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Case Report

Use of postmortem computed tomography angiography to detect vascular injuries accompanying skull base fracture

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ABSTRACT

A 58-year-old woman who had presented for upper gastrointestinal barium examination accidently slipped from the movable bed, and her head became compressed between the end of the bed and the side wall. She suffered massive bleeding from her nose and ear followed by cardiac arrest, and subsequent attempts at cardiopulmonary resuscitation failed. A medicolegal autopsy was performed to reveal the cause of death, as part of the investigation of the accident. During the autopsy, postmortem cerebral CT angiography was carried out by injection of 5% gelatin-barium emulsion as a radiopaque contrast medium into the bilateral common carotid arteries, demonstrating transudation of the contrast medium into the right acoustic meatus and the sphenoidal sinus cavity. Considering that the body appeared anemic and that PMCTA suggested vascular injuries, the cause of death was definitively determined to be hemorrhagic shock due to injuries to the right internal carotid artery, accompanied by skull base fracture. Postmortem CT angiography played an important role in confirming that the vascular injuries had been responsible for the bleeding, as the lesions could not be fully confirmed by native CT or macroscopic examination.

1. Introduction

Recently, postmortem computed tomography (PMCT) has proved to be a useful tool for forensic examination, especially in cases involving trauma [1,2], and postmortem CT angiography (PMCTA) is also being used increasingly, mainly in forensic facilities and departments [3–11]. At present, there are various methods of postmortem angiography. For example, whole-body angiography employing a modified heart-lung bypass machine has been used to demonstrate the systemic vascular circulation [4,6], while postmortem selective CT angiography is now being developed as a new and effective adjunct. Several injection routes have been employed for selective CT angiography [3,5,7,8], together with a variety of contrast media including radiopaque silicone contrast medium [3], water-soluble contrast media [8,12], and gelatin-barium emulsion. Postmortem selective CT angiography is now being developed as a new and effective adjunct in the field of forensic pathology for investigation of vascular lesions [3,5,7,8–10].

Previously, we have reported several cases in which postmortem angiography proved to be important for revealing associations between cerebral vessels and ruptures when evaluating complex cerebral injuries [13], an intracranial vascular lesion responsible for iatrogenic cerebral infarction [14], and a bleeding point in the left uterine artery in a fatal case of postoperative hemorrhage after hysterectomy [15]. These postmortem angiography examinations were carried out by injection of 5% gelatin-barium emulsion into relevant vessels of the targeted organ, followed by organ harvest, fixation in formalin solution, and exposure to plain X-ray or CT scanning. In addition, postmortem angiography was useful for demonstrating a rupture of the left internal carotid artery in a case involving a gunshot wound where plain X-ray exposure of the head was performed just after injection of contrast medium [16]. Here we describe a case in which postmortem cerebral CT angiography effectively demonstrated transudation of contrast medium into the right auditory meatus and right sphenoidal sinus, proving that vascular injuries accompanying a skull base fracture could have caused bleeding responsible for death.

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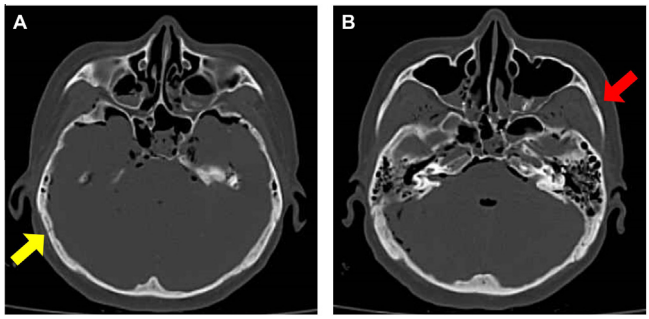

Fig. 1. Dissociation of the left zygomatic bone and linear fracture in the mastoid part of the right temporal bone demonstrable by PMCT. Panels A and B show filtered multiplanar images that were reconstructed from the data obtained by native CT prior to autopsy. The yellow arrow indicates a fracture of the mastoid part of the right temporal bone, and the red arrow denotes dissociation of the left zygomatic bone from the left temporal bone. Pneumocephalus is also evident in both panels.

2. Case report

2.1. Case history

A 58-year-old woman presented for a routine upper gastrointestinal barium examination at a bus equipped with an X-ray radiation system designed for ordinary medical checkup. When the bed was tilted at a steep angle for the examination, her body slipped down so that her head became positioned between the end of the bed and the side wall. When the angle of the bed was immediately restored, the woman's head became compressed between the bed and the wall. Upon rescue from compression, a large amount of bleeding from the nose and right ear was noticed. When a paramedic team arrived at the scene, the woman was in cardiopulmonary arrest, and subsequent attempts at cardiopulmonary resuscitation failed. She had no clinical history of any significant disease. A medicolegal autopsy was performed to clarify the cause of death, as part of the investigation of the accident.

