

Case Report

## A case of iatrogenic cerebral infarction demonstrated by postmortem cerebral angiography

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### Abstract

A 37-year-old man with a meningioma compressing the right frontal lobe underwent preoperative embolization of the feeding vessels from the right meningeal artery. Although the first challenge was apparently successful, an excess amount of embolization agent was accidentally injected during the next procedure. X-ray monitoring demonstrated flow of contrast medium into the right internal carotid, anterior and middle cerebral arteries, and then the patient suddenly developed left hemiparesis, nausea, and deep coma. He died 48 days after the embolization treatment without improvement of the coma. A medicolegal autopsy was performed to determine whether malpractice had occurred during the embolization procedure. An internal examination demonstrated massive necrosis of the cerebral hemispheres and lobar pneumonia with abscess in the lungs. Due to the extensive brain necrosis, it was impossible to carry out ordinary macroscopic examination to identify the precise site of the craniocerebral vessel occlusion. Postmortem angiography was therefore performed, and this successfully revealed occlusion of the right internal carotid artery. In this case, postmortem angiography played a key role in identification of the intracranial vascular lesion that was responsible for the iatrogenic cerebral infarction.

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### 1. Introduction

According to Boulay and O'Connell [1], cerebral angiography was first developed by Egas Moriz in 1927. Since then, a huge volume of literature on angiography has accumulated. Angiography can also be performed for postmortem examination by pathologists. Postmortem angiography has been used mainly to identify the arterial supply of any vascularized organ or tissue as well as the location of an arterial rupture. Karhunen et al. reported that postmortem craniocerebral angiography was useful for clarifying head trauma and for differential diagnosis between arteriovenous malformation and arterial aneurysm in cases of unusual intracranial hemorrhage [2,3]. Smith et al. showed that postmortem

coronary angiography was a valuable tool for both gross and microscopic anatomical studies, because it allowed successful visualization of coronary arterial distribution within the myocardium [4]. Furthermore, Karhunen and Penttila reported the validity and usefulness of postmortem angiography for diagnosis of unusual gastrointestinal hemorrhage [5]. Previously, we demonstrated that postmortem angiography could be used to reveal associations between cerebral vessels and ruptures when evaluating complicated cerebral injuries [6,7]. In addition, it was also useful for identifying a bleeding point in the left uterine artery in a fatal case of postoperative hemorrhage after hysterectomy [8]. As noted here and elsewhere, postmortem angiography is very useful for forensic pathologists when investigating vascular lesions. Here we report a case of iatrogenic cerebral infarction in which the intracranial vascular lesion was demonstrated by postmortem cerebral angiography.

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### 1.1. Case report

A 37-year-old man complaining of headache and nausea was diagnosed as having an intracranial meningioma 6 cm in diameter, which compressed the right frontal lobe. Preoperative embolization of two feeding vessels from the right meningeal artery was attempted to reduce the vascularity of the tumor and thus bleeding during the planned total resection. After selective catheterization into a feeding artery via a femoral approach, followed by a lidocaine provocation test that resulted in no neurological complications, embolization was performed using a mixture of *n*-butyl-2-cyanoacrylate tissue adhesive and iodine-containing ethylesters of fatty acids as the embolizing material and radiopaque contrast medium, respectively. The first embolization of one of the feeding arteries appeared to be successful. However, during the next procedure, an excess amount of the embolization agent was accidentally injected. X-ray monitoring showed that contrast medium flowed into the right internal carotid, anterior and middle cerebral arteries, and then the patient suddenly developed left hemiparesis, nausea, and deep coma. X-ray computed tomography of the head demonstrated right cerebral infarction as well as the presence of residual contrast medium in the right internal carotid, anterior and middle cerebral arteries. To reduce the increased intracranial pressure, osmotherapy with glycerol was carried out. Surgery was performed on the day after the embolization for resection of the meningioma and cerebral decompression. Subsequently, the patient was treated conservatively with respiratory support and transfusion for nutrition and circulating volume supplementation. However, he died 47 days after the operation without improvement of the coma. A medicolegal autopsy was performed to clarify whether malpractice had occurred during the embolization procedure.

