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Case Report

Traumatic arteriovenous fistula of the middle meningeal artery treated with selective coil embolization: A case report

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ABSTRACT

Background: Dural arteriovenous fistulas (AVFs) are reportedly induced by trauma. We report a rare case of traumatic AVF with a direct shunt from the middle meningeal artery (MMA) to the middle meningeal vein (MMV) and multiple drainage routes after head trauma. The patient was effectively treated with selective coil embolization alone without liquid embolic material.

Case Description: A 56-year-old woman was admitted to the emergency department with mild disturbance of consciousness caused by a head contusion after alcohol consumption. She exhibited impaired consciousness with a Glasgow coma scale score of 14 (E4V4M6), complained of headache, and presented with a hemorrhage in the left ear. Computed tomography suggested a skull fracture and cerebral hemorrhage. Magnetic resonance imaging conducted on the 4th day after the injury indicated shunt disease with a feeder in the right MMA. Cerebral angiography on the 7th day suggested a direct shunt from the right MMA to the MMV aligned with the temporal bone fracture line, with multiple drainage route perfusion. Coil embolization was performed on the 14th day to occlude the shunt point selectively. In the final image, the MMA was absent, and the MMV, superior sagittal sinus, or pterygoid plexus was not visible through the shunt. Her symptoms improved, and she was discharged on the 20th day and did not exhibit recurrence at the 1-year follow-up.

Conclusion: AVF with a direct shunt from the MMA to MMV after head trauma can be effectively and safely treated with coil embolization alone, despite the need for long-term postoperative follow-up.

Keywords: Middle meningeal artery, Middle meningeal vein, Selective coil embolization, Temporal bone fracture, Traumatic arteriovenous fistula

INTRODUCTION

Dural arteriovenous fistulas (dAVFs) are reported to be induced by trauma, frequently having severe neurologic consequences, including hemorrhage, intracranial hypertension, focal deficits, and seizures. Posttraumatic dAVFs of the middle meningeal artery (MMA) are rare.[2,11] Here, we report a rare case of a traumatic arteriovenous fistula (AVF) with a direct shunt from the MMA to the middle meningeal vein (MMV) and multiple drainage routes after head

trauma. The patient was effectively treated with selective coil embolization alone without the need for liquid embolic material.

CASE PRESENTATION

A 56-year-old woman fell and hit her head after consuming alcohol. She was brought to the emergency room due to a mild disturbance of consciousness. On arrival, she exhibited impaired consciousness with a Glasgow coma scale score of 14 (E4V4M6), complained of headache, and presented with hemorrhage in the left ear. Computed tomography (CT) of the head suggested right traumatic subarachnoid hemorrhage, cerebral contusion of the right temporal lobe, right pneumoencephalopathy, and longitudinal fracture of the left petrous bone [Figure 1].

To assess the cerebral contusion in the right temporal lobe, magnetic resonance imaging of the head was conducted on the 4th day after the injury. It suggested the involvement of the right MMA and a vein, indicating the occurrence of shunt disease [Figure 2]. Cerebral angiography of the external carotid artery (ECA) performed seven days post-injury aided in the visualization of the MMA, MMV, diploic vein (DV), superior sagittal sinus (SSS), and pterygoid plexus (PP) [Figure 3]. Cone-beam CT (CBCT) of the ECA revealed a right temporal bone fracture that was not evident on the CT scan. In addition, a direct shunt was observed from the MMA to the MMV in conjugation with the fracture line. In the lower segment of this shunt, the MMA was clearly visualized due to the presence of the contrast. However, in the regions above the shunt, the entire contrast agent in the MMA perfused the MMV, causing the MMA to appear darkened and showing a tram track appearance [Figure 4]. Considering the single direct shunt from the MMA to the MMV, coil embolization was selected as the treatment method.

