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Case Report

Iatrogenic cortical pseudoaneurysm following ventriculoperitoneal shunt insertion presenting with intraventricular hemorrhage

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ABSTRACT

Background: Cerebral pseudoaneurysm formation associated with ventricular catheterization is an exceedingly rare complication that results from direct catheter-induced injury to a vessel. We report a case of intracerebral pseudoaneurysm formation associated with ventricular catheterization in a patient with hydrocephalus following aneurysmal subarachnoid hemorrhage.

Case Description: The patient presented with aneurysmal subarachnoid hemorrhage and underwent partial endovascular embolization of the offending wide-necked basilar tip aneurysm with the plan for a Stage 2 stent-assisted coiling after initial recovery. Before discharge, a ventriculoperitoneal shunt (VPS) was placed for postaneurysmal hydrocephalus. Three weeks later, she presented with intraparenchymal and intraventricular hemorrhage. Angiography revealed a cortical aneurysm contiguous to the ventricular catheter of the VPS. She underwent microsurgical excision of the aneurysm, and a new VPS was placed after resolution of the intraventricular hemorrhage. She later underwent the second stage of the treatment and had an excellent neurological recovery to an independent state.

Conclusion: Iatrogenic intracerebral pseudoaneurysm formation is an exceedingly rare complication of ventricular catheterization but is associated with significant mortality. Identifying a pseudoaneurysm in this context warrants prompt and definitive treatment with microsurgical or endovascular treatment.

Keywords: Hydrocephalus, Intraventricular hemorrhage, Pseudoaneurysm, Subarachnoid hemorrhage, Ventriculoperitoneal shunt, Ventriculostomy

INTRODUCTION

Ventriculoperitoneal shunt (VPS) insertion is a routine neurosurgical procedure for managing hydrocephalus and achieving cerebrospinal fluid (CSF) flow diversion. Since an excess of 35,000 ventriculostomies is performed annually in the United States,[20] cerebrovascular complications of the procedure are rare. Hemorrhagic complications, which are attributed to a coagulopathy, damage to bridging veins from CSF overdrainage, hemorrhage from a vascular lesion or tumor, or rebleeding of an unsecured ruptured aneurysm, have been reported with a prevalence of 6–7%, and may be as high as 10–12% when considering asymptomatic hemorrhage on a postprocedure

head computed tomography scan.[1,2,8] Cerebral pseudoaneurysm formation associated with ventricular catheter placement is an exceedingly rare complication resulting from direct injury to the arterial wall. We present a case of cerebral pseudoaneurysm formation secondary to VPS insertion and review the medical literature on this rare cerebrovascular iatrogenic lesion.

CLINICAL PRESENTATION

The patient is a 44-year-old female, smoker with a family history of intracranial aneurysms and aneurysmal subarachnoid hemorrhage, who was transferred to our hospital with a Hunt-Hess Grade 3 and Fisher Grade 4 subarachnoid hemorrhage due to a ruptured basilar tip aneurysm [Figure 1].

Figure 1: Anteroposterior view, digital subtraction angiography through vertebral artery injection delineating the wide neck of the multilobulated ruptured basilar tip aneurysm.

Figure 2: Anteroposterior view, digital subtraction angiography through vertebral artery injection demonstrating the residual neck of the partially coiled basilar tip aneurysm.

After discussing treatment options with the family, they elected for endovascular treatment. The aneurysm had a wide neck, so we performed partial embolization leaving a residual neck [Figure 2] with the plan to complete treatment with stent-assisted coiling after initial recovery. The patient had an excellent neurologic recovery but was deemed to be shunt dependent. A parietal VPS was placed in standard fashion using the neuro-PEN endoscope (Medtronic PS Medical, CA, USA) and laparoscopy [Figure 3]. Her postoperative course was unremarkable and she was transferred to rehabilitation briefly before being discharged home neurologically intact in an independent state.

