Acta Neurochirurgica (2019) 161:1371–1376
https://doi.org/10.1007/s00701-019-03935-z

CASE REPORT - NEUROSURGERY GENERAL

Iatrogenic pseudoaneurysm rupture of the anterior cerebral artery after placement of an external ventricular drain, treated with clip-wrapping: a case report and review of the literature

Joshua S. Catapano[1] · Michaela Lee[1] · Damjan Veljanoski[1] · Alexander C. Whiting[1] · Scott Brigeman[1] · Clinton D. Morgan[1] · Mohamed A. Labib[1] · Andrew F. Ducruet[1] · Peter Nakaji[1]

Received: 7 March 2019 / Accepted: 29 April 2019 / Published online: 17 May 2019

Abstract

External ventricular drains (EVDs) are often placed emergently for patients with hydrocephalus, which carries a risk of hemorrhage. Rarely, rupture of a pseudoaneurysm originating from an EVD placement precipitates such a hemorrhage. An EVD was placed in a patient with a ruptured left posterior communicating artery aneurysm who later underwent endovascular coil embolization. On post-bleed day 20, a distal right anterior cerebral artery pseudoaneurysm along the EVD tract ruptured, which was successfully treated via clip-wrapping. Although EVD-associated pseudoaneurysms are rare, they have a high propensity for rupture. Early treatment of these lesions should be considered to prevent neurologic deterioration.

Keywords Clip-wrapping · External ventricular drain · Iatrogenic pseudoaneurysm rupture

Abbreviations

ACA	Anterior cerebral artery
CT	Computed tomography
CTA	Computed tomography angiography
EVD	External ventricular drain
GCS	Glasgow Coma Scale
PBD	Post-bleed day
PCoA	Posterior communicating artery

Introduction

An external ventricular drain (EVD) is primarily used in patients with hydrocephalus and is often inserted at bedside [5]. The accuracy and safety of this procedure are well established [8, 21], and the most common complications include infection and hemorrhage [16]. A vascular injury that causes a pseudoaneurysm is extremely rare, with only seven case reports found in the literature, and may occur when the drain is inserted improperly [2, 3, 7, 11, 23, 29]. Here, we present a rare case of a pseudoaneurysm of the distal anterior cerebral artery that was caused by insertion of an EVD and treated with clip-wrapping.

This article is part of the Topical Collection on *Neurosurgery general*

✉ Peter Nakaji
Neuropub@barrowneuro.org

[1] Department of Neurosurgery, Barrow Neurological Institute, St. Joseph's Hospital and Medical Center, 350 W. Thomas Rd., Phoenix, AZ 85013, USA

Case report

A 71-year-old man with a decreasing level of consciousness presented with the worst headache of his life and a Hunt and Hess grade of III. On neurologic examination, his Glasgow Coma Scale (GCS) was 13 (eyes, 3; motor, 6; voice, 4), and he followed commands for all four extremities. Noncontrast computed tomography (CT) of the head revealed a Fisher grade III subarachnoid hemorrhage with hydrocephalus (Fig. 1).

During EVD placement at the bedside, the patient developed acute respiratory distress that required emergent endotracheal intubation. CT angiography (CTA) of the head revealed a left 7 × 5-mm posterior communicating artery (PCoA) aneurysm with a new intraventricular hemorrhage, with the EVD adjacent to the distal right anterior cerebral artery (ACA) (Fig. 2). The ruptured left PCoA aneurysm was successfully treated with coil embolization.

The patient developed *Staphylococcus epidermidis* bacteremia causing sepsis, and methicillin-resistant *Staphylococcus*

Fig. 1 Axial head computed tomography initial patient presentation shows subarachnoid hemorrhage and hydrocephalus. *Used with permission from Barrow Neurological Institute, Phoenix, Arizona*

aureus was cultured from sputum obtained on post-bleed day (PBD) 5, necessitating treatment with multiple antibiotics.

On PBD 9, a surveillance cerebral angiogram showed stable occlusion of the left PCoA aneurysm and a small pseudoaneurysm of the right callosomarginal artery measuring 2.8 mm × 3.3 mm adjacent to the EVD (Fig. 3). It was thought that the lesion would be best addressed by microsurgical treatment because of the small caliber of the parent vessel. However, given the patient's poor medical condition, immediate treatment was deferred.

