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# Traumatic pericallosal artery aneurysm: a rare complication of transcallosal surgery

## Case report

**Ian F. Dunn, M.D.,[1,2] Graeme F. Woodworth, M.D.,[2] Adnan H. Siddiqui, M.D., Ph.D.,[2] Edward R. Smith, M.D.,[2] G. Edward Vates, M.D., Ph.D.,[1] Arthur L. Day, M.D.,[1] and Liliana C. Goumnerova, M.D.[2]**

*[1]Department of Neurosurgery, Brigham and Women's Hospital; and [2]Department of Neurosurgery, Children's Hospital Boston, Harvard Medical School, Boston, Massachusetts*

✓Traumatic intracranial aneurysms are rare in adults but account for up to 33% of all aneurysms encountered in a pediatric population. The most common location of such lesions in children is the pericallosal or adjacent branch of the anterior cerebral artery, where a head impact exerts sudden decelerating shearing forces on the arteries tethered on the brain surface against an immobile falx cerebri, weakening the arterial wall. This action can lead to dissection of the damaged vascular layers, with resultant expansion of the affected site into a fusiform aneurysm. Pericallosal aneurysms following a penetrating intracranial injury have also been described, and the resultant lesion in some cases can be a pseudoaneurysm. The incidence of iatrogenic pericallosal artery aneurysms, however, is extremely rare.

The authors describe the first reported case of a traumatic pericallosal artery aneurysm following transcallosal surgery. This 6-year-old boy underwent resection of a hypothalamic pilocytic astrocytoma, which was approached via the transcallosal corridor. A follow-up magnetic resonance image obtained within 1 year of surgery disclosed a small flow void off the right pericallosal artery, which was initially interpreted as residual tumor. Serial investigations showed the lesion enlarging over time, and subsequent angiography revealed a round 7-mm pericallosal artery aneurysm with an irregularly shaped 2- to 3-mm lumen. The aneurysm was difficult to treat with clip reconstruction or suturing of the affected segment, and an excellent outcome was ultimately achieved with resection of the lesion and autogenous arterial graft interposition. The authors also discuss the likely pathophysiology of the aneurysm and the surgical procedures undertaken to treat it.

**Key Words • pericallosal artery aneurysm • traumatic aneurysm • anterior cerebral artery aneurysm • transcallosal approach • pediatric neurosurgery**

Traumatic intracranial aneurysms are rare in adults but account for up to 33% of all aneurysms encountered in a pediatric population.[4,5,24] The most common location in children is the pericallosal or adjacent branch of the ACA, where a severe head impact exerts sudden decelerating shearing forces on the arteries tethered on the brain surface against an immobile falx cerebri. Such an injury weakens the arterial wall and can lead to dissection of the damaged vascular layers, with resultant expansion of the affected site into a fusiform aneurysm.[15,19] Two thirds of pediatric patients will experience a symptomatic aneurysmal hemorrhage, with a mortality rate of more than 30%.[5,24] Pericallosal aneurysms developing after a penetrating intracranial injury have also been described, and the resultant lesion in some cases can be a pseudoaneurysm.[1,9,16,20,22] The incidence of iatrogenic pericallosal artery traumatic aneurysms is extremely rare, however.

*Abbreviations used in this paper:* ACA = anterior cerebral artery; MR = magnetic resonance; STA = superficial temporal artery.

## Case Report

*History and Examination.* This 6-year-old boy with no previous closed or penetrating head injury presented with a 2-month history of intermittent headaches, nausea, vomiting, and increasing lethargy. Ophthalmological examination revealed a bitemporal hemianopia, see-saw nystagmus in his left eye, and bilateral up-gaze paresis. A cranial MR image demonstrated an enhancing, cystic, lobulated, 5 × 4 × 4–cm hypothalamic-chiasmatic mass remodeling the sella and extending superiorly and posteriorly to efface the third ventricle and displace the midbrain posteriorly (Fig. 1). Marked obstructive hydrocephalus and dilation of the lateral ventricles was also evident.

