Pericallosal Artery Pseudoaneurysm: Blunt Head Trauma Complicated with Pseudoaneurysm, Delayed Callosal Cistern and Intraventricular Bleeding, Endovascular Coiling

Carlos Candanedo, Samuel Moscovici, Guy Rosenthal, and José E. Cohen

Abstract

Traumatic intracranial pseudoaneurysms are usually secondary to penetrating brain injury, with rare cases reported after blunt head trauma. Exclusion of the aneurysm should be the main treatment to avoid rebleeding, which could be associated with a high morbidity and mortality, especially in cases where the aneurysm has been misdiagnosed after a moderate traumatic brain injury (TBI). We report an unusual case of an interhemispheric subarachnoid hemorrhage (SAH) after a bicycle accident involving a helmeted 61-year-old male. The resulting blunt head trauma caused the rupture of a pseudoaneurysm of the pericallosal artery. The patient developed delayed rebleeding 8 days after admission, with enlargement of the callosal cistern, intraventricular bleeding, and secondary contralateral crural monoparesis. Cerebral angiography confirmed the presence of a small traumatic pericallosal pseudoaneurysm at the level of the superior aspect of the body of the corpus callosum, after the exit of the paracentral artery. This pseudoaneurysm gave rise to an inferior and a superior branch, with the clinical monoparesis likely related to the superior branch. Coil occlusion was performed to occlude the pseudoaneurysm and the superior branch, since its potential clinical implication was already established. The inferior branch patent was left intact to avoid a new visual deficit. We suggest that in a patient with a history of blunt head injury and delayed development of subarachnoid or intraventricular hemorrhage, neurovascular studies including cerebral angiography should be performed for early recognition of a possible pseudoaneurysm, which may be related to a high morbidity and mortality if unrecognized and untreated. The management of traumatic intracranial aneurysms secondary to blunt head trauma and the advantages of the endovascular management are the main topic of this chapter.

Keywords

Pericallosal artery · Blunt head trauma · Traumatic intracranial aneurysm · Endovascular treatment · Pseudoaneurysm · Subarachnoid hemorrhage

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Patient

A 61-year-old male, otherwise healthy, was admitted after suffering blunt head trauma in a bicycle accident, while helmeted. He developed subacute neurological deterioration, 2/5 contralateral inferior limb (crural) monoparesis, with a decreased Glasgow Coma Scale of 8/15 after the delayed hemorrhage.

Diagnostic Imaging

Admission noncontrast head CT revealed a diffuse interhemispheric and cortical traumatic subarachnoid hemorrhage (SAH). A second noncontrast CT performed 8 days later showed enlargement of the hemorrhage over the corpus callosum, with intraventricular involvement. CT angiography depicted a pericallosal artery aneurysm, suggesting a dissecting aneurysm or pseudoaneurysm formation. Diagnostic cerebral angiography of the right ICA followed by rotational angiogram with tridimensional reconstruction confirmed the presence of a small traumatic pericallosal aneurysm giving rise to two branches (superior and inferior parietal arteries) in a vasospastic anterior cerebral artery (ACA) (Fig. 1).

Treatment Strategy

The primary goal of treatment was to occlude the aneurysm and thus avoid rebleeding. The aneurysm was in the A4 segment of the pericallosal artery where it is divided in superior and inferior parietal branches. The superior parietal artery was most likely correlated with the already established neurological deficit, while the inferior branch provided a blood supply to the cuneus in the occipital lobe. Conservative management and observation of the aneurysm was not an option after the delayed bleeding incident. Since it was clearly better to sacrifice one and not both of the branches by embolizing the aneurysm rather than sacrificing it, it was essential to decide which of the branches to sacrifice. We decided to sacrifice the superior branch, since it was probably correlated with the established neurological deficit.

