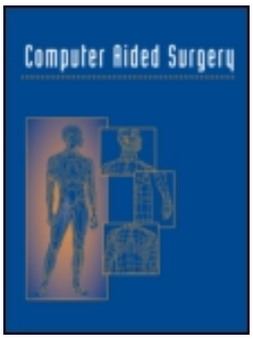

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Brief Clinical Report

Image Guided Excision of a Ruptured Feeding Artery "Pedicle Aneurysm" Associated with an Arteriovenous Malformation in a Child: *Case Report*

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ABSTRACT **Excision of a ruptured aneurysm located at a lenticulostriate feeding artery associated with an arteriovenous malformation was performed using image guided neuronavigation in an 8-year-old child. The management of this lesion, which is rare in childhood, demonstrates the potential of combining frameless stereotaxy for precise target approach with conventional open microneurosurgery to minimize morbidity. Because of the unavoidable shifting of the brain that occurs during surgery, a catheter pointing towards the dome of the aneurysm was placed using image guidance prior to insertion of spatulae.** *Comp Aid Surg 2:5–10 (1997).* ©1997 Wiley-Liss, Inc.

Key words: **aneurysm, arteriovenous malformation, childhood, image guided surgery, neuronavigation**

INTRODUCTION

The association of arteriovenous malformations (AVMs) with arterial aneurysms is a well known clinicoroentgenological phenomenon, with an incidence ranging from 2.7% to 23% of all AVMs.[9] As a specific type, the "pedicle aneurysm" arises from the midcourse of an AVM feeding artery remote from the circle of Willis and may represent a source of spontaneous hemorrhage. In children, this is a very rare clinical condition.

We report here the successful excision of a ruptured feeding artery "pedicle aneurysm" located in the right caudate nucleus, associated with a frontoparietal arteriovenous malformation. Exact exposure and safe excision of this atypically located aneurysm were achieved through image guided neuronavigation, immediately prior to complete extirpation of the AVM. For this purpose, we used the Viewing Wand system (ISG Technologies, Toronto, Ontario, Canada).

ILLUSTRATIVE CASE REPORT

An 8-year-old girl suffered from a spontaneous hemorrhage of the right caudate nucleus (Fig. 1); presenting symptoms included sudden onset of headache, vomiting, and drowsiness. Angiography revealed a right-side AVM in the frontoparietal area, associated with an aneurysm arising from a lenticulostriate feeding artery (Fig. 2).

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Fig. 1. Hemorrhage of the right caudate nucleus, with penetration into the lateral ventricle.

The aneurysm was believed to be the source of the bleeding.

After spontaneous clinical recovery, multistep selective catheter embolization was used for flow reduction of the AVM. Finally, microsurgical excision of both the feeding artery pedicle aneurysm and the AVM was performed during one procedure. The patient's postoperative course was uneventful. A left-side hemiparesis that had occurred after the last embolization improved substantially until discharge and resolved completely after 3 months.

MATERIALS AND METHODS

For the purpose of precisely exposing the deep-seated aneurysm without additional morbidity, we took advantage of image directed neuronavigation, based on postcontrast computed tomography (CT; Fig. 3). Image acquisition was carried out using a Picker PQ2000 scanner, with a 1.5 mm thickness of CT slices and 512 × 512 image matrix. For referencing, we used surface matching with seven skin markers on the child's forehead and bregma. The original ISG viewing wand system, an articulated arm-based, frameless stereotactic system, was supported by an HP735 workstation. Immediate preoperative fiducial registration revealed a root mean square (rms) error of 1.54 mm. Fiducial and surface check evaluation of the discrepancy of the image probe position and the actual probe position resulted in an overall accuracy of 1.7 mm. A tip-to-landmark check at the end of the procedure showed an intraoperative shift of 1.9 mm.

