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Case Report

Intracranial aneurysm formation after radiotherapy for medulloblastoma

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Abstract

Background: The development of an intracranial aneurysm after radiotherapy is rare but secondary effect of cranial irradiation in a primary disease treatment.

Case Description: The patient was a 17-year-old male adolescent who was diagnosed as having a posterior fossa medulloblastoma when he was 8 years old. He had undergone tumor resection with radiotherapy and chemotherapy. A distal posterior inferior cerebellar artery aneurysm was identified by magnetic resonance imaging 8 years after radiotherapy and grew rapidly throughout the next 1 year. The patient underwent microsurgical clipping and was discharged without deficit.

Conclusion: This experience demonstrates that physicians caring for patients who have undergone intracranial radiotherapy should carefully consider the possibility of an aneurysmal formation when conducting follow-up imaging.

Key Words: Chemotherapy, intracerebral aneurysm, medulloblastoma, radiation induced

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INTRODUCTION

Radiotherapy is increasingly being performed for many intracerebral lesions. The benefits have been proven, however, negative consequences have also been reported.[6-8] The later vascular complications include intracerebral hemorrhage, infarction, atherosclerosis, cavernous malformation, development of moyamoya syndrome, and aneurysmal formation.[4] In particular, the incidence and natural history of these aneurysms are not well understood.[1,9] Here, we present the case of a man in whom a distal right posterior inferior cerebellar artery (PICA) aneurysm developed 8 years after radiotherapy for medulloblastoma treated during childhood.

CASE REPORT

A 17-year-old man was found to have a posterior fossa medulloblastoma when he was 8 years old [Figure 1a]. He had undergone gross-total tumor resection without complication followed by craniospinal radiotherapy (total dose, 55.8 Gy) [Figure 1b] and combination chemotherapy with ifosfamide, cisplatin, and etoposide as adjuvant treatment. He was monitored throughout the next 9 years with serial magnetic resonance (MR) imaging, and no new neurological deficit was found [Figure 1c].

At 17 years of age, Gd-enhanced T1-weighted MR image revealed a 5-mm hyperintense nodule on the continuous

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wall of the resected cavity [Figure 1d]. Retrospectively, the same lesion was detected as a 2-mm hyperintense nodule 1 year previously. Three-dimensional computed tomographic angiography (3D-CTA) revealed that the nodule was an PICA aneurysm [Figure 2a and b]. A digital subtraction angiogram (DSA) demonstrated an irregular 5.2-mm saccular, multilobular aneurysm arising from the right PICA between the caudal and cranial loops [Figure 2c and d]. This was thought to be a radiation-induced aneurysm because the patient was young, the location was unusual, the shape was irregular, and the aneurysm occurred in the previously irradiated area.

The patient underwent suboccipital craniotomy. The wall of the parent artery and aneurysm was normal, and the neck of saccular aneurysm was clipped using a fenestrated L-shaped clip to maintain the parent-artery flow [Figure 3]. An intraoperative indocyanine green angiogram showed excellent flow through the parent artery, as well as perforator branches to the brainstem. The aneurysmal dome was buried in the brainstem, and we could not perform resection for histological evaluation. Postoperative 3D-CTA revealed no residual aneurysm, and MR image showed no ischemic complication. He was discharged without deficit.

DISCUSSION

Ionizing radiation has been linked to certain cerebrovascular pathologies, including radiation-induced vasculopathy, atherosclerotic vascular changes, vascular stenosis and occlusion, intracerebral hemorrhage, cavernous malformation, and aneurysmal formation.[4,6-8] Most reported cases involved arterial stenosis or occlusion, however, 47 patients with 70 intracranial aneurysms in irradiation fields were reported, including only 6 cases irradiated for medulloblastoma.[1,5,7,9,10] Of the reported aneurysms, 69% occurred in the anterior circulation, 27% in the posterior circulation, and 4% were associated with arteriovenous malformations.[7] As for aneurysmal morphology, the ratios of saccular, fusiform, and pseudoaneurysms were 83, 9, and 9%, respectively.

The pathophysiological mechanism of radiation-induced aneurysms is likely to resemble that of radiation-induced vasculopathy, in which initial endothelial injury caused by radiation results in aneurysmal change.[9,11] Although no evident pathognomonic features have been described, similar histological features have been reported by different authors. These findings include fibrosis, necrosis, atherosclerotic changes, and inflammation of the aneurysmal wall, affecting mostly the media and intima. In our case, we could not perform a histological examination; however, in general, radiation-induced