At autopsy, which was performed on the day after death, the body measured 165 cm and weighed 65.4 kg. External examination revealed only a few traces of the treatment, including injection and respiratory support. Internal examination demonstrated massive brain necrosis and severe lobar pneumonia with abscesses in both lungs. Before opening the cranium, postmortem angiography was performed by injection of radiopaque contrast medium consisting of 5% gelatin–barium emulsion into both common carotid arteries. The injection pressure ranged from 100 to 150 mmHg, corresponding to normal human blood pressure. It took approximately 15 min to complete selective intubation into the vascular system and injection of around 600 ml of the radiopaque contrast medium. After the contrast medium had been injected, it was found to fully fill the capillaries of the left, but not the right, conjunctiva. When the cranium was opened, the left cerebral hemisphere was found to be rather necrotic, and filling of the contrast medium with extravascular leakage was observed in the vessels

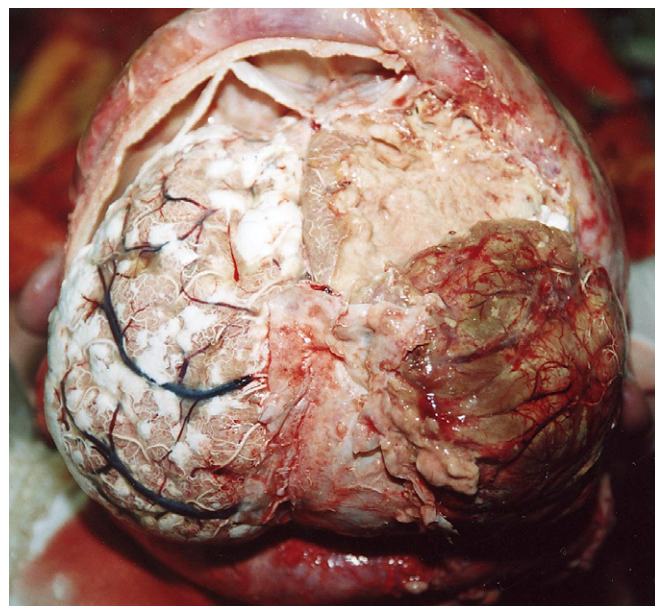


Fig. 1. Appearance of both cerebral hemispheres. Radiopaque contrast medium (5% gelatin–barium emulsion) was injected into both the right and left common carotid arteries before opening the cranium. Both hemispheres were widely necrotic, and the dura mater was adhered to the surface of the right hemisphere.

of the left hemisphere (Fig. 1). The right hemisphere was highly necrotic and fragile, and the white medium was observed not to fill the vessels. Because of the mechanical fragility of the brain tissue due to massive necrosis and adhesion of the dura mater to the surface of the right hemisphere, it was difficult to identify any vascular lesion by ordinary macroscopic inspection and microscopic examination. Therefore, the brain was harvested and fixed in 10% phosphate-buffered formalin solution for one month to allow examination by X-ray exposure. X-ray computed tomography showed that the arteries of the left cerebral hemisphere were almost fully filled with the radiopaque medium, whereas only a small proportion were filled in the right hemisphere (Fig. 2). This suggested that almost complete occlusion of the right internal carotid artery had occurred. Filling of contrast medium in some of the arteries of the right hemisphere could have been due to bypass through the arterial circle on the inferior surface of the brain. Communications are present between the middle meningeal artery and the intracranial internal carotid artery through the inferolateral trunk, the meningohypophyseal trunk, and the ophthalmic artery, which are the branches of the internal carotid artery [9]. Therefore, the embolization agent injected into the feeding artery originating from the right middle meningeal artery would have been able to pass along a collateral conduit of the right intracranial internal carotid artery, and embolize the right internal carotid artery and its branches, causing infarction of the right cerebral hemisphere, followed by edema, impaired perfusion, and necrosis of the brain.

