

# Gamma Knife® stereotactic radiosurgery for intracranial cavernous malformations

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## Introduction

Gamma Knife® stereotactic radiosurgery (GKSRS) can be an alternative to surgical resection for intracranial cavernous malformations with series data demonstrating a reduction in haemorrhagic risk with minimal morbidity rates. We evaluated longitudinal clinical outcomes in patients with intracranial cavernous malformations treated with GKSRS at our institution.

## Methods

A single institution retrospective review was performed on consecutive patients who received GKSRS for cavernous malformations between April 2016 to April 2020 who had at least one-year follow-up. All patients were discussed prior in a multidisciplinary forum with radiation oncology, neurosurgery and neuroradiology input. McNemar's test was used to test for differences in matched pair outcomes prior to and following GKSRS with an  $\alpha = 0.05$ . Logistic regression was used to assess relationships between explanatory variables and binary outcomes. Cox proportional hazards modelling assessed outcomes relating to time to post GKSRS adverse events.

## Results

35 patients with 39 cavernomas underwent GKSRS. Median age at treatment was 43 years (IQR 33.5-51). Median time of follow-up from GKSRS was 609 days (IQR 336-760). Median dose rate was 2.3 Gy/min (2.13-2.44). Median dose was 12.5Gy in single fraction (IQR 12-13). Median prescription isodose was 50%. Median treatment time was 25.5 minutes (IQR 21.2-33). The most

common site was brainstem (51.2%) followed by thalamus and basal ganglia (25.6%). Median volume of treated cavernous malformations were 0.42cc (IQR 21.2-33.4). 25.6% of patients had surgery prior to GK SRS. 25.6% of patients had a developmental venous anomaly and 20% of patients had a family history or background of bleeding disorders. There was no statistically significant difference in unadjusted cohort seizure incidence prior to GK SRS (30.7%) and after (17.9%) GK SRS ( $p=0.13$ ) [OR=0.167, 95%CI 0.004-1.37]. There was a significant reduction in matched annual bleed rate from prior to GKSRS (52.1%) compared to after treatment (12.3%) ( $p<0.0001$ ) [OR = 0.07, 95% 0.008-0.283]. Median time to bleeding post GKSRS in patients who had a post treatment bleed was 267.5 days (IQR 185-397).

There was no univariate or multivariate association between post SRS outcomes for seizure, bleed or neurological deficit associated with age, gender, dose, dose rate, treatment time or cavernoma volume.

reached on Kaplan Meier analysis. 23% of patients experienced resolution of their symptoms post SRS (Figure below). 1 patient (3%) with a brainstem lesion experienced long-term treatment related oedema causing persistent ipsilateral weakness and tremor.

## Conclusion

GKSRS is associated with a statistically significant reduction in matched annual bleed rate for intracranial cavernous malformations with an overall low rate of long-term adverse events and may present a non-invasive management option in appropriate patients. Whether haemorrhage control differs longitudinally with treatment compared to the natural history of untreated lesions warrants investigation in prospective studies.

