CASE REPORT

Intracranial pseudoaneurysm after intracranial pressure monitor placement

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SUMMARY

Traumatic intracranial pseudoaneurysms are a rare but severe complication following arterial injury. Pseudoaneurysm formation can occur secondary to blunt or penetrating trauma or iatrogenic injury. We report a case of traumatic pseudoaneurysm secondary to placement of an intracranial pressure (ICP) monitor. A 27-year-old man was involved in a motorcycle accident resulting in multiple intracranial hemorrhages. The patient underwent craniectomy and placement of an ICP monitor. 17 days later he developed dilation of his left pupil, with imaging demonstrating a new hemorrhage in the vicinity of the previous ICP monitor. A cerebral angiogram confirmed a left-sided distal M4 pseudoaneurysm which was treated by n-butyl cyanoacrylate embolization. Intracranial pseudoaneurysm formation following neurosurgical procedures is uncommon. Delayed intracranial hemorrhage in a region of prior intracranial manipulation, even following a procedure as 'routine' as placement of an ICP monitor, should raise the suspicion for this rare but potentially lethal complication.

BACKGROUND

Traumatic intracranial pseudoaneurysms account for less than 1% of all cerebral aneurysms.¹ Among this uncommon subset, pseudoaneurysm formation following placement of an intracranial pressure (ICP) monitor is exceptionally rare.² With an appropriately high index of suspicion, these lesions can be diagnosed, often with non-invasive imaging techniques, allowing for early treatment and improved patient outcomes.³

CASE PRESENTATION

A 27-year-old man was involved in a high speed motorcycle collision without a helmet. He was intubated in the field and brought to our emergency department. Cranial nerve reflexes were intact, and he would intermittently follow commands in a delayed fashion in bilateral upper extremities. He spontaneously moved his right lower extremity more than his left. CT scan showed a 5 mm right-sided subdural hematoma with 6.5 mm of midline shift, traumatic subarachnoid hemorrhage, intraventricular hemorrhage, diffuse cerebral edema, mild pneumocephalus, and multiple left (contralateral) temporal bone fractures (figure 1).

The patient underwent emergent right-sided craniectomy, subdural hematoma evacuation, and partial right temporal lobectomy. At the conclusion of the procedure, a Camino ICP monitor (Integra Neurosciences) was placed in the left frontal

Figure 1 Axial non-contrast CT scan of the head showing a 5 mm right-sided subdural hematoma with 6.5 mm of midline shift.

region. As per routine, a hand held drill was used to create a left frontal burr hole. An 18 gauge needle was used to pierce the dura followed by passage of the fiberoptic monitor into the brain parenchyma. The patient underwent CT scanning immediately postoperatively which demonstrated a large left-sided (contralateral to the initial injury) epidural hematoma (figure 2).

Figure 2 Axial non-contrast CT scan of the head showing a left-sided epidural hematoma with evidence of midline shift.

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He immediately returned to the operating room for craniotomy and evacuation. The left-sided ICP monitor was removed to allow for the surgical exposure. Fracture of the temporal bone with injury to the middle meningeal artery was determined to be the source of the hemorrhage. At the conclusion of the operation, a new ICP monitor was placed in the right frontal region. Postoperatively, the patient was stabilized in the intensive care unit. His neurologic examination demonstrated marked debilitation, but improved slowly to positive brainstem reflexes, localization with the right upper extremity, and withdrawal in bilateral lower extremities. The ICP monitor was removed during this course without complication.

Seventeen days after the neurosurgical procedures, the patient developed dilation of the left pupil (non-reactive), right gaze preference, and demonstrated minimal movements to stimuli. CT head revealed a new left frontal hemorrhage (figure 3). A right frontal external ventricular drain was placed and the neurologic examination improved towards baseline.

INVESTIGATIONS

Development of delayed spontaneous hemorrhage in an area of the brain previously uninvolved with the injury raised the suspicion of an iatrogenic pseudoaneurysm associated with the previously placed left frontal ICP monitor. CT angiography with reconstructions was obtained, and a left frontal fusiform pseudoaneurysm along the trajectory of the ICP monitor tract was suggested (figure 4). The lesion was confirmed at cerebral angiography (figures 5 and 6).

TREATMENT

The distal left M4 frontal branch pseudoaneurysm was successfully excluded from the circulation by n-butyl cyanoacrylate embolization (figures 6 and 7).

OUTCOME AND FOLLOW-UP

The hemorrhage remained stable and did not require operative evacuation. No new hemorrhage was encountered thereafter. The ventriculostomy was weaned and removed, and no further

Figure 3 Axial non-contrast CT scan of the head showing left frontal intraparenchymal hemorrhage with intraventricular extension.

Figure 4 Sagittal reconstruction of a CT angiogram of the brain showing an intracranial pseudoaneurysm (arrow) along the tract of the previously placed intracranial pressure monitor.

intracranial pathology was encountered. After eventual discharge to a distant rehabilitation facility, he has shown slow improvement with the ability to speak in short phrases, feed himself with use of his right arm, and he is able to transfer to a wheelchair with minimal assist.

DISCUSSION

Although rare, traumatic intracranial pseudoaneurysms pose a significant hemorrhage risk. Published and anecdotal accounts serve to highlight the often times remarkable clinical and radiographic behaviors associated with these lesions.¹⁻³ Histologically, these lesions are characterized by complete interruption of the vessel wall with intravascular blood retained by an extravascular hematoma.⁴

Intracranial pseudoaneurysms can develop following blunt or penetrating trauma, with the latter being more common.¹⁻⁵ Blunt trauma often results in pseudoaneurysm formation in stereotypical locations where shear forces can result in vessel injury.⁶ Pseudoaneurysms following penetrating trauma encompass a more heterogeneous distribution and include iatrogenic causes.