She presented 3 weeks later to an outside hospital with severe headache. Imaging revealed intraventricular hemorrhage for which reason she was transferred back to our institution. On arrival, her neurologic examination was nonfocal, but she rapidly became obtunded with worsening intraparenchymal and intraventricular hemorrhage [Figure 4]. Emergent

Figure 3: Noncontrast computed tomography, axial view demonstrating no evidence of intraparenchymal hemorrhage postshunt placement.

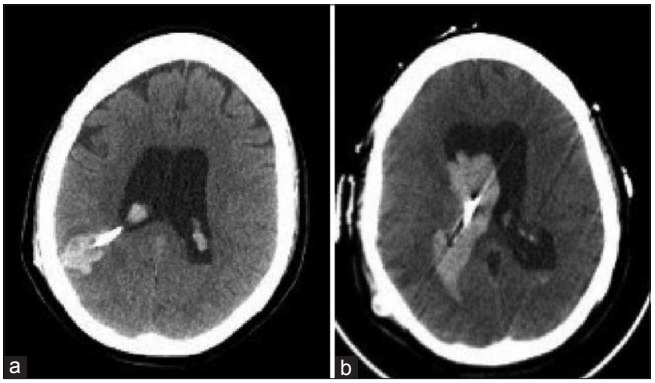

Figure 4: Noncontrast computed tomography, axial view showing (a) right parietal intraparenchymal hemorrhage along tract of the right parietal ventriculostomy catheter, as well as (b) intraventricular hemorrhage and associated hydrocephalus.

ventriculostomies were placed, and the patient was taken for angiography which revealed a cortical pseudoaneurysm contiguous to the ventricular catheter [Figure 5]. Given the cortical location and the need for shunt removal, we treated the aneurysm with open microsurgical excision [Figure 6]. It was not felt that intraoperative localization was needed given that the aneurysm was directly related to the catheter. Sacrificing the cortical vessel associated with the aneurysm was inconsequential. Postprocedure angiography revealed no residual or recurrence of the aneurysm.

Again, she recovered very well, neurologically intact and was discharged to rehabilitation after insertion of a new VPS. She then returned for elective stent-assisted coiling of the residual aneurysm and continues to be neurologically intact and independent.

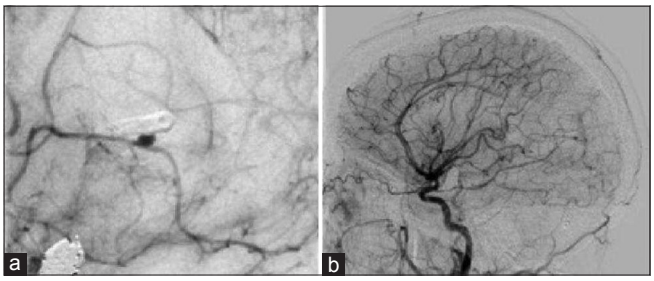

Figure 5: Lateral view, digital subtraction angiography through the right internal carotid artery injection revealing (a) cortical pseudoaneurysm contiguous to the ventricular catheter (b) magnified.

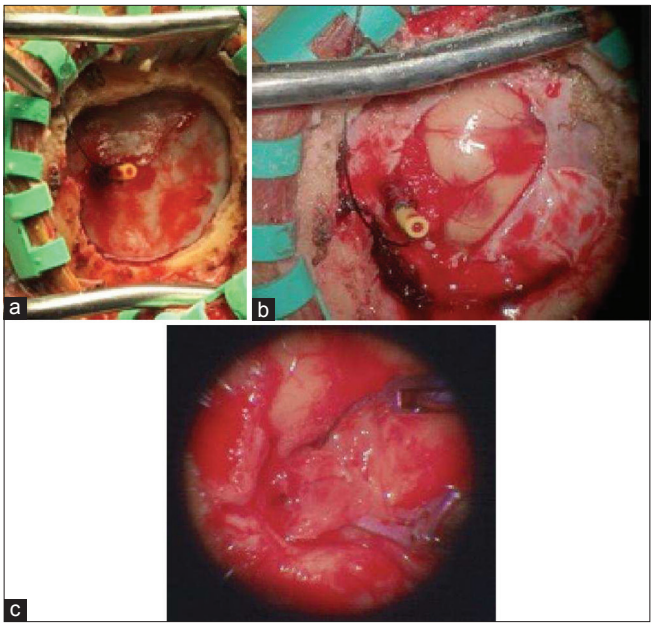

Figure 6: Intraoperative imaging (a) after disconnecting the shunt and extending the burr hole, (b) after opening the dura, and (c) after removal of the ventricular catheter and trapping of the associated cortical pseudoaneurysm (magnified).