Treatment

Procedure, 24.02.2020: diagnostic cerebral angiography and endovascular coil occlusion of a traumatic pericallosal artery pseudoaneurysm

Anesthesia: local anesthesia, converted to general anesthesia; bolus of 4000 IU unfractionated heparin (Heparin Natrium, B. Braun) IV, target activated clotting time (ACT): 250–320 s

Premedication: none

Access: right femoral artery, 6F Arrow sheath (Arrow); *guide catheter:* Navien A+ 058 (Medtronic); *microcatheter:* Excelsior SL-10 (Stryker) for coiling; *microguidewire:* Synchro2 0.014″, 200 cm (Stryker)

Implants: 3 coils: 1 × 2/4 Cosmos 3D coil, 2 × 1.5/2 HyperSoft helical coils (MicroVention)

Course of treatment: the right ICA was catheterized with the guiding sheath and guide catheter. The guide catheter was placed at the upper cervical ICA. A microcatheter was navigated through the right ACA and placed at the aneurysm body. Then, 1× 2/4 tridimensional Cosmos coil followed by 2× 1.5/2 helical HyperSoft coils were implanted. Both pericallosal arteries arose from the traumatic microaneurysm itself. Coiling occluded the aneurysm and the superior (1 mm diameter) branch. The inferior branch of the posterior pericallosal arch was confirmed patent (Fig. 2).

Duration: 1st–14th DSA run: 66 min; fluoroscopy time: 31 min

Complications: none

Postmedication: none

Clinical Outcome

Immediately after the therapeutic endovascular procedure, the patient was transferred to the neurosurgical intensive care unit. The introducer sheath was removed 1 hour after ACT re-evaluation. The patient was then extubated and returned to baseline status (left leg paresis

