Published in final edited form as:

J Neurosurg Pediatr. 2008 April ; 1(4): 316–319. doi:10.3171/PED/2008/1/4/316.

Recurrent intracerebral hemorrhage from a cerebral arteriovenous malformation undetected by repeated non-invasive neuroimaging in a 4-year-old boy

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Abstract

We report a case of a 4-year-old boy with a spontaneous intracerebral hemorrhage related to an arteriovenous malformation (AVM) that was not found with good quality magnetic resonance imaging and angiography (MRI/MRA) performed serially in the acute phase and at 2 and 7 months of follow-up. Digital subtraction angiography identified the peripheral AVM when the patient re-bled one year after his initial presentation. This case illustrates the need for a complete diagnostic evaluation including conventional angiography in cases of idiopathic intracerebral hemorrhage in children.

Keywords

Intracerebral Hemorrhage; Child; Evaluation

Spontaneous intracerebral hemorrhage (ICH) is almost as prevalent as ischemic stroke in children.⁹ Taken together, ischemic and hemorrhagic stroke are as common as brain tumor in the pediatric population.¹² Unfortunately, no clear guidelines exist to suggest the appropriate diagnostic evaluation of children with ICH. Adult guidelines may not be applicable since the most frequent causes of adult ICH, *i.e.*, hypertension and amyloid angiopathy, are rare in children.^{2, 8} Based on case series data, the most common causes of ICH in children are arteriovenous malformations (AVM), hematological abnormalities, brain tumors, and cavernous malformations,^{1, 17, 18, 23} while cerebral aneurysm rupture is rare.^{3, 11, 15, 17}

For these reasons, the diagnostic evaluation of ICH in childhood varies with the individual preferences and experience of treating physicians and with institutional policies. Typically, the first test obtained in a child with suspicion of ICH is non-enhanced computed tomography (CT) of the head. When ICH is recognized, subsequent testing may include contrast-enhanced CT, CT angiography (CTA), magnetic resonance imaging and angiography (MRI/MRA), catheter cerebral angiography, and screening for bleeding disorders or coagulopathy. Currently, non-invasive neuroimaging is often considered sufficient¹⁴ and preferred to catheter or digital

subtraction angiography (DSA). We report a case that illustrates the importance of a complete diagnostic evaluation in children presenting with ICH of undetermined origin.

CASE REPORT

A 4-year-old boy with no significant past medical history presented to the emergency department with headache, nausea, and vomiting. His blood pressure was higher than the 95th percentile for his age at 131/63 mmHg,²⁴ his heart rate was 87, and he was afebrile. He had no focal neurologic deficits, his Glasgow Coma Scale was 15. A non-enhanced CT scan revealed a large right temporal-parietal ICH, with a 7-mm midline shift, and some intraventricular blood (Fig. 1). Brain MRI and MRA obtained less than 24 hours after admission did not reveal a source for the hemorrhage. Basic hematological testing was normal, including platelet count, prothrombin time, and partial thromboplastin time. His liver functions were also unremarkable. Additional studies including factor VII, factor VIII, and factor IX activity, the von Willebrand antigen, and ristocetin cofactor were normal. There was initial concern for unreported head trauma because the child's parents had a history of substance abuse and there was an open Child Protective Services case for child neglect. All evaluations for occult fractures and other injuries were negative. The history of spontaneously developing headache, nausea, and vomiting was consistent throughout the hospital stay.

The patient was discharged home neurologically intact. He had a follow up CT scan two weeks later that showed no evidence of hydrocephalus. Follow up brain MRI and MRA with contrast administration were obtained two months after the ICH. Both studies were repeated one more time, seven months after presentation (Fig. 2). At this time, the hematoma had resolved, and no etiology for the hemorrhage was identified. In particular, there was no evidence of intracranial vascular malformations. The patient remained neurologically intact with no further symptoms.

The patient was admitted again one year and five days after the initial episode for recurrent ICH. The new lesion was located immediately posterior to the previous site of hemorrhage. Four-vessel DSA was obtained, which revealed a right parietal AVM, fed by the right middle cerebral artery (Fig. 3). The location of the AVM and the superficial pattern of venous drainage made him a good candidate for surgical treatment,⁶ which was performed approximately eight weeks after the second hemorrhage.