Immediately after opening of the dura, a

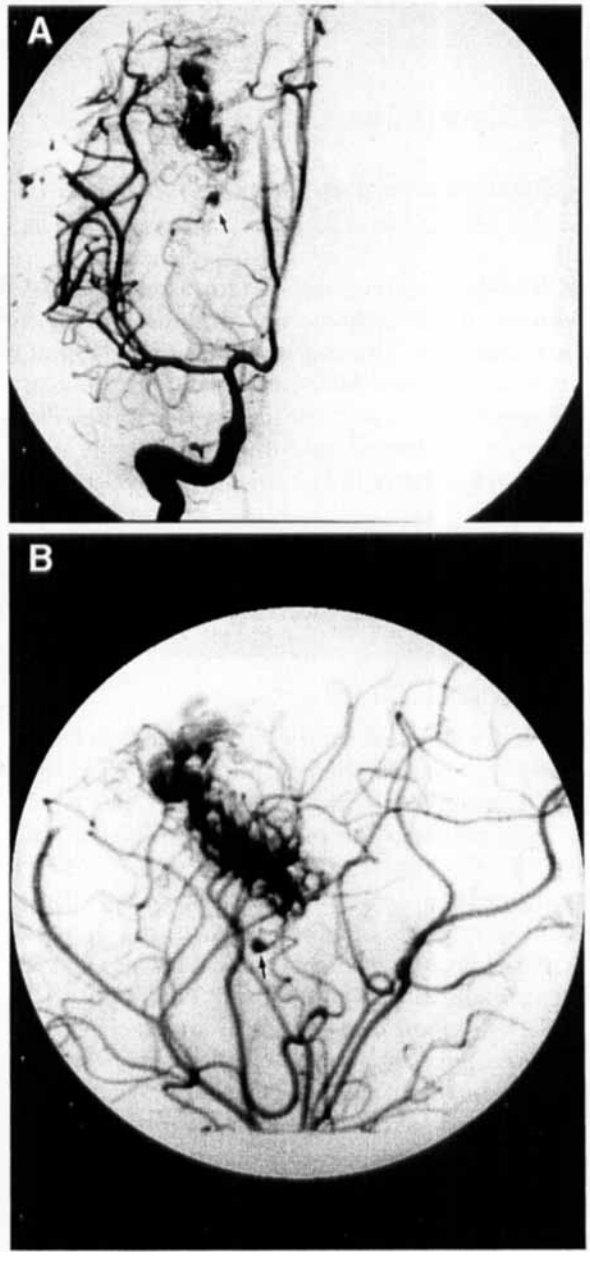


Fig. 2. Right-side frontoparietal AVM, following partial embolization. "Pedicle aneurysm" (arrow) arising from a lenticulostriate feeding artery. **A:** A-P view. **B:** Lateral view.

Fig. 3. Postcontrast CT revealing the feeding artery "pedicle aneurysm" (arrow) at the rim of the hematoma cavity.

silicone ventricular catheter was put over the articulated arm-borne probe of the viewing wand system. This applicator had been modified according to our instructions (manufactured by Aesculap Co., Tuttlingen, Germany), combining the probe adapter with a very thin rod 1.5 mm in diameter and 80 mm in length (Fig. 4). The catheter was then introduced by image guidance via a sulcal puncture anteriorly to the AVM and placed with its tip pointing toward the aneurysm dome (Fig. 5). After withdrawal of the probe, the aneurysm could be easily exposed via a small incision following down the course of the catheter. Figure 6 depicts the exact exposure of the aneurysm, which was then resected together with occluding of the feeding artery. Finally, the AVM was excised completely (Fig. 7).

DISCUSSION

The association of arteriovenous malformations with aneurysms is well known, with an incidence ranging from 2.7% to 23% of all AVMs.[2,9] Lasjaunias et al.[7] described three different types of arterial aneurysms associated with AVMs: 1) distal or intranidal aneurysms, 2) proximal aneurysms on vessels directly supplying the AVM, and 3) remote aneurysms unrelated to inflow vessels. Perata et al.[9] additionally differentiated between proximal aneurysms arising at the circle of Willis origin of a vessel supplying the AVM and pedicle aneurysms arising from the midcourse of a feeding artery remote from the circle of Willis. As in our case, pedicle aneurysms seem to be associated with a significant risk of hemorrhage.[9]

Among children, AVM-associated aneurysms represent a very rare clinical condition.[1,13] In a review by Hayashi et al.,[5] among 73 cases with aneurysms of this special type, only two patients were younger than age 10 years. In 1984, Østergaard[8] reported two children aged 3 and 9 years who harbored an intracranial AVM combined with an attendant saccular aneurysm. In one patient, the aneurysm was the source of a fatal hemorrhage.

Unlike typically located aneurysms of the circle of Willis, pedicle aneurysms arising from distal AVM feeders are difficult to localize when embedded in the surrounding brain parenchyma. Especially in locations close to or even within the basal ganglia, their exposure may involve a high risk of significant morbidity. In this situation, image directed neuronavigation based on CT or magnetic resonance imaging angiography provides a useful tool for the precise localization and safe excision of the aneurysm, minimizing the adverse effect of brain dissection. Alternate methods, e.g., intraoperative ultrasound and stereotaxy, are either less suitable or more complicated to carry out. Stereotaxy in the treatment of