A 5Fr FUBUKI guiding catheter (Asahi Intecc Co., Ltd., Aichi, Japan), along with an intermediate catheter Guidepost (Tokai Medical Products, Aichi, Japan), was used to approach the right MMA. Subsequently, CHIKAI (Asahi Intecc Co., Ltd.) was used to guide the GREACH (Tokai Medical Products) to the shunt point. Coil embolization commenced from the MMA distal to the shunt point and continued until immediately before the point. At the shunt point, the MMV was embolized with the coil, concluding with proximal MMA embolization. Seven coils were used for the embolization. In the final image, the MMA was no longer visible, and the MMV, DV, SSS, and PP were absent [Figure 5]. Postoperatively, the headache symptoms experienced by the patient had improved; she was discharged on the 20th day after the injury and exhibited no recurrence at the 1-year follow-up.

DISCUSSION

Here, we present a case of dAVF with a single shunt from the MMA to the MMV and multiple drainage routes early in the injury after a temporal bone fracture. The patient was treated successfully with coil embolization alone.

The incidence of traumatic AVF involving MMA is 8 (1.8%) in 446 head trauma cases, signifying its relative rarity.[2] Most cases were associated with skull fractures, seven with epidural or subdural hematomas, three with multiple drainages from the MMV, and one with an MMA-to-MMV shunt [Table 1].[1,2,6,9,10,12] Among the patients who underwent endovascular treatment, coil embolization alone was performed only for the patients included in the present study. Coils and liquid embolic material were used in the remaining cases.

The MMA courses within the dura mater on the inner surface of the skull and in cases of head trauma with compromised

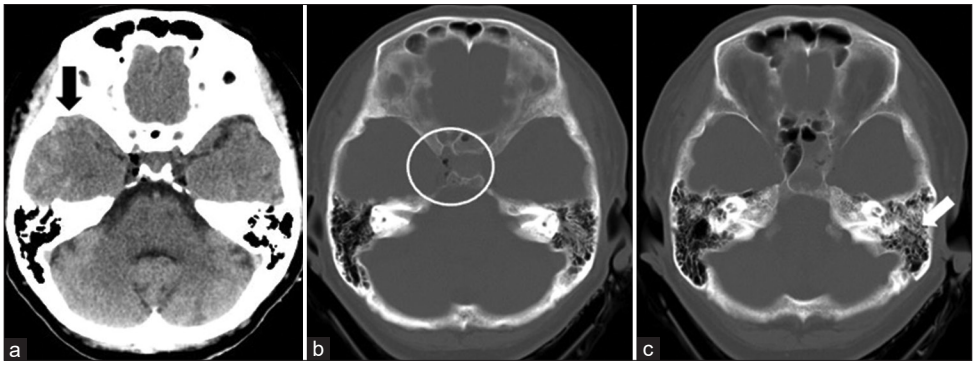

Figure 1: (a-c) Head computed tomography reveals a cerebral contusion in the right temporal lobe (black arrow), right pneumoencephalopathy (circle), and a left petrous bone fracture (white arrow).

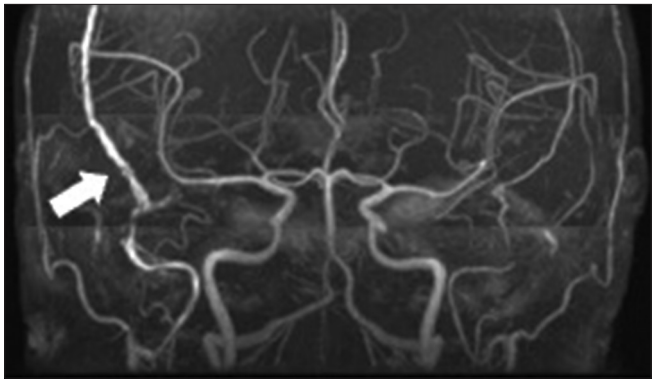

Figure 2: Head magnetic resonance imaging shows the right middle meningeal artery and a vein, indicating shunt disease (white arrow).