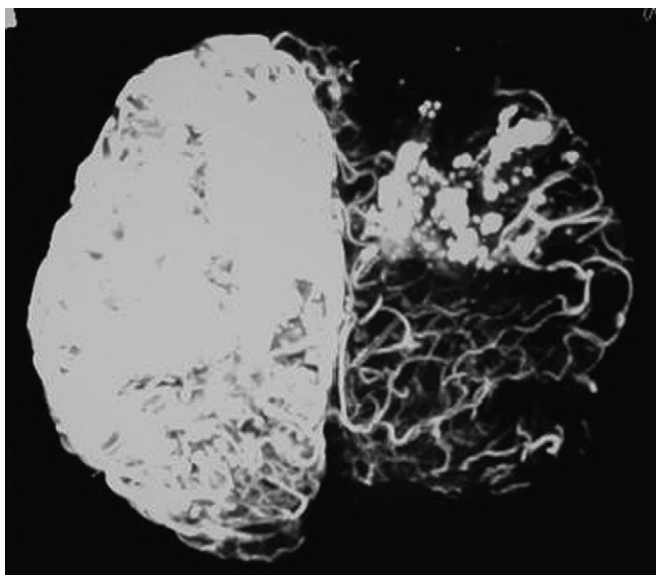


Fig. 2. Craniocerebral angiography of the fixed brain. Radiopaque contrast medium was injected into both the right and left common carotid arteries before opening the cranium. Craniocerebral angiography was performed using X-ray computed tomography. This 3-D image was reconstructed by computer-aided calculation of radiodensity in every part of the tomographic image. The position of this figure has been adjusted to that of Fig. 1 to aid understanding.

## 2. Discussion

Using postmortem angiography, we examined a 37-year-old man who had undergone preoperative embolization therapy complicated by iatrogenic cerebral infarction. In the present case, postmortem angiography played a key role in identifying the intracranial vascular lesion that had caused the cerebral infarction, even though the brain tissue was necrotic and too fragile for ordinary macroscopic examination.

Previously, we reported an individual who died three days after sustaining a jaw injury and becoming unconscious [6]. In this case, subdural hematoma and herniation had caused brain death. Postmortem angiography demonstrated thrombus-like strings in the internal carotid arteries, partial filling of the main cerebral arteries, and total loss of the peripheral arterial shadow. Therefore, postmortem angiography has only limited application to cases of brain death. In the present case, internal examination demonstrated massive necrosis of both hemispheres. However, postmortem cerebral angiography showed that the arteries of the left cerebral hemisphere were almost fully filled with the radiopaque medium, whereas only a small proportion were filled in the right hemisphere. These results seem to be consistent with the clinical diagnosis based on observations obtained by X-ray monitoring during the embolization procedure and computed tomography after the procedure. Thus, postmortem cerebral angiography would have been valid for the present case.

Currently, the angioembolization technique is widely used in endovascular therapy for some diseases of the cen-

tral nervous system such as tumors and aneurysms. However, there have been many complications associated with embolization therapy, mainly cerebral hemorrhage and ischemia [10,11]. It is known that brain hemorrhage is the most frequent and serious complication of endovascular treatment of a brain arteriovascular malformation. A less well recognized side effect is pulmonary embolism [12]. As reported here, postmortem examination in cases of brain necrosis is difficult, and postmortem angiography can be of value to forensic pathologists for identification of occlusion in blood vessels.

Postmortem investigation is increasingly supported by computed tomography and magnetic resonance imaging to reveal injury or disease, and to determine the cause of death [13–15]. Although postmortem angiography is an invasive technique, it can be used to demonstrate the arterial supply of any vascularized organ or tissue as well as the location of an arterial rupture [6–8]. There are several approaches for visualizing various types of pathology in the vascular system. Recently, postmortem 3-D coronary angiography using electron-beam computed tomography has been developed by Rah et al. [16]. The convincing results obtained by these new methodologies have led to the implementation of noninvasive or minimally invasive autopsy techniques as alternatives for forensic autopsy in some special cases. Postmortem angiography is now being developed as a new and effective adjunct for investigating vascular lesions in the field of forensic pathology.

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