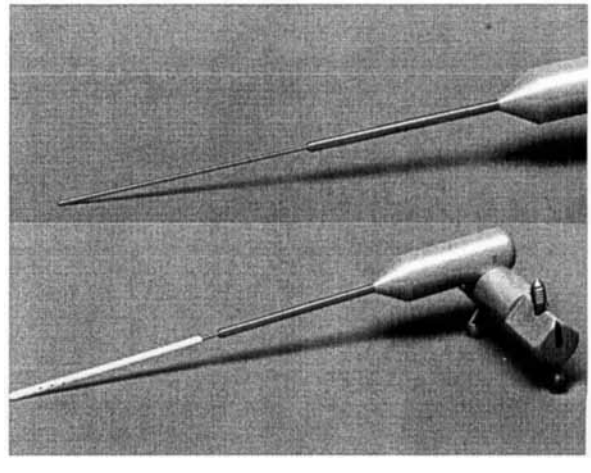
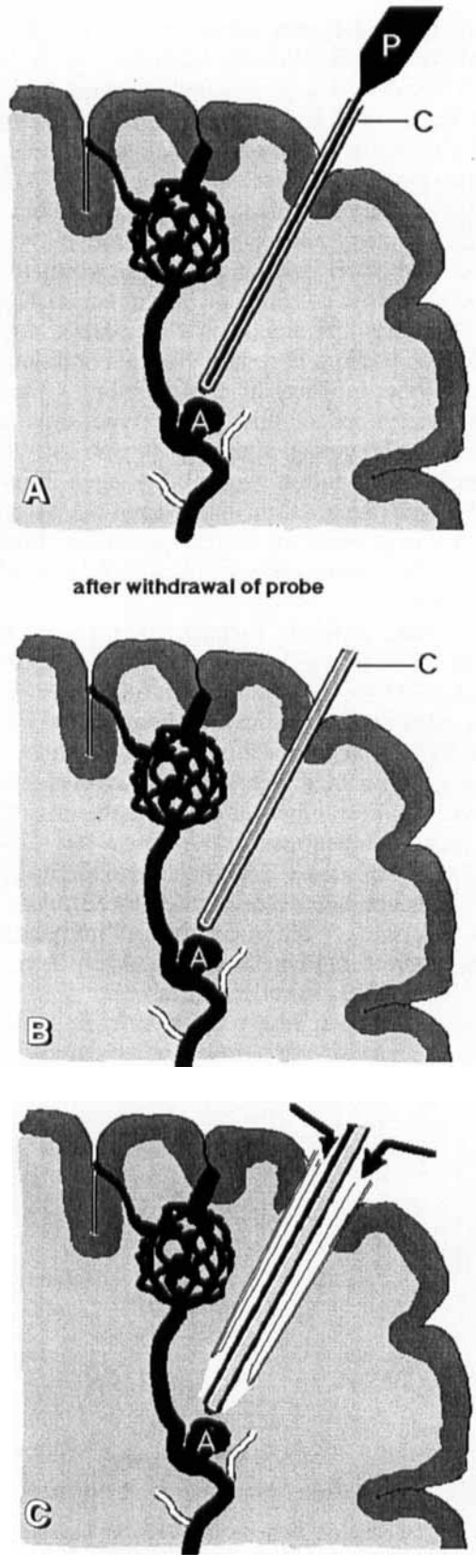


Fig. 4. Modified viewing wand probe for placement of the guiding catheter.