DISCUSSION

Pseudoaneurysms are distinguished from true aneurysms in that there is a complete disruption of all vessel layers, whereas in true aneurysms, the tunica adventitia remains intact. In pseudoaneurysm formation, a contained hematoma associated with the vessel maintains the integrity of the vessel but also, when compared to true aneurysms, accounts for their relative instability and high rate of expansion and rupture.[7,16]

Traumatic intracranial pseudoaneurysms comprise <1% of all cerebral aneurysms[9,14] and may be caused by penetrating injury or blunt trauma.[9,12] Iatrogenic traumatic pseudoaneurysms are rare, with one review identifying only 52 reported cases since 1955.[5] These aneurysms have been described following intracranial surgery, endonasal procedures, endoscopic third ventriculostomy, and repeated subdural hematoma aspiration.[6,15,17,18] Only nine cases of iatrogenic pseudoaneurysm formation due to ventricular catheter insertion or removal have previously been reported [Table 1].[3,4,10,11,13,19,21,22] We report the tenth case of intracerebral pseudoaneurysm formation in a patient who required insertion of a VPS for hydrocephalus following aneurysmal subarachnoid hemorrhage.

We searched MEDLINE and Embase for articles published in English between January 1, 1960, and March 1, 2018. Search terms were "pseudoaneurysm," "traumatic aneurysm," "cerebral," "intracerebral," "ventriculostomy," "external ventricular drain" OR "EVD," "VPS" OR "VPS," and "iatrogenic." References in the original articles were also reviewed. We identified nine cases[3,4,10,11,13,19,21,22] of intracerebral pseudoaneurysm formation secondary to ventricular catheter insertion or manipulation: eight in which pseudoaneurysm formation was associated with catheter insertion and one with ventricular catheter removal. In the latter, the authors noted that choroid plexus was pulled out with the catheter tip and postulated that, due to traction on the choroid plexus, the anterior choroidal artery (AChA) was avulsed from the internal carotid artery causing pseudoaneurysm formation at the origin of the AChA.[21] Considering that traumatic intracranial aneurysms are more common in the pediatric age group compared to adults,[14] it is noteworthy that four of the nine reports are of pediatric patients. In our review of the nine reported cases, seven involved a pseudoaneurysm located in a distal branch of a cortical artery, and in two cases, the pseudoaneurysm was located at the AChA origin[21] and posterior communicating artery-posterior cerebral artery junction.[4] Only one of the nine cases involved pseudoaneurysm formation in the posterior circulation[4] and was deemed to occur secondary to nontarget placement of an EVD catheter. The remaining eight cases involved pseudoaneurysm formation in the anterior circulation.

Table 1: Summary of reported cases of intracerebral pseudoaneurysms secondary to ventricular catheter manipulation.

