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CASE REPORT

Radiation-induced intracranial aneurysm presenting with acute hemorrhage in a child treated for medulloblastoma

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Abstract

Radiation-associated aneurysms are rare, difficult to treat, and associated with high morbidity and mortality when ruptured, compared with aneurysms unrelated to radiation treatment. We present a 16-year-old patient with a radiation-induced intracranial aneurysm arising from the left posterior inferior cerebellar artery (PICA), 10 years following radiotherapy for medulloblastoma. The patient successfully underwent endovascular coil embolization of the parent artery across the neck of the aneurysm. CT angiography and MRI in the days following the procedure demonstrated maintained flow in the anterior and lateral medullary PICA segments with no brainstem infarct.

Keywords Medulloblastoma · Radiation · Aneurysm · Embolization

Introduction

Following surgical resection, the treatment of medulloblastoma is dependent on clinical risk assessment and the child's age (above or below 3 years of age). For children above 3 years of age, external beam radiation to the brain and spine with tumor boost is combined with multidrug chemotherapy. Compared with average-risk patients (< 1.5 cm^2 post-surgical residual tumor, no metastasis at diagnosis), high-risk patients (> 1.5 cm^2 post-surgical residual tumor or metastasis at diagnosis) are treated with increased cranio-spinal irradiation of up to 39.6 G [1]. Long-term complications of radiation therapy are well-described and include neurocognitive dysfunction, secondary cancers, and hearing loss. Radiation-induced vasculopathy and strokes are rare [2].

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We present a case of radiation-induced ruptured aneurysm of the posterior inferior cerebellar (PICA) artery in a child with a history of medulloblastoma.

Case report

A 16-year-old male presented acutely with blurred vision, emesis, frontal and occipital headache, and transient loss of consciousness. Eleven years prior, he underwent a suboccipital craniotomy and gross total resection of a group 4 medulloblastoma, followed by adjuvant therapy as per the SJMB03 protocol with radiation (23.4-Gy craniospinal irradiation with tumor bed boost to 55.8 Gy) and four cycles of cisplatin-based chemotherapy. After completion of therapy, his clinical course was complicated by prolonged neutropenia, transient posterior fossa syndrome, hearing loss, and growth hormone deficiency. Upon most recent presentation, an urgent head CT revealed Fisher grade 4 subarachnoid hemorrhage (Fig. 1a) with early hydrocephalus. CT angiography (CTA) demonstrated a multilobulated 6 × 6 mm aneurysm arising from the telovelotonsillar segment of the left PICA, pointing into the fourth ventricle. A review of his imaging history revealed stability of postsurgical findings on serial MRI over 10 years following treatment, with a new 2-mm saccular prominence on the left PICA on MRI performed 10 months before the current presentation (Fig. 1b, c).

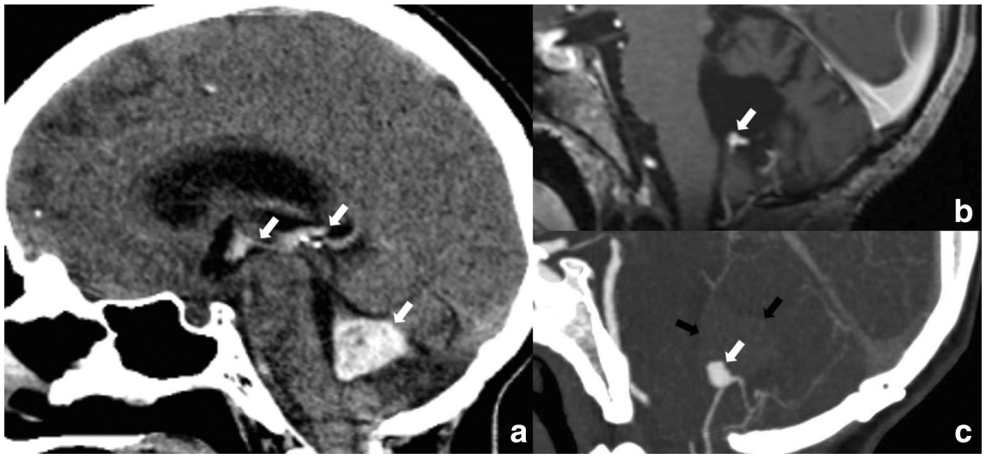

Fig. 1 Intraventricular hemorrhage from ruptured PICA aneurysm. **a** Sagittal reformat from the CT head at presentation showing third and fourth ventricular hemorrhage (white arrows). **b** Post-gadolinium sagittal 3D T1-WI showing a 2-mm focal dilatation 10 months prior to presentation. Serial MRI prior to this had a normal appearance. **c** Maximum intensity projection from CT-A at presentation showing enlargement to a 6-mm aneurysm (white arrow) with intraventricular hemorrhage (black arrows)

Emergent insertion of an external ventricular drain was performed, followed by transfer to the interventional suite for catheter angiography. Angiography confirmed an aneurysm arising from the cranial loop of the telovelotonsillar segment of the left PICA. 3D rotational angiography with cone-beam CTA reconstruction allowed detailed assessment of angioanatomy, which suggested focal luminal narrowing and discontinuity at the site of the outpouching, suggesting a pseudoaneurysm. Right vertebral injection showed a hypoplastic right PICA, but there was a dominant left anterior inferior cerebellar artery. A decision was made to sacrifice the parent artery. This was performed using five detachable coils