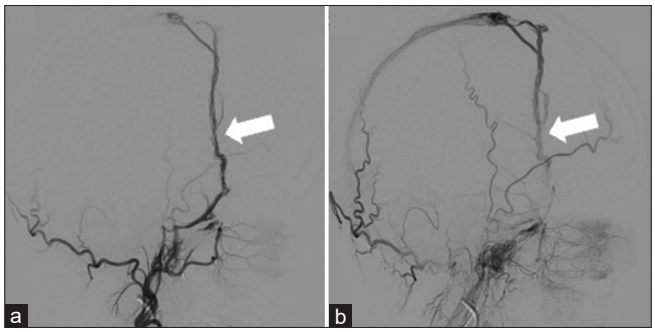

Figure 3: (a and b) Early (a) and late (b) arterial phases of external carotid arteriography suggest perfusion from the middle meningeal artery into the superior sagittal sinus, diploic vein, and pterygoid venous plexus (arrow).

dura mater; moreover, the MMA is susceptible to injury.[6] Histologically, the MMA lacks a tunica media in its intracranial segment.[3] These factors supposedly contribute to trauma-induced bleeding from the MMA into the veins, leading to AVFs.[7]

Anatomically, venous tracts in the periosteal dura are parallel to the MMA and its major branches, typically accompanied by two veins, creating a tram-track appearance. In addition, MMVs communicate with each other and with the venous sinus through DVs. Typically, they enter the PP through the foramen ovale but often open into the temporal venous plexus through the guiding venous tract before reaching the skull base.[2,8]

Unlike non-traumatic dAVF, traumatic AVF often involves only a single shunt in a single artery.[5] It is typically treated with transarterial embolization using coils, liquid material, or a combination of both. Proximal occlusion is ineffective in such cases, and secure occlusion of the shunt is imperative.[4]

In this case, a temporal bone fracture resulting from head trauma damaged the MMA specifically. This damage may have caused a direct shunt from the MMA to the MMV at a specific site, leading to perfusion to the DV, SSS, and PP through the MMV. Using CBCT, we accurately located the shunt point for perfusion from the MMA to MMV. This allowed us to secure the MMA and MMV beyond the shunt point using a microcatheter, and we occluded the shunt using selective coil embolization without the need for liquid embolic material.

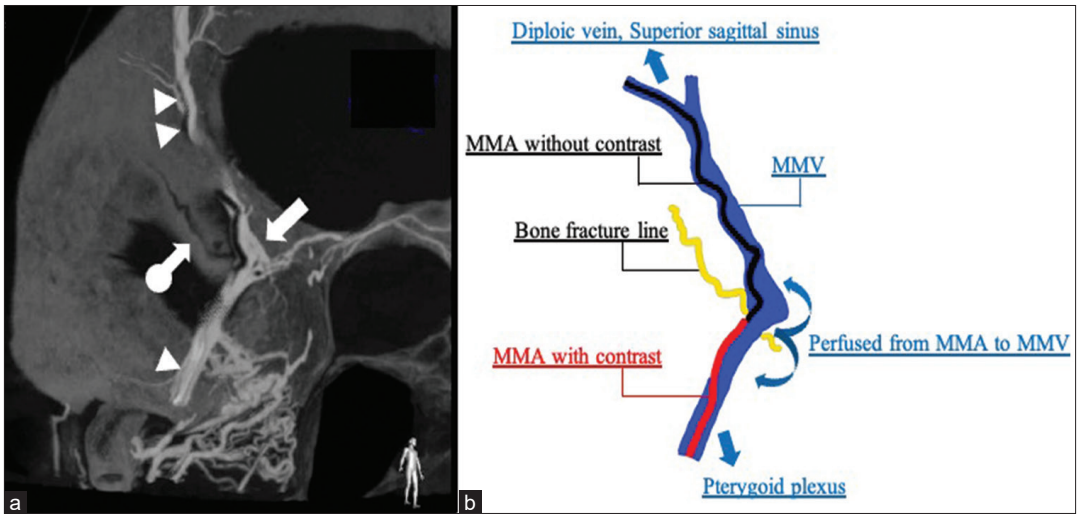

Figure 4: (a and b) Cone-beam computed tomography (a) and schema (b). Direct shunt from the middle meningeal artery (MMA) to middle meningeal vein (MMV)(arrow) along the bone fracture line (ball arrow). Proximal MMA with contrast (arrowhead) and distal MMA without contrast (double arrowhead).