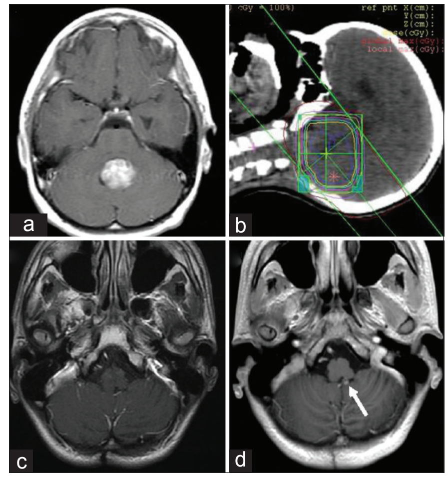

Figure 1: Primary tumor and follow-up magnetic resonance imaging. (a) Gross-total removal of the medulloblastoma. (b) Radiotherapy at 32.4 Gy for the posterior fossa and 23.4 Gy for the whole brain and spine; consequently, 55.8 Gy was irradiated around the tumor cavity. (c) Image obtained 7 years later showing no evident aneurysmal formation. (d) The 5-mm hyperintense nodule (arrow) on the continuous wall of the resected cavity discovered 9 years later

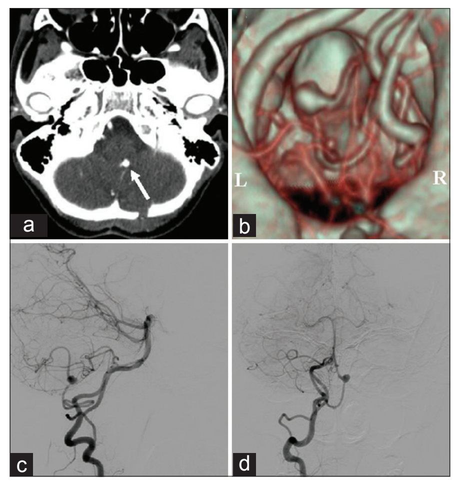

Figure 2: Radiological findings of aneurysm. (a, b) A three-dimensional computed tomographic angiogram showing that the nodule was a right posterior inferior cerebellar artery aneurysm (arrow). R, right and L, left. (c) Lateral and (d) anteroposterior digital subtraction angiographic views confirming the fenestrated vertebral artery and the aneurysm between the infratonsillar and supratonsillar loops

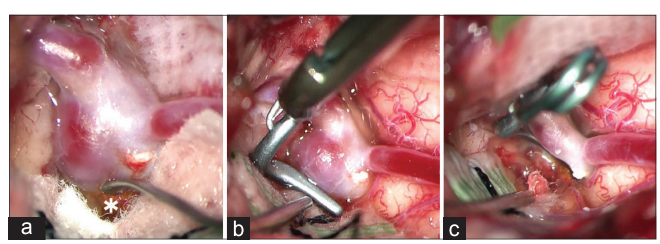

Figure 3: Intraoperative findings. (a) The aneurysmal dome buried in the medulla oblongata (asterisk). (b, c) The aneurysm neck was clipped to keep the parent artery flow

aneurysms belong to one or a combination of these four categories or have more non-classifiable findings.

Regarding radiation-induced vasculopathy, the Child Cancer Survivor Study reported that tumor relapse, cranial radiotherapy, and concurrent alkylating chemotherapy with radiotherapy are risk factors of stroke.[2] Moreover, glioma showed a trend toward protection against neurovascular events, however, primitive neuroectodermal tumor showed a trend toward an increased risk.[3] This is the first case of a radiation-induced aneurysm after radiotherapy with chemotherapy, including an alkylating drug for medulloblastoma, although it is uncertain whether surgical vascular injury, radiotherapy, or chemotherapy alone or in combination were the likely culprits. Further studies are needed to clarify the relationship between chemotherapy, primary tumor, and aneurysmal formation in irradiated fields.

Radiation-induced aneurysms are considered more fragile. The reported frequency of rupture was significantly greater than that in nonradiation-induced aneurysms; 55% presented with some form of hemorrhage and only 13% presented with incidental hemorrhage.[7] On the other hand, this may be due to reporting bias that may have occurred because of the high possibility of undetected and unruptured radiation-induced aneurysms in many patients. However, in our case, an aneurysm formation after radiotherapy occurred after 8 years and enlarged rapidly in 1 year. This is different from the natural course of typical saccular aneurysm and might indicate that radiation-induced aneurysms are prone to rupture.

In our case, 3D-CTA could reveal an PICA aneurysm clearly. However, we additionally performed DSA to consider how to treat the aneurysm. Owing to the irregular morphology of the radiation-induced aneurysms, detailed evaluation were essential to decide the treatment among neck clipping, coil embolization, proximal occlusion, and aneurysmal trapping with or without bypass. This may suggest that 3D-CTA is sufficient to detect radiation-induced aneurysms, however, DSA is recommended to manage these unusual aneurysms.

Intracranial aneurysms in irradiated fields are rare but are an important secondary effect of cranial radiotherapy for a primary tumor. Careful attention should be paid on serial follow-up of possible vascular involvement in long-term surviving patients who have undergone radiotherapy.

CONCLUSION

We reported a case of radiation-induced distal PICA aneurysm after radiotherapy for medulloblastoma. Our case suggests aneurysmal formation following radiotherapy is a rare but potentially late delayed complication. Thus, careful follow-up of imaging including vascular analysis is necessary for long-term survivors with cranial irradiation.

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Conflicts of interest

There are no conflicts of interest.

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