# Gamma knife radiosurgery for brainstem cavernous malformation

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## Case series

Forty five patients (14 males, 31 females) were treated with GKS for s-BSCM from January 1998 to December 2011. All patients were followed up for more than 5 years and their clinical data were analyzed retrospectively. All patients had a history of symptomatic bleeding once or more before GKS. These hemorrhages caused neurological deficits including cranial nerve deficits, hemiparesis, hemisensory deficits, spasticity, or chorea. The mean target volume of s-BSCM was 1.82 cm3 and the median prescribed marginal dose of radiation was 13 Gy. The mean clinical and imaging follow-up period was 9.31 years (range, 5.1 - 19.4 years).

The 45 patients had 69 hemorrhagic events before GKS. During follow-up period after GKS, 35 patients had no hemorrhagic event, six patients had one episode of symptomatic hemorrhage, and four patients had two episodes. The calculated annual hemorrhage rate was 40.06% at pre-GKS, 3.3% at 2 years after GKS, 1.48% at 5 years after GKS, and 4.64% at >5 years after GKS. In this study of 45 patients, symptomatic radiation-induced complications developed in only one patients (2.2%). No patients had died at the last follow-up.

GKS for s-BSCM is safe and effective alternative to surgical resection for reducing the rate of recurrent hemorrhage. Because the annual hemorrhage rate increases more than 5 years after GKS, clinicians should monitor patients closely to determine their subsequent treatment [1)]

### 2016

All patients who underwent GKS for the treatment of a hemorrhagic brainstem CM(s) in the Department of Neurosurgery, Lille University Hospital, CHU Lille, Université de Lille, Lille, France. between January 2007 and December 2012. The GKS was privileged when the surgical procedure was evaluated as very risky. The mean dose of radiation was 14.8 Gy, and the mean target volume was 0.282 cm3. All patients participated in a scheduled clinical follow-up. The posttreatment MRI was performed after 6 months and after 1 year, and then all patients had an annual MRI follow-up.

There were 19 patients with a mean age of 36.7 years. The mean follow-up period was 51.2 months. The annual hemorrhage rate (AHR) was 27.31% before GKS, 2.46% during the first 2 years following the GKS, and 2.46% after the first 2 years following the GKS. The decrease in AHR after GKS was significant ($p < 0.001$).

GKS should be suggested when the surgical procedure harbors a high risk of neurological morbidity in patients with brainstem CM. Compared to prior literature results, a lower dose than applied in this study could be discussed [2)].

Between January of 2009 and December of 2014, 43 patients (20 males and 23 females) with brainstem cavernous malformations were treated at the West China Hospital, Sichuan University, Gamma Knife Center. The mean age of these patients was 41.7 years. All of the patients experienced 1 or more episodes of symptomatic bleeding (range 1-4) before undergoing GKS. The mean volume of the malformations at the time of GKS was 442.1mm3, and the mean prescribed marginal radiation dose was 11.9Gy. The mean follow-up period after radiosurgery was 36 months (range 12-120 months).

Before GKS, 50 hemorrhages (1.2 per patient) were observed (25.0% annual hemorrhage rate). Three hemorrhages following GKS were observed within the first 2 years (3.92% annual hemorrhage rate), and 1 hemorrhage was observed in the period after the first 2 years (1.85% annual hemorrhage rate). In this study of 43 patients, new neurological deficits developed in only 1 patient (2.32%; permanent paresthesia on the left side of the face and the right lower limb of the patient). There were no deaths in this study.

GKS is a favorable alternative treatment for brainstem CMs. Using a low marginal dose treatment might reduce the rate of hemorrhage and radiation-induced complications [3)].

**2014**

From 1992 to 2011, 49 patients with brainstem CMs were treated with Gamma Knife radiosurgery (GKS). Lee et al., classified patients into two groups: Group A (n = 31), patients who underwent GKS for a CM following a single symptomatic bleed, and group B (n = 18), patients who underwent GKS for a CM following two or more symptomatic bleeds. The mean marginal dose of radiation was 13.1 Gy (range 9.0-16.8 Gy): 12.8 Gy in group A and 13.7 Gy in group B. The mean follow-up period was 64.0 months (range 1-171 months).

In group A, the annual hemorrhage rate (AHR) following GKS was 7.06 % within the first 2 years and 2.03 % after 2 years. In group B, four patients (22.2 %) developed new or worsening neurologic deterioration as a result of repeat hemorrhages. In group B, the AHR was 38.36 % prior to GKS, 9.84 % within the first two years, and 1.50 % after two years. There was no statistically significant difference in the AHRs at each follow-up period after GKS between the two groups. Adverse radiation effects (AREs) developed in a total of four patients (8.2 %); among them, one patient (2.0 %) developed a permanent case of diplopia. No mortality occurred in this series.

In this study, GKS was demonstrated to be a safe and effective alternative treatment for brain stem CMs that resulted in a reduction in the AHR. Consequently, we suggest that even CM patients who have suffered only a single bleed should not be contraindicated for SRS [4)].

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39 patients (16 males, 23 females) were treated with GKS for BSCA from January 1997 to September 2012. Clinical data were analyzed retrospectively. The mean age was 41.5 years. All patients had a history of symptomatic bleeding once or more before performing GKS. Mean volume of BSCA was 1095.3mm(3) and median prescribed marginal dose was 13 Gy.

Mean follow-up period since diagnosis was 4.1 years. The number of hemorrhagic events between initial diagnosis and GKS was 5 over a total of 14.9 patients-years with annual hemorrhagic rate of 33.6%. Following GKS, there were five hemorrhagic events within the first 2 years (8.1%/year) and

two after the first 2 years (2.4%/year). The difference was not statistically significant. Neurologic status improved in 24 patients (61.5%), and stationary in eleven (28.2%). 4 patients (10.3%) experienced the exacerbation of symptoms at the last follow-up and none of them were related to the radiation injury. Significant volume reduction after GKS was observed in 24 patients (61.5%). Surgical excision was performed in one patient due to swelling and rebleeding after GKS. Age at presentation, sex, mass size of BSCA, and location, GKS dose did not affect post-GKS hemorrhage.

GKS for BSCA using relatively low marginal dose is safe and effective. Long-term prospective study is needed to confirm the optimal dose for BSCA [5].

1)
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