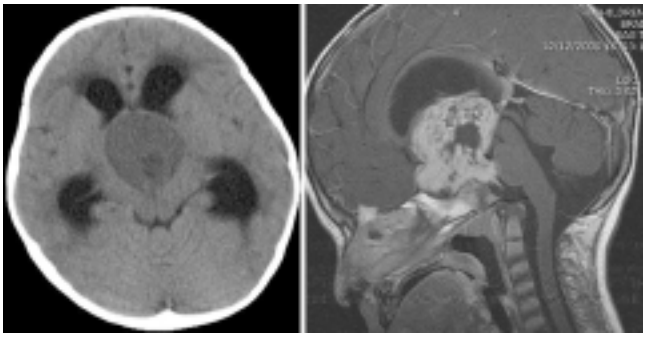

FIG. 1. *Left:* A computed tomography scan revealing a 4 × 4–cm suprasellar mass with attendant obstructive hydrocephalus. *Right:* Sagittal MR image demonstrating an enhancing, cystic, lobulated 5 × 4 × 4–cm hypothalamic-chiasmatic mass. Note the remodeling of the sella, effacement of the third ventricle, and displacement of the midbrain.

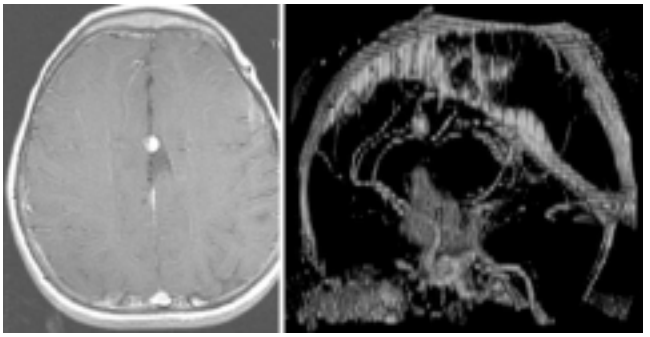

FIG. 2. Axial MR image *(left)* and MR angiogram *(right)* demonstrating a partially thrombosed pericallosal artery aneurysm.

*Treatment.* The mass was accessed via an anterior transcallosal approach, during which both pericallosal arteries were identified in the interhemispheric fissure atop the bulging, thinned out corpus callosum. Retractors were placed on the medial right frontal lobe and falx, the corpus callosum was incised, and the tumor was easily identified extending up from the third ventricle. After the lesion was debulked, an external ventricular drain was placed and the craniotomy was closed. Pathological features were consistent with pilocytic astrocytoma. Placement of a right lateral ventriculoperitoneal shunt was required to treat persistent hydrocephalus. A left lateral ventricular catheter was later added to treat persistent ipsilateral ventriculomegaly. At no point during any of these procedures was injury to the pericallosal arteries noted.

*Posttreatment Course.* In the ensuing 4 years, two further debulking procedures were performed via a left pterional craniotomy. A follow-up MR image obtained 4 years after the initial surgery revealed a rounded 7-mm focus of enhancement with a pulsation artifact along the inferior margin of the falx. Magnetic resonance angiography revealed a partially thrombosed right pericallosal artery aneurysm with a small residual lumen (Fig. 2), which was confirmed on digital subtraction angiography (Fig. 3). In retrospect, we determined that this lesion had been present (although somewhat smaller) on prior MR images as early as 6 months after the initial procedure but was interpreted as residual tumor.

*Additional Treatment.* Because of the progressively increasing size of the aneurysm and the attendant risk of rupture, an exploration with a planned clip reconstruction was proposed. The aneurysm was approached through the previous craniotomy created for the transcallosal approach and was easily identified arising from the right pericallosal artery, immediately adjacent to the prior incision in the corpus callosum. Hemosiderin staining was evident in the region, but a clear relationship of prior bleeding in association with the aneurysm as opposed to that due to the corpus callosotomy could not be established. The aneurysm dome was dissected free of adhesions, and temporary clips were placed to trap the aneurysm. The dome was incised and a thrombectomy performed. Two curved titanium mini-clips were applied across the aneurysm neck parallel to the long axis of the vessel to exclude the aneurysm from the circulation. The temporary clips were removed, and no bleeding was noted. Despite apparent excellent preservation of pericallosal artery patency on external inspection, an intraoperative angiogram revealed no flow through the region of clip reconstruction, and there appeared to be some retrograde thrombosis of the ACA more proximally for several millimeters. The temporary clips were reapplied (under barbiturate-induced burst suppression), and the mini-clips were removed to reveal intraluminal thrombus within the parent vessel. The clot was extracted, and excellent flow was reestablished. The edges of the residual aneurysm neck were trimmed, and a primary vessel reconstruction was performed using running 10-0 nylon stitches. Papaverine was administered external to the vessel to reduce reactive vascular spasm. Restoration of flow and a normal vessel caliber were confirmed on a second intraoperative angiogram.