On PBD 20, the patient experienced neurological deterioration, and urgent head CTA (Fig. 4) revealed a new intraparenchymal hemorrhage adjacent to the right EVD catheter, secondary to rupture of the A3 pseudoaneurysm. The patient was taken emergently to surgery for a left contralateral interhemispheric craniotomy for microsurgical treatment of the A3 pseudoaneurysm. The pseudoaneurysm was found adjacent to the intraparenchymal hemorrhage (Fig. 5a). A decision was made to salvage the callosomarginal artery. The artery did not have enough redundancy for excision of the pseudoaneurysm with an end-to-end bypass and was not within the reach of a contralateral vessel for a side-to-side bypass. Therefore, the pseudoaneurysm was wrapped with Gore-Tex (W.L. Gore and Associates, Newark, DE), secured with a Mizuho 10-mm 45° angled clip (Mizuho Medical Co., Tokyo, Japan) (Fig. 5b), and reinforced with cotton. Robust flow through the parent and distal vessel was confirmed using indocyanine green fluorescence and ultrasound (Fig. 5c). Postoperative CTA demonstrated contrast through the A3 vessel distal to the aneurysm clip (Fig. 6).

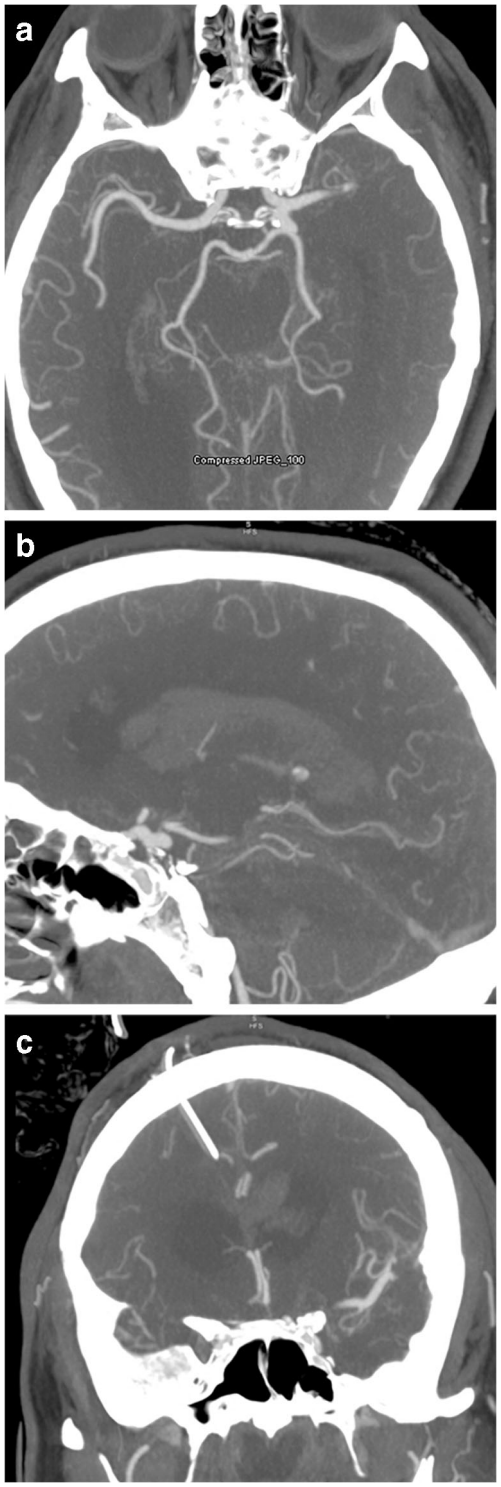

Fig. 2 Axial (**a**) and sagittal (**b**) computed tomography angiography (CTA) shows a left posterior communicating artery aneurysm and intraventricular hemorrhage after external ventricular drain (EVD) placement. **c** Coronal CTA shows new hemorrhage in the region of the corpus callosum, after EVD placement, adjacent to the anterior cerebral artery. *Used with permission from Barrow Neurological Institute, Phoenix, Arizona*