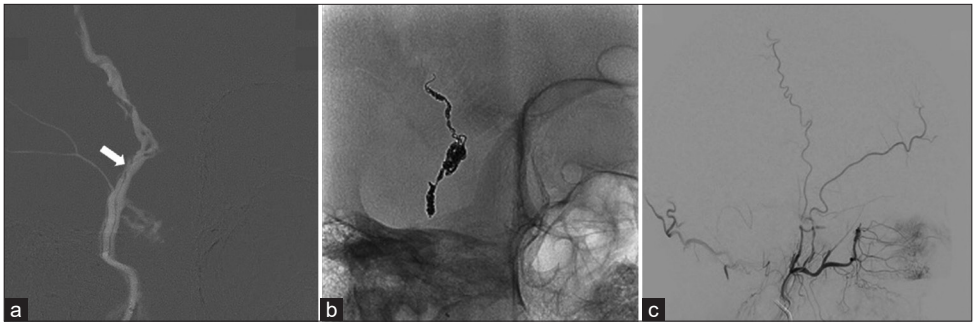

Figure 5: (a and b) Shunt point is identified (arrow), and seven coils are used for occlusion. (c) After coil embolization, the middle meningeal artery is no longer visualized.

Table 1: Clinical profiles of traumatic arteriovenous fistulas with a shunt from the MMA to MMV.

Reference	Case	Age and sex	Bone fracture	Hemorrhage	Features of feeder	Drainage route from MMV	IVR treatment	Result
Freckman *et al.*[2]	1	65, F	Frontal, parietal	EDH	Single branch	PP	None	Fatal outcome
	2	40, M	Sphenoid, temporal, occipital	EDH	Unknown	Unknown	None	Survival with severe deficits
	3	62, F	Sphenoid	SDH	Several branches	SS, SSS	None	Apallic syndrome
	4	44, F	Sphenoid	SDH, IPH	Single branch	SPS, Basilar plexus	None	Survival with severe deficits
	5	47, M	Sphenoid, both temporal	IPH	Unknown	Unknown	None	Fatal outcome
	6	44, M	Parietal	SDH	Unknown	Unknown	None	Good recovery
Takeuchi *et al.*[9]	7	57, M	-	SDH, contusion	Single branch	SS	None	Survival with severe deficits
Takeuchi *et al.*[10]	8	21, M	Temporal	SAH	Single branch	SS, CS	Unknown	Good
Vassilyadi *et al.*[12]	9	12, M	Temporal	EDH, SAH, contusion	Three branches	SS	Coil, nBCA	Good
Minami *et al.*[6]	10	36, M	-	-	Pseudoaneurysm	CS	Coil, glue	No deficit
Almefty *et al.*[1]	11	60s	-	IPH, SAH	Pseudoaneurysm	Unknown	nBCA	Stable neurological status
Our case	12	56, F	Temporal, sphenoid	Contusion	Single branch	DV, SSS, PP	Coil	Good

nBCA: N-butyl cyanoacrylate, MMA: Middle meningeal artery, MMV: Middle meningeal vein, F: Female, M: Male, EDH: Epidural hematoma, SDH: Subdural hematoma, IPH: Intraparenchymal hemorrhage, SAH: Subarachnoid hemorrhage, PP: Pterygoid plexus, SSS: Superior sagittal sinus; SPS: Superior petrosal sinus, CS: Cavernous sinus, DV: Diploic vein, IVR: Interventional radiology, SS: Sphenoparietal sinus

CONCLUSION

We encountered a case of traumatic AVF with a direct shunt from the MMA to MMV and multiple drainage routes after head trauma. In contrast to non-traumatic dAVF, traumatic AVF commonly exhibits a direct shunt. In cases of traumatic AVF with such a direct shunt, preoperative identification of the shunt point is important, and CBCT proves to be highly useful for this. When the shunt site is identified accurately, selective coil embolization alone can be used to treat the shunt safely.

Ethical approval

The Institutional Review Board approval is not required.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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