/min, and arterial oxygen saturation was above 96%. Apneic ventilation was started with a respiratory frequency of 4 breaths/min and a mean airway pressure of 16 cmH_2O. Rapid improvements in the air leak syndrome and in the multiple organ failure (heart, kidney, liver) were observed within a few hours after beginning ECMO.

On day 10 after admission, VAECMO was stopped because of disseminated intravascular coagulation. Standard mechanical ventilation was then reinitiated. Haematosis and vital functions were maintained. On day 12 following admission, reconstruction of the carotid artery was performed, with an internal saphenous vein graft. We began to reduce sedation on day 22 after admission, and the patient progressively regained normal consciousness. At that time neurological examination findings were normal.

On day 29 after admission epileptic fits with myoclonic movements of the right lower limb occurred. No precipitating factors (hypotension, hypoxia, electrolyte disorders) could be identified to explain the seizures. On clinical examination left hemiparesis was found. The patient complained of optical illusions, with permanent distortion of objects, and she thought that some intensive care unit physicians had been replaced by a double (identical looking imposter). She stated that there were true and false physicians. She was quite conscious of the abnormality of these phenomena, and there were no psychiatric antecedents. Thus, a diagnosis of Capgras syndrome was made.

Electroencephalography showed periodic lateralized epileptiform discharges (PLEDs) in the posterior right hemisphere (channel C4-O2; Fig. 1). Angiography, performed after surgical repair (on day 36 after admission), revealed normal flow in the repaired carotid artery and in the circle of Willis. CT scan revealed a posterior water-

Figure 2



CT scan: watershed cerebral infarct between the right middle and the right posterior cerebral arterial territories.

shed cerebral infarct (between the right middle and the right posterior cerebral arterial territories; Fig. 2).

Anticonvulsant therapy was initiated. The epileptic fits declined progressively, and then stopped. The signs of Capgras syndrome disappeared in a few days. The patient was discharged from the intensive care unit on day 83 after admission. She was back to her normal professional activity 10 months later. She recovered normal functioning, without any deficiencies. Anticonvulsant therapy has been continued, and should soon be stopped.

Discussion

Cerebrovascular complications following ECMO are not uncommon. Several lesions have been described, including ischaemic neuronal necrosis, focal cerebral infarcts, intracerebral haemorrhages and periventricular leukomalacia. The pathogenesis is multifactorial, and includes one or several of the following: hypotension, profound hypoxaemia, hypocapnia, positioning of the cannula, carotid artery ligation, disseminated thrombosis and embolism.

Capgras syndrome is an unusual clinical manifestation of watershed cerebral infarction. Capgras syndrome (or 'illusion of doubles') was described by Capgras and Reboul-Lachaux in 1923 as a psychiatric syndrome [2,3]. It is defined as a delirious conviction, in which one or several persons are perceived by the patient to be replaced by a double (identical looking imposter) [4]. The patient sees true and false persons (doubles). This delusion is of concern to the patient's close (husband, wife, parents, children, neighbours) and professional circles, and to auxiliary nursing staff (nurses, physicians) [2]. It can extend to animals and objects [3]. The patient is conscious of the abnormality of these perceptions. There is no hallucination.

In addition to Capgras syndrome, other delusional misidentification syndromes exist, such as Fregoli syndrome, intermetamorphosis and the subjective doubles syndromes. These states constitute a complex group of cognitive right cerebral hemisphere dysfunctions [4]. The patient refuses to acknowledge a person as being who they say they are, but recognizes most of the physical features of that person [5]. Illusion of doubles is usually found in psychiatric diseases, particularly in schizophrenia [6]. However, many authors emphasize that the appearance of Capgras syndrome may correlate with the following: cerebral lesions (head injury and ischaemic cerebrovascular lesions, which are often located in the posterior area of the right hemisphere, where face recognition is performed [7–9]); electrical disorders on electroencephalography (seizure disorders) with or without clinical manifestations [10]; and metabolic disorders (secondary nephrotic syndrome, diabetes mellitus with dementia) [8]. Observation of the symptoms of Capgras syndrome should prompt a systematic search for cerebral lesions, electric disorders on electroencephalography, and organic disorders (infectious, toxic, metabolic), even in a defined psychiatric case [2,8–10].

Epileptic seizures are frequent during ECMO, with a rate of 10% according to the ECMO registry report of the Extracorporeal Life Support Organization [11,12]. PLEDs, found on electroencephalography, consist of sharp wave discharges that repeat periodically or quasi-periodically at a rate generally close to one discharge per second, separated by intervals of apparent quiescence that may or may not be associated with clinical manifestations (epileptic fits) [13,14]. PLEDs correlate with the presence of cerebral lesions. The aetiologies of these lesions or disorders include cerebral infarcts (most frequent), cerebral tumors and cerebral haemorrhages [13,15].

Watershed cerebral infarcts are unusual ischaemic lesions, but which can easily be recognized by CT (a guide of vascular territories can be used) and magnetic resonance imaging [1]. Several border zone areas exist [1]: superficial between cortical territories of anterior and middle cerebral arteries (anterior watershed infarct); superficial between cortical territories of middle and posterior cerebral arteries (posterior watershed infarct); between the superficial and deep territories of the middle cerebral artery (subcortical watershed infarction); and the 'last meadow' territory (located at the junction of the three cortical territories). Clinical manifestations vary according to the location of the lesion(s). Optical illusions with distortion of objects are described in posterior watershed infarct [1]. The border zone areas correlate with an anastomosis

between two main artery territories. In these regions vascularization is achieved with low blood flow and low cerebral perfusion pressure, which are similar on both sides of each territory. If blood flow decreases on one side, then the anastomosis is usually able to vasodilate, which partly permits blood supply to the ischaemic territory [1]. The border zone regions are sensitive to a reduction in cerebral blood flow [1]. The main causes of cerebral border zone infarction are as follows [1]: serious cervical arterial artherosclerotic disease (specifically internal carotid artery occlusion), in which unilateral lesions are usually observed; and systemic hypotension, especially during cardiac surgery with extracoporeal circulation and cardiac arrest, which may cause bilateral lesions.