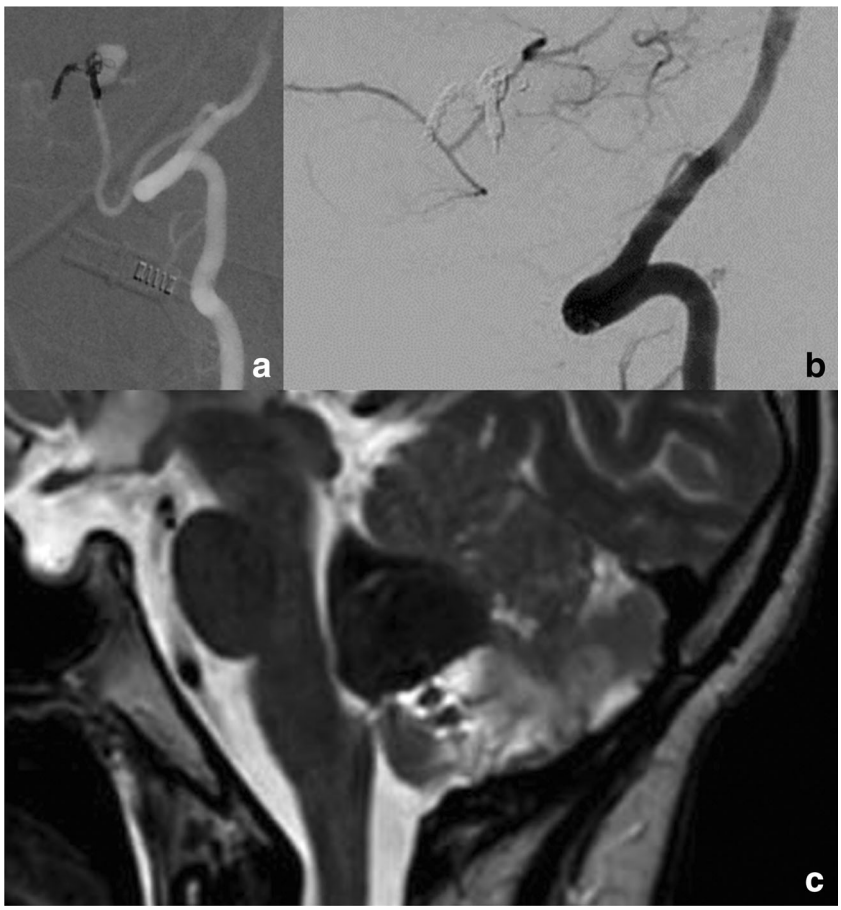

Fig. 2 Endovascular treatment. **a** Roadmap overlay from digital subtraction angiography showing parent artery sacrifice with coils. **b** Post-coiling angiogram showing occluded aneurysm with maintained flow in the anterior and lateral PICA segments. **c** Sagittal T2 MRI performed 2 days later showing normal signal of the brainstem and acute cerebellar infarct

(Penumbra SMART coils) across the neck of the aneurysm, achieving complete occlusion (Fig. 2a, b). CTA and MRI in the following days showed maintained flow in the anterior and lateral medullary PICA segments with no brainstem infarct, and expected ischemia limited to the postero-inferior left cerebellar parenchyma (Fig. 2c).

Discussion

Children account for less than 5% of all intracranial aneurysms, most commonly related to dissection, trauma, infection, or arteriopathies [3]. We report a rare occurrence of delayed formation of an intracranial aneurysm in a child following posterior fossa radiotherapy for medulloblastoma. To our knowledge, there are only nine previous cases of intracranial radiation-induced aneurysm reported in children [4].

Aneurysms in previously irradiated fields are believed to be particularly fragile with higher tendency to rupture than aneurysms unrelated to radiotherapy. In addition, vessels in the anterior circulation appear to be more radiation sensitive to aneurysm formation than those in the posterior circulation [4]. It has been hypothesized that histologic changes secondary to radiation including fibrosis, medial necrosis, and endothelial inflammation degrade the integrity of the vessel wall [5]. Continued shear stress of blood flow can eventually lead either to aneurysmal dilatation, or to rupture at the weakest point with pseudoaneurysm formation. This chronic process is reflected by the long median lag time between radiation and aneurysm diagnosis of up to 10 years (SD 9 years) [5]. Although the likelihood of intracranial aneurysm formation is associated with higher doses of radiotherapy, doses have not been shown to affect latency of presentation [6]. Follow-up MRI and 3D-MRA should be performed in long-term surviving patients who have undergone radiotherapy and whenever there are vessels in the surgical bed. We recommend closer follow-up and/or endovascular treatment when aneurysm formation is suspected.

Data availability Internal hospital network

Compliance with ethical standards

Conflict of interest None

Ethics approval Not applicable (case report)

Consent to participate Not applicable

Consent for publication Obtained from the patient's parent

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