De novo intracranial aneurysm formation after Gamma Knife radiosurgery for vestibular schwannoma

Case report

KEUN YOUNG PARK, M.D., JUNG YONG AHN, M.D., PH.D., JAE WHAN LEE, M.D., JONG HEE CHANG, M.D., AND SEUNG KON HUH, M.D., PH.D.

Department of Neurosurgery, Brain Research Institute, Yonsei University College of Medicine, Seoul, Republic of Korea

Vascular complications, including vessel occlusion and hemorrhage, can arise after radiosurgery; however, hemorrhage due to a ruptured de novo aneurysm after Gamma Knife radiosurgery (GKS) for tumor is extremely rare. To the authors’ knowledge, only a single case of de novo aneurysm formation after GKS for vestibular schwannoma has been previously reported. In this study, they describe their experience with the treatment of a 74-year-old woman with subarachnoid hemorrhage limited to the cerebellopontine cistern, who had undergone GKS for vestibular schwannoma 5 years earlier. Cerebral angiography demonstrated a left distal anterior inferior cerebellar artery aneurysm; coil embolization was attempted and failed. However, self-resolution of the aneurysm was revealed on follow-up angiography. (DOI: 10.3171/2008.9.JNS08860)

KEY WORDS • acoustic schwannoma • Gamma Knife radiosurgery • intracranial aneurysm • vascular complication • vestibular schwannoma

Gamma Knife surgery is an effective treatment option for long-term tumor control and complication avoidance in patients with VSs. Vascular complications of radiosurgery, including vessel occlusion or hemorrhage, are rare events which occur in only 1.1–2.3% of cases. Hemorrhagic presentations due to the rupture of a de novo aneurysm after GKS are extremely rare. To our knowledge, only 1 case of aneurysmal rupture after GKS for VS has been reported previously; however, there remains some uncertainty in this case because the authors did not perform angiography prior to radiosurgery. We present a case of SAH secondary to an AICA aneurysm, which was probably induced by GKS for VS.

Case Report

History and Operation. This 69-year-old woman presented to our institution with a 1-month history of left hearing impairment. Brain MR images demonstrated a well-enhanced mass of the left cerebellopontine angle, possibly implying the presence of a VS. Magnetic resonance angiography did not reveal any vascular abnormalities in the posterior circulation (Fig. 1), and the patient subsequently underwent GKS for a left VS in December 2003. The tumor margin was covered by the 50% isodose line, and 12 Gy was delivered to the margin. After GKS, follow-up MR images demonstrated internal tumor necrosis and a reduction in tumor volume.

Second Presentation. Five years after GKS, the patient presented again to our institution, this time with a sudden onset of severe headache, vomiting, and altered level of consciousness. On neurological examination the patient was drowsy but arousable. She was slightly confused but able to follow commands, her pupils were equal and reactive, and cranial nerve functions were normal with the exception of the preexisting hearing impairment. Routine laboratory testing showed no abnormalities, including coagulopathy.

Computed tomography scanning revealed a localized SAH around the cisterns of the posterior fossa (Fig. 2). Cerebral DSA was performed to determine the origin of the hemorrhage, and a tiny aneurysm of the left distal AICA measuring 3.3 × 2.6 mm was revealed (Fig. 3). There was no definite neck of the aneurysm, suggesting a pseudoaneurysm. We attempted endovascular treatment...
Aneurysm formation after radiosurgery

because a surgical approach was deemed challenging due to the necrotic tumor mass and post-GKS adhesions. However the acute angle of the AICA vasculature made it difficult to select an AICA orifice, and endovascular treatment failed. We suspected that thrombosis of the aneurysm resulting from irradiated vessel alterations would occur, and decided on conservative care for the patient. One month after endovascular treatment was attempted, follow-up DSA demonstrated self-occlusion of the aneurysm (Fig. 4). The patient recovered and was discharged without any neurological deficit.

Discussion

Several authors have reported cases of conventional radiation-induced intracranial aneurysms with subsequent rupture. However, in our literature review, we found only 1 case of GKS-induced de novo intracranial aneurysm. Although no angiography was performed prior to GKS, and therefore the existence of the aneurysm prior to GKS cannot be excluded, Takao et al. present a
reasonably convincing case that the pseudoaneurysm was causally linked to treatment. Our case is the first proven case of aneurysmal SAH after GKS.

Radiotherapy-induced vascular disease primarily occurs from early injury of the endothelial cells of small vessels, especially capillaries. Capillaries undergo pinocytosis and hypertrophic changes correlating with endothelial proliferation and luminal narrowing. Various changes occur in the small arteries, including fibrosis and thrombosis, thickening of the smooth-muscle layer, lymphocytic infiltration, thickening of the vessel wall with fibrinous thrombosis, and leakage of fibrin into the surrounding tissue. However, large arteries are less frequently injured than small or medium-sized arteries, and sometimes incomplete and segmented endothelial lining will contribute to aneurysm formation.

The literature regarding pathophysiological processes of radiosurgery is sparse, and to date there have been no experimental studies elucidating the mechanism underlying aneurysm formation associated with low-dose radiosurgery. In our patient, the distal AICA aneurysm developed within the irradiated field. A retrospective review of the treatment plan and the findings on cerebral DSA permits speculation that the AICA aneurysm existed at a site near or adherent to the tumor wall. Moreover, the ruptured aneurysm in our patient was not located at the branching site, but rather on the wall of the distal AICA. Radiation-induced aneurysms originate directly from the arterial wall rather than from a branching site as in a saccular aneurysm, and doses as low as 5–9 Gy may be sufficient to induce changes in normal vessels. These findings suggest that GKS was responsible for the distal AICA aneurysm formation; however, it is difficult to determine which factors or circumstances led to aneurysm formation in our patient based on only a single case report.

Which treatment modality is most effective in the treatment of this type of aneurysm? Endovascular treatment is preferable to open surgery in cases of large tumor masses and expected brain swelling. However, the aneurysm is sometimes not large enough to be treated by coil, and the irradiated parent vessel may have thrombus, intimal thickening, and necrosis. These vessel alterations could contribute to fatal complications such as embolization, parent artery rupture, or ischemia. If surgery is a reasonable option, wide exposure should be obtained to prevent complications. In our case, the aneurysm fortunately occluded itself; however, conservative care is not the best choice in most aneurysms due to the risk of rebleeding.

Conclusions

Aneurysm formation after GKS is a very rare, but potentially fatal complication; neurosurgeons should therefore be aware of its possibility. A focal vasculopathic effect of radiation on the vessel wall could have led to aneurysm formation.

Disclaimer

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

References