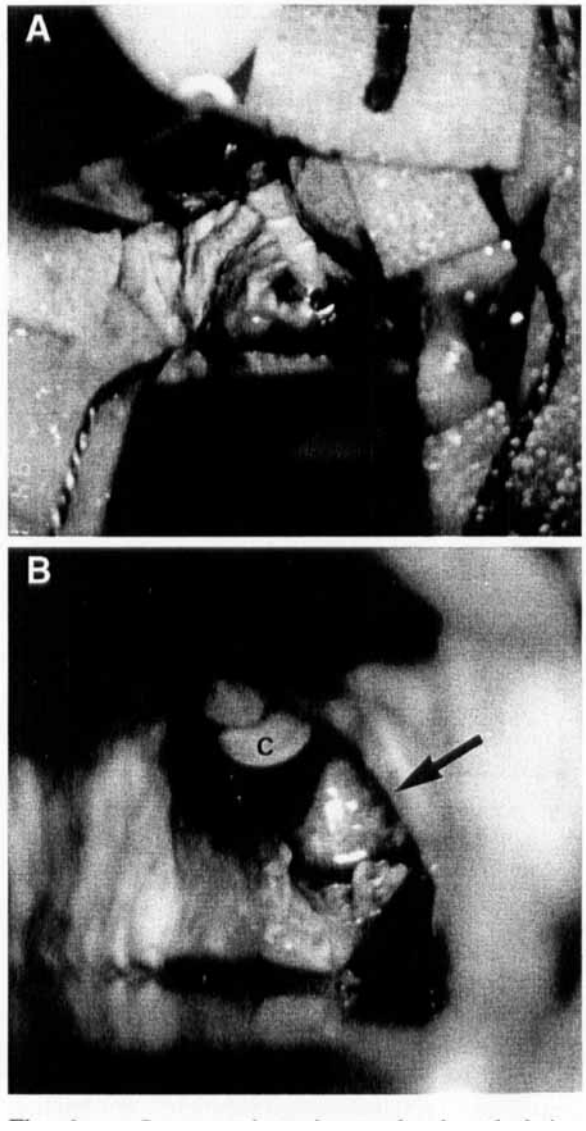


Fig. 6. **a:** Intraoperative microscopic view depicting the catheter introduced through image guided navigation. **b:** Tip of the catheter (c) pointing exactly to the "pedicle aneurysm" (arrow).

AVMs was successfully applied for two patients by Guiot and coworkers[4] more than 35 years ago, which was followed in 1964 by Riechert and Mundinger's[10] description of stereotaxic ligation of feeding arteries in four patients with AVMs. Later, Kandel and Peresedov[6] reported on stereotaxic aneurysm clipping in three patients and

Fig. 5. Schematic depiction of catheter placement with use of the navigational probe. A, "pedicle aneurysm"; C, catheter; P, probe.

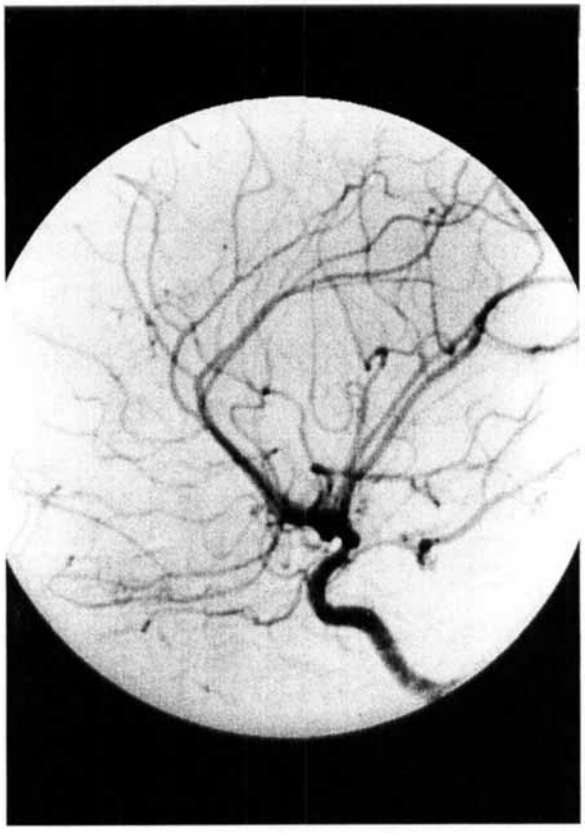


Fig. 7. Postoperative angiography revealing complete excision of both the AVM and the associated aneurysm.

AVM feeding artery ligation in five patients. Modern microsurgery, as well as interventional neuroradiology, made these techniques a matter of history. Nowadays, however, frameless stereotaxy can support open microneurosurgery during exposure and excision of such atypically located vascular lesions such as the feeding artery aneurysm described herein.

However, image guided exposure of the pedicle aneurysm has to be performed in conjunction with consideration of the unavoidable shift of intracerebral targets after release of cerebrospinal fluid and the insertion of spatulae. This fundamental shortcoming of image guided neurosurgery in not being a real-time method can be compensated for by defining the trajectory to the lesion immediately after the opening of the dura. In our experience, the open image directed insertion of a catheter as a guide that marks the trajectory is a reliable and a practicable method that we now often use to expose lesions within deeper brain areas or to define the resection margins of intraaxial tumors prior to resection. In a similar manner, Sisti et al.[11] described stereotactic guidance for catheter placement to localize small and deep-seated angiomas, as Esposito and coworkers[3] did for microsurgical excision of deep-seated cavernomas. Image directed microsurgery was used by Takizawa et al.[12] for clipping posterior communicating artery (PCA) aneurysms in two patients. Until now, computer-assisted microsurgical navigation for the excision of an AVM-associated aneurysm in a child has not been described.

CONCLUSIONS

Pedicle aneurysms are a rare complication of AVMs in children and carry a high risk of hemorrhage. Therefore, these lesions should be excised whenever possible, even when associated with an AVM that would not normally be considered for surgical treatment. Image directed neuronavigation provides a useful tool for the precise localization and safe elimination of these atypically located aneurysms, which are otherwise difficult to expose and carry a high risk surgical morbidity. To compensate for shifting of the brain phenomena during surgery, precise image guidance is achieved by inserting a catheter as a guide that marks the trajectory towards the lesion.

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