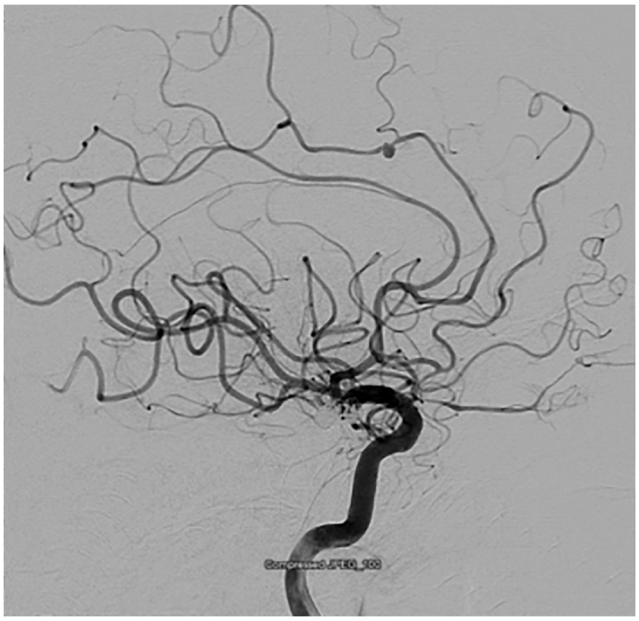

Fig. 3 Repeat angiogram on post-bleed day 9 reveals a pseudoaneurysm of the left callosomarginal artery. *Used with permission from Barrow Neurological Institute, Phoenix, Arizona*

The rest of the patient's hospital course was uneventful, and on PBD 36, a ventriculoperitoneal shunt was placed for hydrocephalus. The patient was discharged to a skilled nursing facility on PBD 38 with a GCS of 8. On 14-month follow-up, the patient is currently living at home with a modified Rankin Scale socre of 4 and GCS of 14 due to confusion.

Discussion

Ventriculostomies are common neurosurgical procedures performed for hydrocephalus, elevated intracranial pressure, subarachnoid hemorrhage, and intraventricular hemorrhage, among other neurologic conditions [16]. However, EVD placement is not risk free; reported hemorrhage rates range from 0 to 42% [1, 5, 6, 8–10, 12–20, 22, 24–28, 30, 31]. Although hemorrhage risk is high, the majority of bleeds are small, with only 1% requiring surgical intervention [16]. Rupture from an iatrogenic pseudoaneurysm is a very rare cause of hemorrhage after EVD placement.

Only seven other cases of intracranial iatrogenic pseudoaneurysm after ventricular catheter insertion or removal have been reported (Table 1) [2, 3, 7, 11, 23, 29]. The majority of cases ($n = 5$) involved the ACA. Similarly, in our case, a distal branch of the ACA, the callosomarginal artery, was injured. The temporal range of these pseudoaneurysm diagnoses varies widely, from < 1 day to 21 weeks after catheter placement [2, 3, 7, 11, 23, 29]. The pseudoaneurysm in our case was found on routine angiography 9 days after EVD placement. Among other case reports, two pseudoaneurysms were discovered incidentally as part of routine follow-up

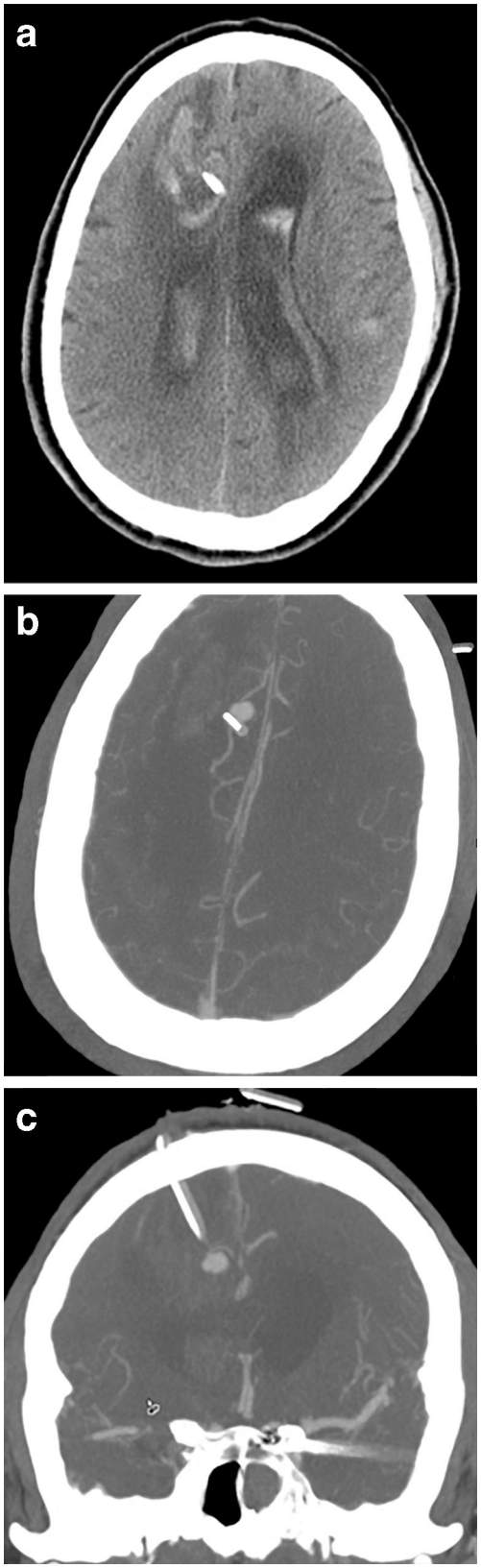

Fig. 4 **a** Axial computed tomography revealed a new intraparenchymal hemorrhage adjacent to the right external ventricular drain catheter; axial (**b**) and coronal (**c**) computed tomography angiography revealed enlargement of a ruptured right A3 pseudoaneurysm. *Used with permission from Barrow Neurological Institute, Phoenix, Arizona*