*Posttreatment Course.* Digital subtraction angiograms obtained 4 days later revealed an interval expansion of the repaired segment (Fig. 4). The patient returned to the operating room the following day for resection of the diseased arterial segment. After temporary clip application and barbiturate-induced burst suppression, the aneurysm and adja-

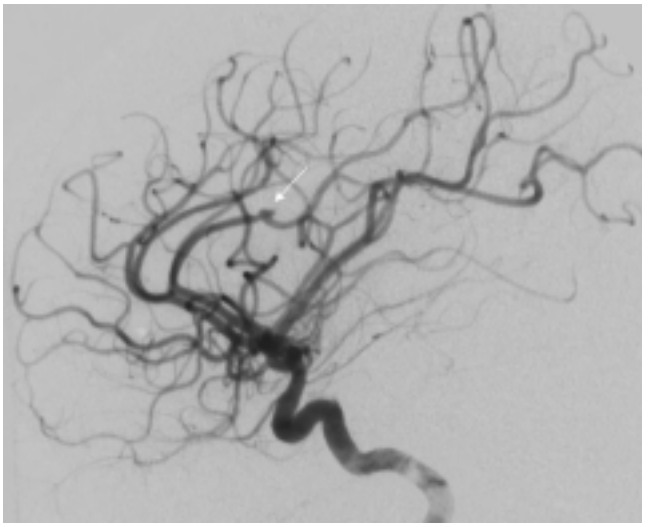

FIG. 3. Digital subtraction angiogram revealing a small, irregularly shaped residual lumen of the partially thrombosed pericallosal artery aneurysm *(arrow).*

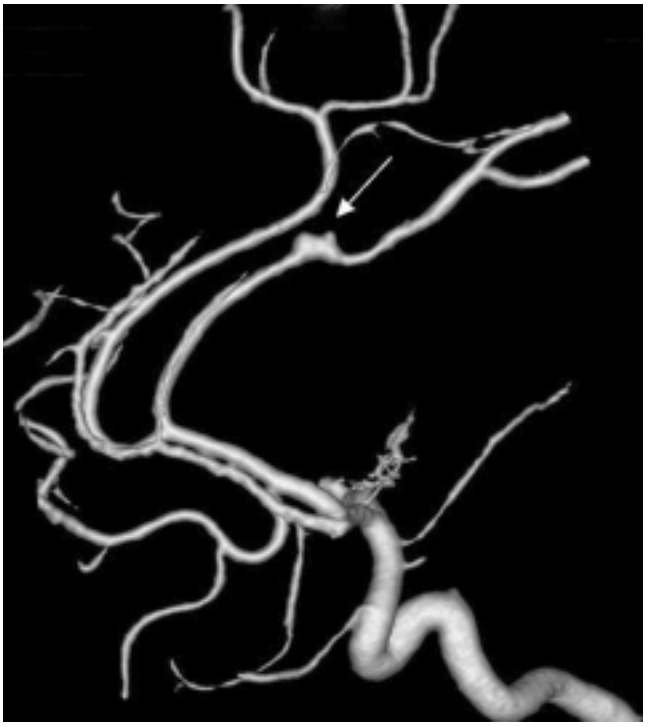

FIG. 4. Three-dimensional angiogram exhibiting postoperative reexpansion of the pericallosal artery aneurysm *(arrow)*. The artery appeared normal on the intraoperative arteriogram obtained 3 days prior.

cent 5-mm segments of the right pericallosal artery were resected. Too much tension on the proposed suture line was encountered during mobilization of the parent vessel for attempted primary anastomosis, so an STA graft was interposed using 10-0 nylon interrupted sutures. An intraoperative angiogram confirmed preserved blood flow through the interposition graft with complete aneurysm obliteration (Fig. 5). The patient was awakened uneventfully and was discharged home 3 days later in good condition.