Iatrogenic intracranial pseudoaneurysm formation has been associated with a variety of neurosurgical operations, including brain biopsy or carotid injury during transsphenoidal

Figure 5 Anteroposterior left carotid artery angiogram showing the pseudoaneurysm (arrow), as well as on a superselective angiogram (arrow).

Figure 6 All three images show lateral left carotid artery angiogram. (A) The pseudoaneurysm (box), (B) magnified view of the pseudoaneurysm (arrow), and (C) post embolization sequence showing absence of filling of the pseudoaneurysm (box).

surgery.^{4 7 8} The reported cases outline a shared sequence of events; a penetrating intraparenchymal procedure results in occult arterial injury. Thereafter, delayed spontaneous hemorrhage prompts radiologic investigation^{3 8–10} confirming the diagnosis of intracranial pseudoaneurysm.^{6 10}

Fiberoptic ICP monitors, commonly referred to as ‘bolts,’ are well established tools in the care of neurotrauma patients.² Although generally considered safe, they are not free from the risk of complication. Hemorrhage after ‘bolt’ placement may occur in as many as 9.7% of patients, most commonly at the time of the procedure due to direct passage of the fiberoptic instrument through brain tissue.² To our knowledge, there is only one other case in the literature that has described the formation of an iatrogenic intracranial pseudoaneurysm following placement of an ICP monitor.¹ In this case, the hemorrhage was detected on a routine CT scan as the patient did not have any change in their neurologic examination. The pseudoaneurysm

was treated with craniotomy.¹ The mechanism of injury was not precisely known. Multiple steps in the placement of the ICP monitor involve penetration into the intracranial compartment without direct visualization; drilling the burr hole, incising the dura, and placing the fiberoptic lead. Each step theoretically carries a very small risk of compromising the integrity of an underlying vessel. The risk is likely elevated when cerebral edema is more pronounced, as brain parenchyma is more closely approximated to the inner table of the skull. Treatment of intracranial pseudoaneurysms can be quite challenging. In the ruptured setting, treatment usually involves occlusion of the feeding vessel. This can be accomplished surgically or endovascularly.³

In the present case, surgeons discussed both surgical and endovascular options as both were reasonable and plausible. However, as the patient had already undergone bilateral craniotomies previously, an endovascular approach was felt to be simpler. Sacrifice of the M4 vessel with embolization was accomplished without any clinical stroke sequela. As there was hemorrhage in the region supplied by this vessel, encephalomalacia would likely develop.

In patients who present with delayed intracranial hemorrhage in a region of prior neurosurgical manipulation, a high level of suspicion towards the possibility of an iatrogenic pseudoaneurysm is warranted. This report serves as a reminder that even bedside neurosurgical procedures that are often considered ‘routine’ and ‘unremarkable’ may be associated with this serious complication. Appropriate evaluation for this pathology can lead to a reduced risk of rehemorrhage and improved patient outcome.

Figure 7 Anteroposterior left carotid artery angiogram showing the aneurysm has been excluded from the circulation after embolization with n-butyl cyanoacrylate.

Learning points

- ▶ The development of delayed spontaneous hemorrhage in an area of previously uninjured brain should raise the suspicion of pseudoaneurysm rupture.
- ▶ Manipulation of brain tissue with an intracranial pressure monitor or other surgical instrument can lead to vessel wall injury predisposing to pseudoaneurysm formation.
- ▶ Early detection and treatment of intracranial pseudoaneurysms, either with craniotomy or endovascular techniques, decreases the risk of rehemorrhage and improves outcome.

Competing interests None.

Patient consent Obtained.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

- 1 Le H, Munshi I, Macdonald RL, *et al.* Traumatic aneurysm resulting from insertion of an intracranial pressure monitor. Case illustration. *J Neurosurg* 2001;95:720.
- 2 Blaha M, Lazar D. Traumatic brain injury and haemorrhagic complications after intracranial pressure monitoring. *J Neurol Neurosurg Psychiatry* 2005;76:147.
- 3 Lim J, Suh SH, Lee KY, *et al.* Endovascular treatment of iatrogenic intracranial pseudoaneurysm following stent angioplasty. *J Neuroimaging* 2012;22:194–6.
- 4 Rayes M, Bahgat DA, Kupsky WJ, *et al.* Middle cerebral artery pseudoaneurysm formation following stereotactic biopsy. *Can J Neurol Sci* 2008;35:664–8.
- 5 Blei AT, Olafsson S, Webster S, *et al.* Complications of intracranial pressure monitoring in fulminant hepatic failure. *Lancet* 1993;341:157–8.
- 6 Miley JT, Rodriguez GJ, Qureshi AI. Traumatic intracranial aneurysm formation following closed head injury. *J Vasc Interv Neurol* 2008;1:79–82.
- 7 Fu M, Patel T, Baehring JM, *et al.* Cavernous carotid pseudoaneurysm following transsphenoidal surgery. *J Neuroimaging* 2013;23:319–25.
- 8 Valentine R, Wormald PJ. Carotid artery injury after endonasal surgery. *Otolaryngol Clin North Am* 2011;44:1059–79.
- 9 Ciceri EF, Regna-Gladin C, Erbetta A, *et al.* Iatrogenic intracranial pseudoaneurysms: neuroradiological and therapeutical considerations, including endovascular options. *Neurol Sci* 2006;27:317–22.
- 10 Medel R, Crowley RW, Hamilton DK, *et al.* Endovascular obliteration of an intracranial pseudoaneurysm: the utility of Onyx. *J Neurosurg Pediatr* 2009;4:445–8.

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