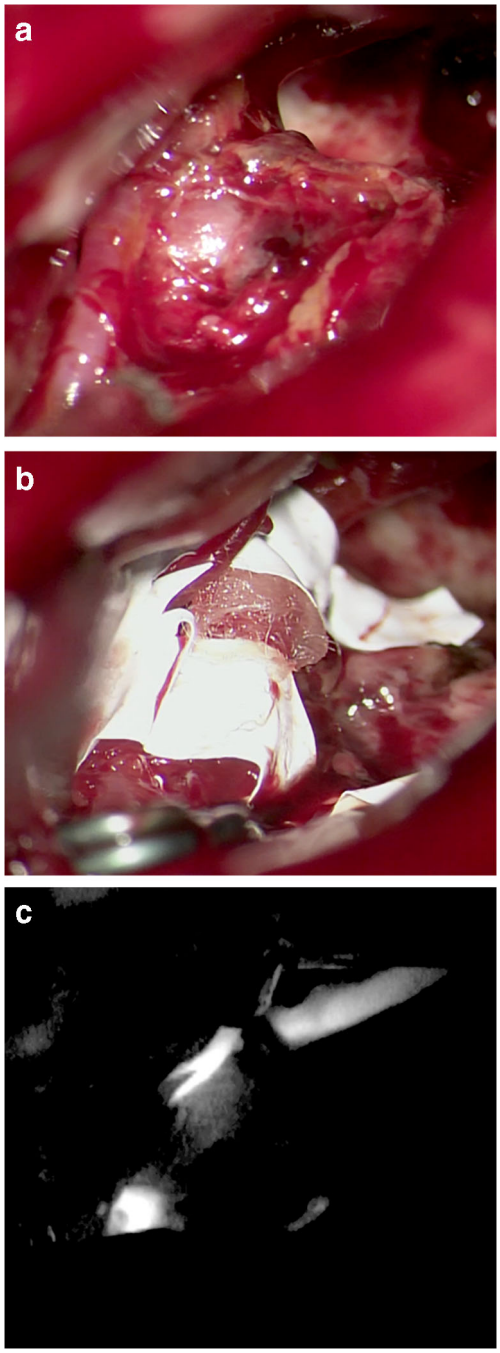

Fig. 5 **a** Microscopic view of right A3 pseudoaneurysm before treatment. **b** Microscopic view of right A3 pseudoaneurysm wrapped with surgical membrane and secured with a 10-mm 45° angled clip. **c** Indocyanine green fluorescence videoangiography and micro-Doppler ultrasound showing robust flow through the parent and distal vessel. *Used with permission from Barrow Neurological Institute, Phoenix, Arizona*

imaging [11, 23]. In another four cases, a change in the patient's neurologic status prompted radiologic investigation that revealed the pseudoaneurysm [2, 3, 7, 29]. Finally, one pseudoaneurysm was diagnosed during initial intraoperative angiographic studies [3].

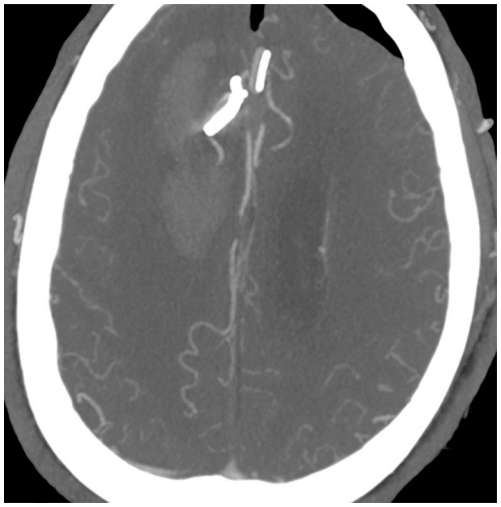

Fig. 6 Postoperative axial computed tomography angiography demonstrates contrast through the A3 vessel distal to the aneurysm clip. *Used with permission from Barrow Neurological Institute, Phoenix, Arizona*