DISCUSSION

Intracerebral hemorrhages (ICH) occur in children with an incidence estimated at 0.8 per 100,000 person-years,⁹ which is just less than half the incidence of brain tumors in the same age group.¹² Despite the significance of this number, no clear guidelines have been proposed for the evaluation of spontaneous ICH in the pediatric population. The diagnostic work up of children with an ICH varies greatly with the experience and preferences of the physicians and institutions responsible for their care. In fact, several case series suggest that no etiology can be found up to 53% of children presenting with ICH.^{1, 3, 25–27}

We believe that the diagnostic means used to evaluate children with an ICH influence this high percentage of undiagnosed etiologies. We report the observation of a 4-year-old boy presenting with two spontaneous intracerebral hemorrhages that occurred approximately one year apart. In this child, neither the initial non-invasive imaging work up nor several follow-up studies were able to detect the cause of the hemorrhage. After the second hemorrhage, DSA was obtained and documented a right parietal AVM. It is reasonable to argue that accurate diagnosis after the first bleed would have prompted earlier therapy, and most likely prevented the second episode. The annual rate of rupture of cerebral AVMs ranges between 2% and 4%.^{7, 19, 20}

However, this risk may increase to 17% during the year following an initial hemorrhage.¹⁰ AVM-related hemorrhages are often incorrectly viewed as more benign than hemorrhages resulting from a ruptured aneurysm. In fact, AVM ruptures tend to result in more neurological disability due to the high occurrence of lobar hematomas. The mortality associated with a first AVM rupture ranges between 17.6% and 40.5%, but can be as high as 66.7% for posterior fossa lesions.²¹ It is therefore important to prevent the occurrence of recurrent hemorrhages in children presenting with ICH from an AVM when possible. The progress made in multimodality therapy of cerebral AVMs, using a combination of endovascular, surgical and radiosurgical techniques, can help achieve this goal. It remains, however, that the initial step in the management of cerebral AVMs lies in the early and accurate diagnosis of the lesion by neuroimaging.

Recently several reports comparing MRA and DSA in small numbers of children with stroke have been published.^{14, 16, 22} Husson and Lasjaunias looked at children with ischemic stroke and compared contrast angiography and MRA in detecting arterial lesions.¹³ They found anomalies detected by angiography but not by MRA in 34% of their patients. Particular difficulty was apparent in visualizing medium and small sized branches of the middle cerebral artery (MCA). These authors concluded that conventional angiography “remains the reference examination when therapeutic decisions require a confident diagnosis.” One paper specifically looked at children with spontaneous intraparenchymal hemorrhage.¹⁶ The authors found that the diagnostic yield of the combination of MRI, MRA and MR venography (MRV) to be 66%, i.e., these studies established an etiology for the hemorrhage in 25 of 38 children. Conventional cerebral angiography established a diagnosis in 11 of 18 children (61%). Only nine children, however, had both MRA and conventional angiography; conventional angiography was pursued because MRI and MRA were not helpful. The authors note that in two of these nine children (22%), MRI/MRA was falsely negative. One child had a mycotic aneurysm obscured by T1 shine through on MRI. The other had a peripheral AVM. These publications serve to reinforce the point that when non-invasive studies are unrevealing, DSA should be strongly considered in children with spontaneous ICH.

We believe that the observation reported here of a ruptured cerebral AVM undetected by repeated noninvasive neuroimaging helps make the case that conventional angiography, which remains the gold standard test for neurovascular imaging,⁵ should be considered in children presenting with an ICH of unclear etiology. The invasive nature of conventional angiography often deters physicians from ordering it for their pediatric patients. The main concern remains the risk of intraprocedural adverse events, principally the occurrence of a stroke. However, diagnostic cerebral angiography in children has been shown to be safe, in fact safer than in adult patients, more than twenty-five years ago by Pettersson and co-authors. In their large series of 3,731 pediatric angiograms, they found a 0.4% incidence of distal vessel embolization (14 patients), with only one instance of transient neurological symptoms.²¹ Since then, major improvements have been made in angiography equipments and devices, as well as in contrast agents, allowing for a recent pediatric angiography series to show even lower complication rates.⁴ Prospectively analyzing 241 consecutive studies performed at a single institution, these authors found intraprocedural and postprocedural complication rates of 0.0% and 0.4%, respectively.

CONCLUSIONS

The indication for any diagnostic test, in particular when invasive, must be carefully weighed. We believe, however, that false assumptions about the risk of procedural complications should not deny pediatric patients the benefit of a conventional angiogram, when this study is clinically indicated.

Acknowledgments

Financial Support: Dr. Jordan received funding from NIH NCRR K12 017627

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Figure 1.
Head CT at initial presentation showing a right temporal-parietal intracerebral hemorrhage with intraventricular extension.

Figure 2.

The 7-month follow-up MR study documents healing of the hemorrhagic site, with a residual slit-like cavity without mass effect (A, B). MR angiography (C) did not reveal the arteriovenous malformation.

Figure 3.

Digital subtraction angiography (DSA) obtained after the second hemorrhage reveals an arteriovenous malformation nidus in the right temporal-parietal region, supplied by the posterior division of the right middle cerebral artery (A). The venous drainage is superficial via a cortical vein (the lesser anastomotic vein of Trolard) (B).