## Discussion

Intracranial aneurysms in children are rare. Becker and colleagues[3] found no incidental aneurysms on more than 9000 routine cerebral angiograms obtained in the pediatric population. Locksley[13] reported that of 6368 aneurysms documented in a cooperative study, only 41 were identified in children. Aneurysms in children appear to have a male predilection (1.3–2.8:1). Typical saccular aneurysms similar to those seen arising from bifurcation sites in adults are rare in any location other than the internal carotid artery bifurcation. In further contrast to the lesions encountered in adults, most aneurysms in children are symptomatic at presentation, more frequently reach giant (≥ 2.5 cm in maximal external diameter) proportions (28–45% compared with 2–5%), and rarely occur in multiples (4% compared with 20%).[8,10,17,19,25] It is unlikely that saccular aneurysms in children develop as a result of the hemodynamic breakdown of arterial bifurcations, which is associated with a greater duration of time and thus is more likely to occur in adults. Instead, these lesions might be caused by spontaneous dissections. Infectious and traumatic origins are also frequently encountered in the pediatric population.[4,24]

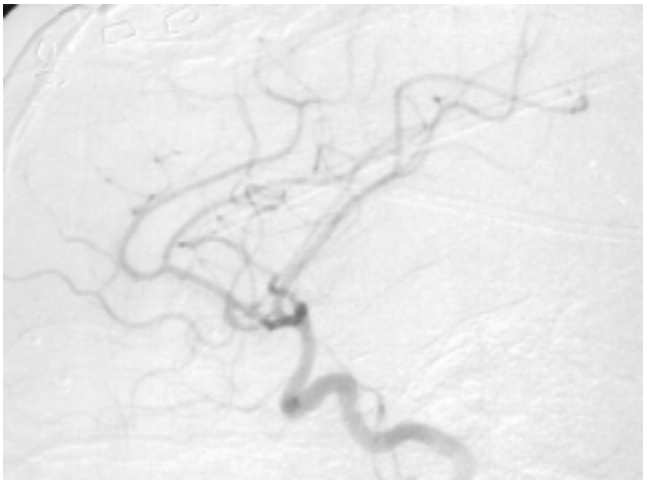

FIG. 5. Intraoperative angiogram obtained after aneurysm resection and an STA graft interposition, showing no aneurysm and intact arterial patency.

Traumatic intracranial aneurysms in children occur most commonly in peripheral locations (63%) and less frequently in the internal carotid artery (29%) or the vertebrobasilar system (8%).[5,12,21,22,24] Peripheral traumatic aneurysms can be further divided into two groups. The most common includes those arising from the distal ACA (38%), which are thought to develop because of trauma to the vessel against the free edge of the falx cerebri. The other group of peripheral lesions includes those arising from distal cortical arteries (25%), and their origins are frequently associated with an overlying skull fracture.[5,18] Less common sites are the $M_1$ segment of the middle cerebral artery, which can be injured against the sphenoid ridge, and the posterior cerebral artery, which can be sheared by the tentorial edge. Approximately two thirds of patients with traumatic lesions experience symptomatic aneurysmal hemorrhage, with an associated mortality rate of more than 30%.[5,24]

The distal ACA is a relatively infrequent location for aneurysm development, accounting for 4 to 5% of lesions identified across all patient populations.[21] The reported origins of lesions in this location include saccular types associated with hemodynamic stress (90%), trauma (7%), and infections (3%).[8,10,19,25] Most distal ACA aneurysms in adults are saccular and originate where the parent vessel bifurcates into a continuation of the pericallosal artery and callosomarginal artery. In contrast, most lesions in children arise in association with trauma.

As a group, distal ACA aneurysms tend to be fragile and thin-walled and when encountered are frequently associated with intracranial hemorrhage and its consequences.[8] Their delicacy and direction of projection are associated with an increased frequency of premature intraoperative rupture during exposure, and these lesions have higher morbidity and mortality rates than might be expected from their angiographic appearance, size, and location.[6,11] Successful aneurysm obliteration not surprisingly reduces the overall risks to the patient, particularly in those harboring posttraumatic lesions.[7,24]

Iatrogenic injury leading to aneurysm formation has been

described previously, two cases of which were in children. Shirane and colleagues[21] described an anterior choroidal artery pseudoaneurysm associated with the removal of an occipital ventricular catheter in a 4-month-old girl. Catheter removal was associated with severe intraventricular hemorrhage, suggesting that injury to nearby or tethered vessels can occur during catheter insertion or withdrawal. McLaughlin et al.[14] described a basilar tip aneurysm that developed after laser fenestration of the third ventricular floor during endoscopic third ventriculostomy in a 3-year-old child. Severe intraventricular hemorrhage was reported at the time of injury, but an initial angiogram was nondiagnostic. The patient presented 1 month later with subarachnoid hemorrhage from a basilar tip aneurysm. Hayashi and associates[9] reported on the development in an adult patient of two pericallosal artery aneurysms at the site of avulsed cortical arteries during clipping of a giant azygous ACA aneurysm. As in the two prior instances, arterial injury was evident at the time of the iatrogenic insult. Aneurysm formation following internal carotid artery injury after surgery for craniopharyngioma has also been reported.[12,23]

