



Delayed Intracerebral Hemorrhage After Pseudoaneurysm of Middle Meningeal Artery Rupture: Case Report, Literature Review, and Forensic Issues

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Key words

- CT angiography
- Forensic science
- Intraparenchymal hemorrhage
- Middle meningeal artery pseudoaneurysm

Abbreviations and Acronyms

CT: Computed tomography
CTA: Computed tomography angiography
DSA: Digital subtraction angiography
GCS: Glasgow Coma Scale
IPH: Intraparenchymal hemorrhage
MMA: Middle meningeal artery
PMMA: Pseudoaneurysm of middle meningeal artery

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INTRODUCTION

Aneurysms of the middle meningeal arteries (MMAs) are rare; they account for <1% of all intracranial aneurysms but represent 27% of all intracranial traumatic aneurysms.^{1,2} If promptly recognized, they can be successfully treated surgically; otherwise, their rupture is associated with high mortality risk,³ and bleeding aneurysms lead to high mortality (20%).⁴

Depending on etiologic and anatomic characteristics, meningeal aneurysms can be defined as true and false. False aneurysms have a traumatic origin, whereas true aneurysms are generally associated with systemic diseases such as Paget disease,⁵⁻⁷ arterial hypertension,⁸ dural arteriovenous malformation,^{2,9,10} meningioma,¹¹ cavernous hemangioma of the skull,¹²

■ **BACKGROUND:** Traumatic pseudoaneurysm of the middle meningeal artery (PMMA) is rare. Its rupture is associated with high mortality, so an early diagnosis is recommended for this risky condition. In the absence of a specific guideline, computed tomography (CT), digital subtraction angiography, and CT angiography (CTA) are proposed for its diagnosis. CTA is the technique of choice even if it is almost never performed, especially in mild head injury. We report a rare case of a delayed rupture of PMMA, analyzed from a forensic point of view.

■ **METHODS:** Fifteen days after mild blunt head trauma, characterized by temporal fracture and a small hemorrhage near the rim, a wide intraparenchymal hemorrhage (IPH) occurred. The onset of IPH was marked by neurologic deterioration and arm paralysis. Immediate head CT showed IPH, and CTA showed PMMA. Prompt surgery could not help patient survival. The goal of autopsy was to formulate the cause of death and to individuate potential medical negligence.

■ **RESULTS:** In the literature, 16 cases of 54 are related to PMMA (26%) and are associated with IPH. IPH can be acute or delayed. Eight cases of acute IPH and 8 cases of delayed IPH (including our case), both coexisting with PMMA, are described. The literature review showed that the association of temporal rim fracture and a small hemorrhage nearby is highly predictive of PMMA formation.

■ **CONCLUSIONS:** Therefore, in the presence of these 2 risk factors after head trauma, CTA is strongly suggested.

moyamoya disease,¹³ occlusion of a cerebral artery,^{14,15} and abnormal implantation of a meningeal artery.¹⁶

Regarding anatomy, the presence of 3 artery layers is a characteristic of true aneurysm, whereas the arterial wall of a false aneurysm constitutes a single thin layer. This feature of the pseudoaneurysm depends on its formation. It is postulated that a fractured rim can injure the artery. If the defect in the arterial wall is small, the loss of blood is minimal and does not result in symptomatic hematoma, and the clot seals the defect. Once the clot undergoes fibrous organization, the spilled blood is lined by surrounding tissue or secondary connective tissue, and the pseudoaneurysm is formed.^{4,17} The fibrous tissue that constitutes the wall of the pseudoaneurysm is more fragile than a normal 3-layer vessel wall, so the risk of

rupture is consistent. In this case, the rupture of the aneurysm occurs in a delayed fashion.

Between 70% and 90% of traumatic aneurysms of the MMA are associated with skull fracture occurring in the temporal/parietal bone in the groove of the MMA¹⁸; however, some cases from the literature report that pseudoaneurysms of the MMA (PMMAs) appear without documented bone fracture on the same side.^{1,4,19,20} If a fracture is not documented and PMMA is instrumentally recognized, the hypothesized mechanism of lesion is represented by an important traction of the MMA vessel during closed head trauma,^{4,21} instead of direct arterial wall damage.