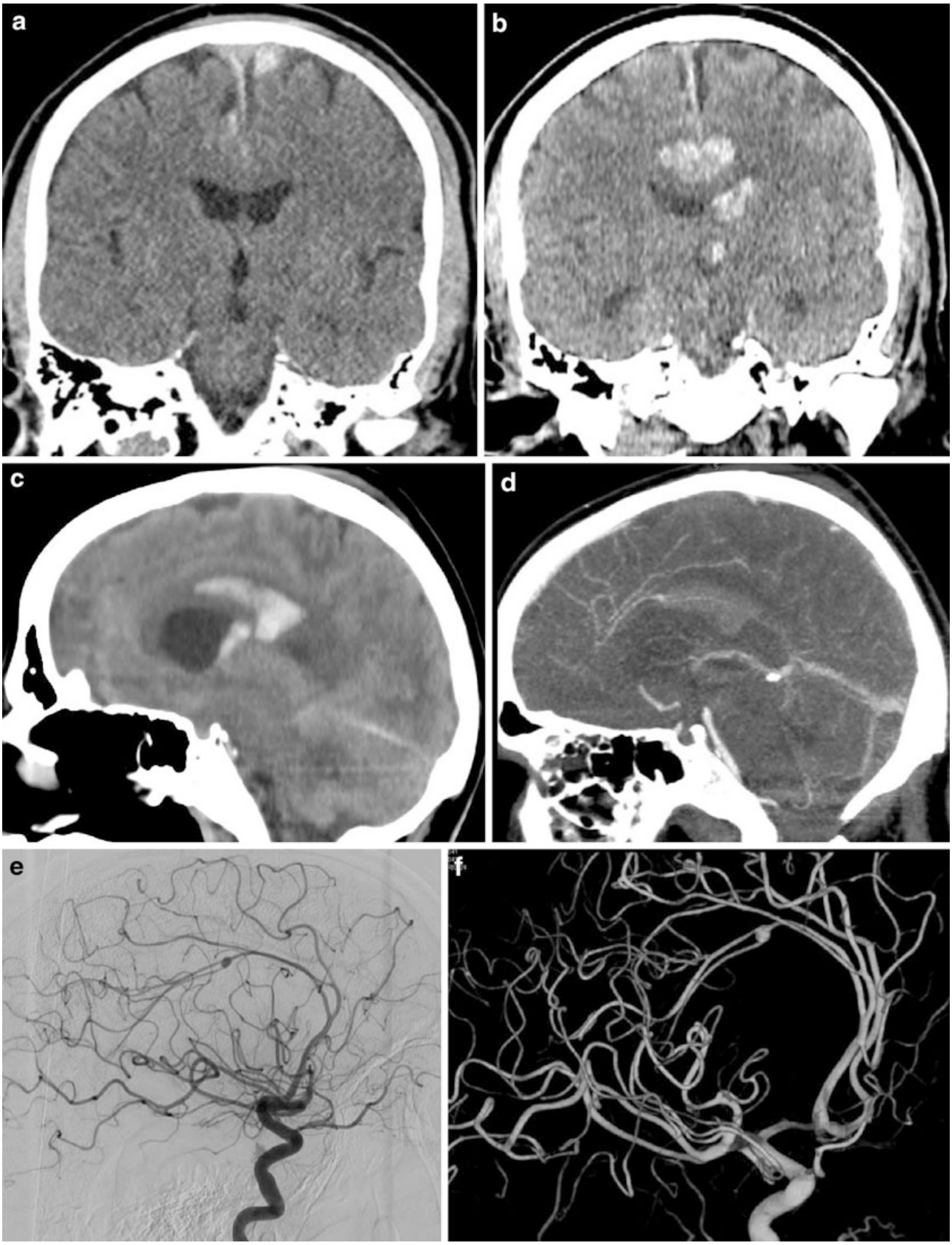

Fig. 1 (continued)

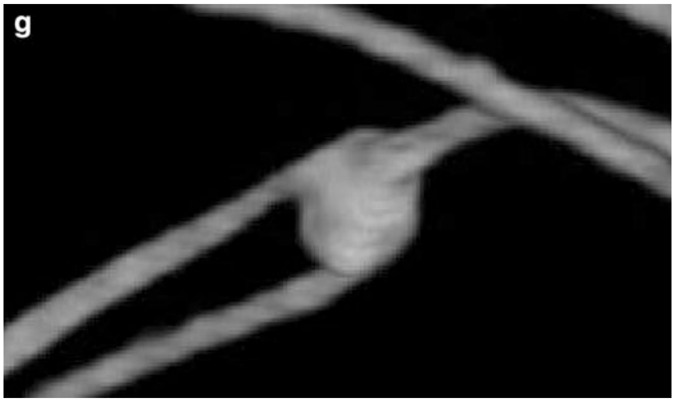

Fig. 1 Diagnostic imaging in a 61-year-old man after blunt head trauma. Admission noncontrast CT, coronal view, revealed a diffuse interhemispheric and cortical traumatic subarachnoid hemorrhage (**a**). Repeat CT performed 8 days after admission, coronal (**b**) and sagittal (**c**) views, showing enlargement of the callosal bleeding with ventricular involvement. CTA (**d**) depicted a pericallosal artery aneurysm, suggesting pseudoaneurysm formation. Diagnostic cerebral angiogram of the right ICA, lateral view (**e**), rotational angiogram with tridimensional reconstruction, right oblique view (**f**), and magnified view (**g**), confirmed the presence of a traumatic small pericallosal aneurysm giving rise to two branches in a vasospastic anterior cerebral artery (ACA)

secondary to the bleeding before the procedure) without feeling pain or discomfort. Head CT performed 24 hours later was unremarkable. The patient was discharged to an inpatient rehabilitation program 7 days after the intervention.

Follow-Up Examinations

Follow-up DSA obtained 3 months later confirmed stable and complete exclusion of the embolized aneurysm. The patient's monoparesis had improved, and he was able to walk with a walker.

Discussion

Traumatic intracranial aneurysms (TICA) are rare lesions constituting 0.15% to 0.4% of all intracranial aneurysms, although the true incidence is probably higher since most are asymptomatic until rupture (Jung et al. 2017; Mao et al. 2012). Mortality as high as 50% during the first 1 to 3 weeks after rupture in untreated lesions has been reported (Cohen et al. 2008), and neurological decline is common in patients who survive (Proust et al. 1997). The natural history of traumatic pseudoaneurysms, including the mechanism of formation and the frequency of spontaneous resolution, growth, and rupture, as well as their prevalence, remains unknown (Dujardin et al. 2019). Surgical treatment may be complicated because of the nature of the lesion as well as the extent of other traumatic injuries (Cohen et al. 2008).