Authors and Year	Age	Sex	Inciting injury	Indication for ventricular catheterization	Pseudoaneurysm location	Duration to lesion diagnosis	Management	Outcome
Shirane *et al.*, 1999[21]	4 months	Female	VPS removal	Myelomeningocele, Chiari II, hydrocephalus	Left ICA-AchA junction	21 weeks	Surgical trapping and resection	Neurologically intact postoperative
Horowitz, *et al.*, 2005[10]	1 week	Male	VPS insertion	Myelomeningocele repair, hydrocephalus, CSF leak	Left A3 segment of ACA	2 weeks	Coil embolization	Neurologically intact at 1 year
Jenkinson, *et al.*, 2006[11]	15 years	Female	VPS insertion	Hydrocephalus secondary to IVH in infancy	Left distal MCA	6 weeks	Surgical trapping and resection	Residual right flaccid hemiparesis, mild expressive dysphasia
Tubbs, *et al.*, 2006[22]	10 years	Male	EVD placement	Hydrocephalus	Right pericallosal artery	1 week	Surgical trapping	Residual left lower limb weakness at 1 year
Chen, *et al.*, 2013[3]	39 years	Male	VPS insertion	Posthemorrhagic hydrocephalus	Left distal callosal marginal artery	13 days	Glue embolization	Good
Kosty, *et al.*, 2013[13]	62 years	Male	EVD placement, converted to VPS	Suboccipital pseudomeningocele	Right distal ACA	12 weeks	Glue embolization	No adverse outcome
Choudhri, *et al.*, 2014[4]	NR	NR	EVD placement	Ruptured aneurysm and hydrocephalus	Middle inferior frontal branch of right pericallosal artery	<1 day	Coil and glue embolization	No adverse outcome
Choudhri *et al.*, 2014[4]	NR	NR	EVD placement	Hydrocephalus due to resection cavity hemorrhage	Left PCOM-PCA junction	NR	Coil embolization	Died
Raygor, *et al.*, 2016[19]	58 years	Female	EVD placement	SAH	Right middle frontal artery	10 days	Surgical trapping and resection	Neurologically intact at 2 months

ACA: Anterior cerebral artery, AChA: Anterior choroidal artery, CSF: Cerebrospinal fluid, EVD: External ventricular drain, IVH: Intraventricular hemorrhage, MCA: Middle cerebral artery, NR: Not reported, PCOM: Posterior communicating artery, PCA: Posterior cerebral artery, SAH: Subarachnoid hemorrhage, VP: Ventriculoperitoneal shunt

In our case, we postulate two potential offenders that could have contributed to the formation of the aneurysm. During shunt placement, we usually open the dura in a circular fashion utilizing an 11 blade and a Bovie electrocautery. This maneuver, although routinely used and not previously associated with prior complications, could have caused enough thermal injury to damage the vessel. The other potential offenders could be the catheter itself. We usually use an antibiotic impregnated catheter that we sharply cut its blunt end to be able to advance the endoscope. This could have created a sharp edge that injured the vessel during insertion. We have since modified these practices after encountering this complication. Although a connective disorder such as Ehlers-Danlos syndrome could have increased the risk of her developing another aneurysm, we elected not to investigate that given the patient's lack of family history or features concerning for connective tissue disease and given that we had a good mechanical cause.

The time to intracerebral pseudoaneurysm diagnosis after ventricular catheter insertion varies but can be broadly classified into those pseudoaneurysms that form early (within 2 weeks of catheter insertion) and those that form late (months after catheter insertion).[19] In our review of the reported cases, five reported discovery of the aneurysm within 2 weeks of insertion, and in three cases, there was a period of 6–21 weeks before the pseudoaneurysm was identified. The pseudoaneurysms that form early are

thought to result from direct penetrating trauma to the vessel, whereas those that form late are postulated to be due to chronic inflammation that occurs when the catheter is juxtaposed with a cerebral vessel.[11]

Traumatic intracerebral pseudoaneurysms are associated with significant mortality, with reports as high as 50%, especially when treated conservatively.[14] In the nine cases we reviewed, six had a good neurologic outcome, two had residual deficits, and one died. Open or endovascular intervention was performed in all nine cases. Taken together with the unstable nature of these aneurysms and their propensity for rupture, when pseudoaneurysm is suspected, a definitive diagnostic approach should follow and immediate treatment should ensue.

CONCLUSION

Iatrogenic intracerebral pseudoaneurysm formation is an exceedingly rare complication associated with ventricular catheterization. Catheter tract hemorrhage may be the heralding sign of a developing pseudoaneurysm and should motivate further investigation with vascular imaging. Discovery of a pseudoaneurysm warrants prompt and definitive treatment with microsurgical clip ligation or endovascular treatment with embolization, flow diversion, or vessel sacrifice.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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