Reports have found that ventriculostomy-associated intracranial pseudoaneurysms are associated with a high risk of rupture [23]. Including our case, 5 of 8 (62.5%) reported cases of ventriculostomy-associated pseudoaneurysm ruptured [2, 3, 7, 11, 23, 29]. Thus, prompt treatment is usually favored [23]. In our case, conservative management with blood pressure control was initially attempted because of the patient's sepsis and medical instability, with plans to treat the pseudoaneurysm once stabilized. However, the pseudoaneurysm ruptured, requiring emergent intervention. In four of the preious seven cases, the patients were treated with endovascular intervention [2, 3, 11]. The remaining three patients were treated via microsurgical resection [7, 23, 29]. Although resection of the pseudoaneurysm with end-to-end bypass was considered for our patient, his anatomy was not favorable, and clip-wrapping (typically reserved for unclippable aneurysms and associated with low rates of postoperative complication) [4] of the pseudoaneurysm was used to preserve the callosomarginal artery.

Conclusion

Ventriculostomy-associated intracranial pseudoaneurysms are rare vascular injuries with a high propensity to bleed. Diagnosis and prompt definitive treatment of the pseudoaneurysm are of utmost importance. Although these pseudoaneurysms are uncommon, the risk of hemorrhage should always be considered before any ventricular catheter procedure.

Table 1 Cases of reported pseudoaneurysm associated with catheter manipulation

Case	Study, year	Patient age	Sex	Location	Cause	Diagnosis prompted by	Treatment	Outcome
1	Shirane et al., 1999 [29]	4 months	F	Anterior choroidal aneurysm	Removal of VPS catheter	Postoperative intraventricular and subarachnoid hemorrhage 21 weeks after catheter manipulation	Surgical resection and reconstruction	Discharged without additional neurological deficits
2	Jenkinson et al., 2006 [7]	15 years	F	Fusiform aneurysm of the distal MCA	Removal of old VPS and insertion of new VPS shunt	Acute onset severe headache followed by collapse and loss of consciousness 6 weeks after operation	Surgical resection	Residual flaccid right hemiparesis, mild expressive dysphasia, right visual inattention, right homonymous lower quadrantanopia
3	Chen et al., 2013 [2]	39 years	M	Distal callosal marginal artery	EVD placement	Emergent CTA for altered mental status 13 days after EVD placement	Embolization with 20% glubran/lipiodol mixture (Gem srl, Viareggio, Italy)	Recovered well
4	Kosty et al., 2013 [11]	62 years	M	Saccular 3-mm pseudoaneurysm of a branch of the distal ACA	EVD placement, converted to VPS before discharge	Follow-up angiography at 13 weeks	Embolization with Onyx 18 (ev3, Irvine, CA)	No adverse outcome from embolization
5	Choudhri et al., 2014 [3]	NA	NA	PCA/Pcomm junction	EVD placement, which required multiple replacements due to involuntary removal	Seizures and somnolence prompted follow-up CTA within 24 h of catheter placement	Endovascular coil embolization using three Target 360 coils (Stryker, Kalamazoo, MI)	Death
6	Choudhri et al., 2014 [3]	NA	NA	Branch of the pericallosal artery	EVD placement	Intraoperative angiographic studies demonstrated the pseudoaneurysm within 24 h of catheter placement	Endovascular coil embolization with two Target 360 coils and 0.5 mL of 1:1 *N*-butyl cyanoacrylate: ethiodized oil mixture (Codman and Shurtleff, Raynham, MA)	No adverse consequences
7	Raygor et al., 2016 [23]	58 years	F	Right middle frontal ACA branch	EVD placement	Routine angiogram on post-bleed day 10	Right frontal craniotomy for resection of aneurysm	Neurologically intact at 2-month follow-up, and magnetic resonance angiography at 3 months showed no evidence of residual PCoA aneurysm
8	Present case	71 years	M	A3 portion of the ACA	EVD placement	Routine angiogram 8 days after insertion of catheter	Interhemispheric craniotomy and clip-wrapping of aneurysm	Discharge to skilled nursing facility

ACA, anterior cerebral artery; *CTA*, computed tomography angiography; *EVD*, extraventricular drain; *MCA*, middle cerebral artery; *NA*, not available; *PCoA*, posterior communicating artery; *VPS*, ventriculoperitoneal shunt

Acknowledgments The authors thank the Neuroscience Publications staff at Barrow Neurological Institute for their help with the manuscript preparation.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Patient consent The current case report was exempt from IRB review, and consent for the report was obtained by a medical power of attorney.

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