It is reasonable to recommend cerebral angiography in patients with traumatic brain injury (TBI) and sudden secondary deterioration, and it is definitely indicated if new blood is found on the tentorium, in the basal cisterns, or the third or fourth ventricles (Dujardin et al. 2019). The gold standard for diagnosis is cerebral angiography followed by rotational angiogram with tridimensional image reconstruction. In cases where doubt remains, magnetic resonance angiography (MRA) could be performed to determine whether there is an intimal flap (Han et al. 2014). Most reported cases of supratentorial traumatic intracranial pseudoaneurysm are located in areas adjacent to bony structures, such as the cavernous, supraclinoid, or petrous segment of the internal carotid artery (ICA) or ophthalmic artery, or in the posterior fossa. Few cases of distal anterior cerebral artery pseudoaneurysms have been reported (Cohen et al. 2005; Mao et al. 2012; Sami et al. 2018).

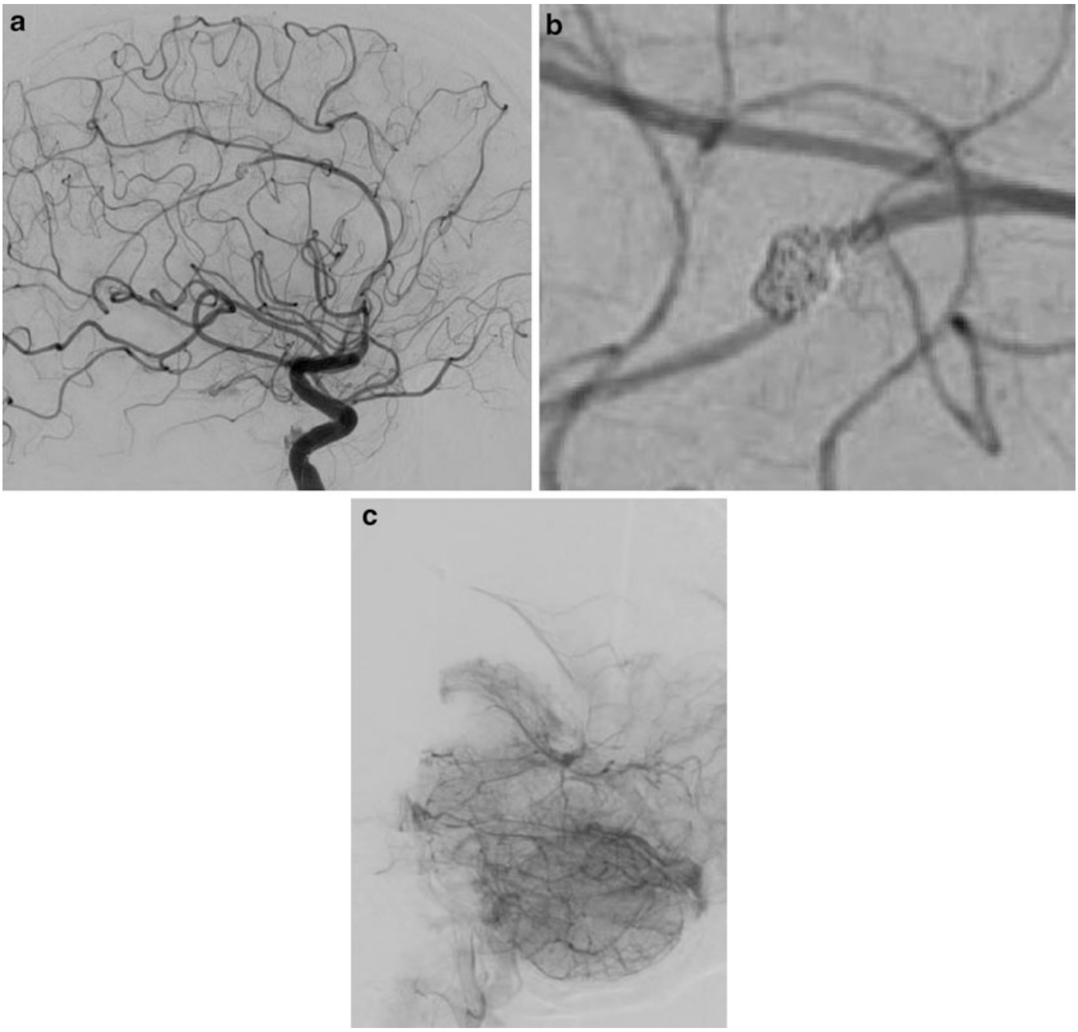

Fig. 2 Endovascular coil occlusion of a traumatic pseudoaneurysm of the right pericallosal artery. Post-procedure cerebral angiogram of the right ICA, lateral (**a**) and magnified (**b**) views, showing complete occlusion of the aneurysm. Occlusion of the superior branch coming from the aneurysm, with patency of the inferior branch of the posterior pericallosal arch (**c**)

The A1 segment of the ACA arises in the inner sector of the Sylvian fissure, lateral to the optic chiasm and below the anterior perforated substance. It continues anteriorly and medially above the optic nerve or optic chiasm and anastomosizes with the its contralateral equivalent through the anterior communicating artery. The A2 segment is already considered the pericallosal artery. It ascends anterior to the lamina terminalis to enter the longitudinal fissure, continues along the same posterior curve of the genu of corpus callosum as the A3 segment, enters into the pericallosal cistern in a posterior direction as A4 segment, and then ends as A5, coursing around the splenium of the corpus callosum. The most important cortical branches are the orbitofrontal and frontopolar arteries arising from A2, the paracentral artery arising from A4 or in some cases from the callosomarginal artery, the superior parietal artery arising anterior to the splenium of the corpus callosum and supplying the superior portion of the precuneus, and the inferior parietal artery, the last cortical branch of the ACA, which supplies the posterior-interior part of the precuneus. The callosomarginal branch is the major branch of the pericallosal artery. It exits at the A2 or A3 segment and courses above the cingulate gyrus, running into the cingulate sulcus (Perlmutter and Rhoton 1976).