When the right primitive carotid artery is used for VAECMO, a watershed cerebral infarct can result. The collateral supply through the circle of Willis, via leptomeningeal vessels, or through spontaneous extracranial to intracranial anatomosis, can adequately compensate for the resultant fall in cerebral blood flow and cerebral perfusion pressure. In this situation occlusion remains asymptomatic [16]. However, the presence of an anomalous circle of Willis (hypoplasia of one or both posterior communicating arteries, embryonic derivation of posterior cerebral artery, hypoplasia of the first portion of anterior cerebral artery, hypoplasia of basilar artery) can interfere with collateral circulation [17]. Another problem regarding collateral compensation is that it may be limited, and insufficient to meet changing metabolic demands [16].

Ligature of the common carotid artery is considered by several authors to be a safer procedure than ligature of the internal carotid artery (ICA; which is used to treat some patients with intracranial saccular aneurysm). Nevertheless, some reports [18,19] stress that an unpredictable haemodynamic state may ensue following such a procedure. The pressure in external carotid artery may be sufficient to maintain a high ICA blood pressure, and cause a marked forward flow in the ICA; this negated the effect of ligature in approximately 50% of 12 patients studied [18,19]. In the remaining 50%, ligature of common carotid artery induced a reversal of flow in the ICA and resulted in a steal of blood flow from the ipsilateral hemisphere. This phenomenom carries a significant risk of ischaemic complication [18,19].

In the patient reported here the exact cause of cerebral ischaemia was unclear, and one or several factors can be considered: severe hypotension before ECMO; episodes of collapse during ECMO; disseminated thrombosis; and cerebral embolism. In addition, the right carotid artery was ligated after ECMO. Our observation of right posterior cerebral border zone infarction is interesting, because clinical and electrical manifestations, and cerebral scan were consistent with a diagnosis of Capgras syndrome.Thus, we concede that the syndrome might have been a clinical manifestation of cerebral lesions in the right cerebral hemisphere. Electrical disorders on electroencephalography and organic disorders should also be researched [8].

In conclusion, our observation emphasizes the neurological pitfalls associated with blood reinjection into the primitive carotid artery during VAECMO. On the other hand, the present case report stresses that, in case of life-threatening hypoxia, the use of ECMO may be the only way to save the patient's life.

References

1. Evrard S, Bousser MG: **Watershed cerebral infarcts [in French].** *Sang Thrombose Vaisseau* 1991, **3**:103–108.
2. Bogousslavsky J, Salvador A: **The Capgras syndrome [in French].** *Ann Méd Psychol* 1981, **139**:949–964.
3. Samson E, Picard S: **The Capgras syndrome.** *Can J Psychiatry* 1986, **31**:142–145.
4. Bogousslavsky J: **Major syndromes of the minor hemisphere [in French].** *Encycl Med Chir* 1991, 17022, E10,6.
5. Debruille J, Stip E: **Capgras syndrome: evolution of the hypotheses [in French].** *Can J Psychiatry* 1996, **41**:181–187.
6. Silva JA, Leong GB: **The Capgras' syndrome in paranoid schizophrenia.** *Psychopathology* 1992, **25**:147–153.
7. Ellis H: **The role of right hemisphere in the Capgras delusion.** *Psychopathology* 1994, **27**:177–185.
8. Collins MN, Hawthorne M: **Capgras' syndrome with organic disorders.** *Postgrad Med J* 1990, **66**:1064–1067.
9. Weston MJ, Whitlock FA: **The Capgras syndrome following head injury.** *Br J Psychiatry* 1971, **119**:25–31.
10. Chawla HM, Virmani V: **Capgras phenomenon in a case of temporal lobe epilepsy.** *Folia Psychiatr Neurol Jpn* 1977, **31**:615–617.
11. Rodichok L, Winters J, Myers J, Schwentker M, Marshall W: **The evolution of EEG changes during extracorporeal circulation and progressive hypothermia with or without circulary arrest.** *Am J EEG Technol* 1994, **34**:66–74.
12. Campbell LR: **Significance of seizures associated with extracorporeal membrane oxygenation.** *J Pediatr* 1991, **119**:789–792.
13. Emilio C: **The significance of periodic lateralized epileptiform discharge in EEG: an electrographic clinical and pathological study.** *Electroencephalogr Clin Neuropsychol* 1964, **17**:177–193.
14. Schwartz MS, Prior P, Scott DF: **The occurrence and evolution in EEG of lateralized periodic phenomenom.** *Brain* 1973, **96**: 613–622.
15. Schraeder PL, Singh N: **Seizure disorders following periodic lateralized epileptiform discharges.** *Epilepsia* 1980, **21**:647–653.
16. Leblanc R, Yamamoto YL, Tyler JL, Diksic M, Hakim A: **Border-zone ischemia.** *Ann Neurol* 1987, 22:707–713.
17. Lewis M, Wierner, Berry GR: **Intracranial circulation in carotid occlusion.** *Arch Neurol* 1964; **11**:167–171.
18. Nornes H: **The role of the circle of Willis in graded occlusion of the internal carotid artery in man.** *Acta Neurochirurg* 1973, **28**: 165–177.
19. Hardesty W, Roberts B, Toole JF: **Studies of carotid artery blood flow in man.** *N Engl J Med* 1960, **10**:944–946.