Rarely, PMMA can be associated with early or delayed hemorrhage, depending on the entity of vessel lesion. Early

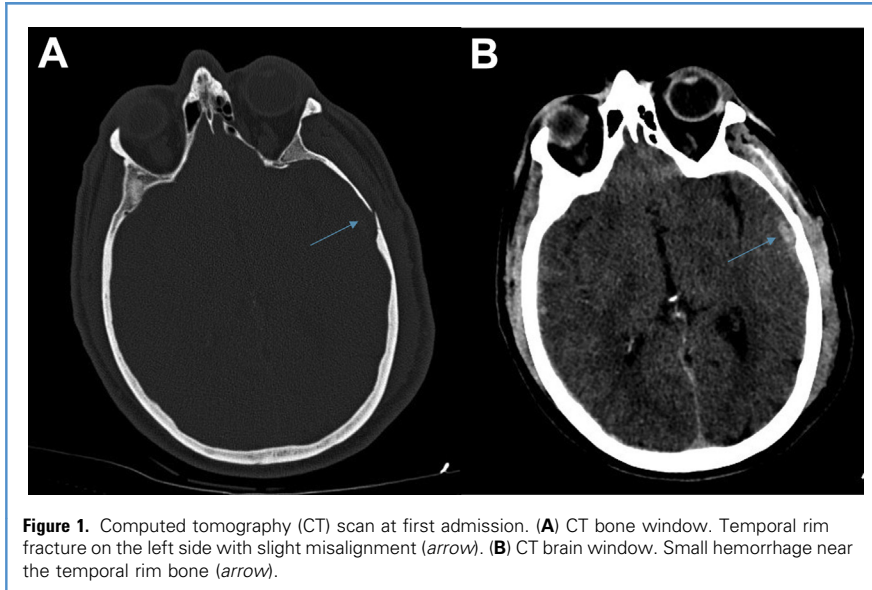


Figure 1. Computed tomography (CT) scan at first admission. **(A)** CT bone window. Temporal rim fracture on the left side with slight misalignment (arrow). **(B)** CT brain window. Small hemorrhage near the temporal rim bone (arrow).

hemorrhages are frequently epidural² and less often subdural or subarachnoid. Occasionally, an acute intraparenchymal hemorrhage (IPH) has been reported to coexist with PMMA.^{1,3,4,21-25} Delayed

rupture of PMMA is generally associated with IPH.^{19,22}

The exact reason why acute or delayed rupture of PMMA can lead to IPH is not known.³ Some investigators^{3,17,24} have

postulated that in cases of delayed rupture of the PMMA, it is the slow growth of the PMMA that thins the inner layer of the dura and consequently causes a subdural hematoma or IPH.

Nevertheless, the natural history of PMMA is not fully known. The literature includes 4 studies that describe spontaneous resolution of PMMA,²⁶⁻²⁹ whereas in the remaining cases reported to date, the natural history of PMMA has not come to light because this lesion had been treated in advance before a high mortality risk has been linked to its rupture. Other investigators have reported a progressive growth of traumatic aneurysm on repeated angiograms^{7-9,30,31}; this growth is linked to high rupture risk.

We herein describe a case of temporal delayed IPH caused by PMMA rupture. The peculiar aspect of this case report is related to its rarity and to the late diagnosis of PMMA, which contributes to death. Moreover, we collected evidence in the literature regarding how to diagnose, treat, and prevent PMMA rupture (which occurred in the case reported). A review of the literature and a critical analysis of the present case report have raised forensic considerations.

CASE REPORT

A 66-year-old man was admitted to the emergency department of a local hospital for temporary loss of consciousness as a result of a 3-step fall to the ground. The patient's medical history showed hypertension and diabetes mellitus under oral hypoglycemic treatment. On admission, the patient was conscious but agitated. During physical examination, he acted in a repetitive way; the Glasgow Coma Scale (GCS) score was 12. Pain was referred in the right thorax (caused by multiple and bilateral rib fractures) and in the left shoulder (caused by glenohumeral dislocation), hypoventilation occurred because of right pneumothorax, and both pupils were regular and normally reactive to light. The first computed tomography (CT) scan, which was performed at admission, showed that the left parietotemporal fracture was slightly displaced, and minimal blood in the left temporal area was close to the fracture (**Figure 1A** and **B**) and other lesions (subarachnoid hemorrhage in the left sylvian site and infraction of the left sphenoid sinus).



Figure 2. Second computed tomography scan performed the day after head trauma. Small brain contusion in the left temporal lobe (black arrow) and decrease in bleeding signs (white arrow).

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