2.2. Native CT scan prior to autopsy

Prior to autopsy, a native CT scan was carried out. All scans were performed using a four-slice CT scanner (Asteion/TSX-021B/4A, Toshiba, Japan) with a slice thickness of 1 mm and settings of 120 kV and 225 mAs for conventional scanning of the head and 120 kV and 100 mAs for helical scanning of the body. Three-dimensional reconstruction of the head was carried out on a CT workstation (Vincent, Fuji Corporation, Japan), followed by reconstruction of serial slices on the basis of the orbitomeatal line, as described previously [11,17]. The CT scan revealed subtle high absorption in soft tissues around the left cheek and right temporal area, suggesting soft tissue bleeding, as well as linear fractures in the mastoid part of the right temporal bone and dissociation of the left zygomatic bone from the left temporal bone, accompanied by pneumocephalus (Fig. 1). Retention of fluid in natural air spaces of the skull, such as the mastoid cells and paranasal sinuses, was observed. Radiopaque contrast medium was present from the pharynx through to the stomach and jejunum (data not shown), as a result of barium ingestion for the upper gastrointestinal examination. Moreover, contrast medium was also present from the larynx through to the bronchus (data not shown), suggesting agonal aspiration of vomit. However, native CT did not demonstrate any intracranial injuries such as epidural hematoma, subdural hematoma, subarachnoid hemorrhage or brain contusion. There were no signs suggestive of significant osteoporosis.

2.3. Autopsy findings other than intracranial lesions

At autopsy, which was performed on the day after death, the body measured 147 cm and weighed 59 kg. Postmortem lividity was barely evident. External examination revealed bruises over the left cheek and right temporal area, as well as hemorrhage in the nasal cavity and right external auditory canal. Only a few traces of the medical procedures, including injections and cardiopulmonary resuscitation, were evident. Internal examination, except for the brain, demonstrated anemia of organs such as the lung, spleen, kidney and liver. On microscopic examination, there were no significant findings except for anemia of those organs, mild steatosis of the liver, and signs of apparent agonal vomitus aspiration in the lung. No vascular lesions were revealed by macroscopic examination before opening the skull. Based on these findings of native CT and macroscopic examination, it seemed likely that compression of the head had caused a skull base fracture and vascular injuries, resulting in bleeding and hemorrhagic shock, leading to death.

2.4. Cerebral CT angiography during autopsy

Since the vascular injury was considered to be located in the petrous part of the right temporal bone, beyond the extent of macroscopic examination, PMCTA was performed before opening the scalp, using a method similar to that described previously [13–16]. Using a 100-mL metal syringe, manual injection of 5% gelatin-barium emulsion radiopaque contrast medium into the left and right common carotid arteries was carried out until the capillaries of the conjunctiva were obviously filled with the white emulsion. Leakage of the pink mixture of white emulsion and blood from the right meatus was evident (Fig. 2A). Introduction of the contrast agent mixture was immediately followed by CT scan of the head using the scan parameters: collimation 1 mm, 120 kVp, 250 mA and 0.75 s/rotation. The data were reconstructed

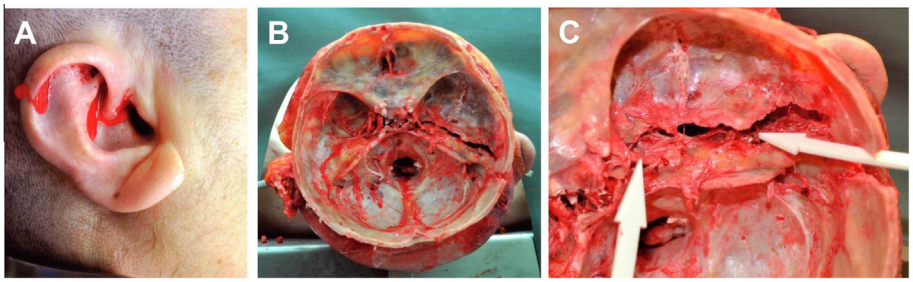

Fig. 2. Macroscopic observations during the autopsy. Panel A shows leakage of gelatin-barium emulsion from the right external auditory canal. The pink mixture of white emulsion and blood leaked from the right meatus after manual injection of gelatin-barium emulsion radiopaque contrast medium into the bilateral common carotid arteries. Panel B indicates a transverse fracture in the petrous part of the right temporal bone. The right petrous pyramid is enlarged in panel C. The white arrows indicate leakage of the white emulsion.