In this report, we describe the development of an asymptomatic pericallosal artery aneurysm in a patient with no history of head injury, presumably due to and following uncomplicated transcallosal surgery. Specific features suggestive of a traumatic origin (Fig. 3) include the aneurysm's peripheral location, lack of association with an arterial branch point, fusiform external shape, irregular luminal morphological characteristics, and absence of a discrete neck.[4,11,18] In our opinion, the genesis of this patient's pericallosal arteriopathy was likely iatrogenic, caused by pericallosal arterial injury during transcallosal resection of the hypothalamic tumor. This approach requires identification of the pericallosal arteries and the creation of a plane between the vessels, followed by lateral retraction on the corpus callosum, falx, and medial frontal lobe. Undue retraction of the right pericallosal artery might have occurred during intended retraction of the medial right frontal cortex, causing luminal shear forces and perhaps secondary focal arterial dissection leading to aneurysm formation. Indeed, the affected arterial segment was immediately lateral to the healed incision in the corpus callosum. Moreover, this segment appeared torqued, as if tethered to the corpus callosum incision.

A dissection origin could also explain the difficulty encountered in the initial efforts to preserve luminal patency. Despite external visual evidence that the clips left plenty of room for continued flow within the parent vessel, the affected segment thrombosed, likely because the clips created some type of intimal inversion that prompted increased clot stimulation or critical luminal narrowing. Ultimately, the native pericallosal artery segment could not withstand normal hemodynamic stress, as shown by aneurysm recurrence within several days after the initial surgical procedure. Definitive aneurysm obliteration and flow restoration required resection of the diseased pericallosal artery segment followed by an STA graft interposition, yielding excellent angiographic and functional results (Fig. 5).

The unusual location away from the free edge of the falx also supports the contention that an arterial dissection led to this aneurysm's formation, rather than a direct and discrete pericallosal arterial injury. Despite an excellent (at least in external and initial arteriographic appearance) reconstruction with microvascular suturing, the aneurysm reformed, indicating a generalized weakening of the vessel wall, rendering it unable to withstand a normal mean arterial pressure. In dealing with dissections elsewhere, a successful surgical outcome almost always requires an approach whereby the aneurysm and the adjacent diseased arterial wall are resected and/or bypassed.

Intraoperative angiography was essential to a good outcome in the present case. In the initial vascular procedure, this imaging modality facilitated immediate identification of a potentially hazardous clip construct, and we were then able to redesign and conduct a safer aneurysm repair while still in the operating room. The value of an early postoperative imaging study was also clearly evident, as it identified the growing lesion before any clinical event occurred, allowing a second procedure while the anatomy and exposure from the first procedure could be easily and clearly defined.

Major considerations in safely establishing a transcallosal surgical corridor are the prevention of hemiparesis (particularly of the lower extremity) and memory loss. Other reported intraoperative complications include sagittal sinus and parasagittal venous injury, variable callosal disconnection syndromes, and forniceal injury.[2] The present case highlights an additional, albeit rare, complication of the transcallosal approach—delayed pericallosal aneurysm formation likely due to arterial injury during retractor placement. Most cases of iatrogenic injury to the vessel result in immediate hemorrhage, and subsequent aneurysm dilation follows thereafter, usually with a silent interval followed by catastrophic rebleeding days, weeks, or months later. In the present case, the insult was silent, and the lesion remained asymptomatic during the follow-up interval.

Although MR imaging and MR angiography first suggested the presence of the lesion, catheter-based angiography was most useful in the precise delineation of the aneurysm's architecture. The events in this case underscore the utility and importance of both intraoperative and timely postoperative angiography. The distal pericallosal segment remains difficult to navigate endovascularly, particularly in the pediatric population. Our experience demonstrates that a skilled team of neurosurgeons equipped to handle neurovascular disease was critical in achieving a successful outcome in this difficult case.

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*Address reprint requests to:* Liliana Goumnerova, M.D., Department of Neurosurgery, Bader 3, Children's Hospital Boston, 300 Longwood Avenue, Boston, Massachusetts 02115. email: liliana.goumnerova@childrens.harvard.edu.