We report a case of a distal A4 pericallosal artery pseudoaneurysm after blunt head trauma in a patient who presented with SAH and secondary contralateral crural monoparesis 8 days after hospital admission due to enlargement of the bleeding in the callosal cistern and intraventricular bleeding. The injury was due to a bicycle accident, and the patient had been wearing a helmet. Cerebral angiography confirmed the presence of a small traumatic pericallosal pseudoaneurysm. The callosomarginal artery originated from the A3 segment at the level of the genu of the corpus callosum and gave rise to the paracentral artery. This pseudoaneurysm was located at the A4 segment of the pericallosal artery, in the superior aspect of the body of the corpus callosum, anterior to the splenium. It gave rise to the superior and inferior parietal arteries, with the superior branch probably correlated to the clinical crural monoparesis. Coil occlusion was performed to occlude the pseudoaneurysm, and one of the parietal branches had to be sacrificed. The paracentral lobe, including the primary motor cortex, is vascularized through the paracentral artery. The superior parietal branch gives vascularization to the precuneus in the parietal lobe, and the inferior parietal artery gives vascularization to the cuneus in the occipital lobe. To avoid a new visual deficit, we decided to embolize the aneurysm and sacrifice the superior parietal artery, keeping patent the inferior parietal branch. Since the arteries are in close vicinity to the falx at this location, blunt impact can displace the brain tissue and the arteries against the fixed falx, likely causing the formation of this pseudoaneurysm.

Early angiographic diagnosis with immediate endovascular treatment provided an effective approach for TICA detection and management. Endovascular therapy is versatile and offers a valuable alternative to surgery, allowing early aneurysm exclusion with excellent results.

Therapeutic Alternatives

- Conservative management
- Microsurgical clipping
- Flow diversion

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