

# GAMMA KNIFE RADIOSURGERY FOR ARTERIOVENOUS MALFORMATIONS

Arteriovenous malformations (**AVM**) are vascular abnormalities with a prevalence of 18 per 100,000 people. The risk of a hemorrhage is approximately 2-4% per year and can result in significant neurological deficit in 30% of patients and death in 10% of patients. Management options for AVMs are focused on nidus obliteration to prevent the risk of hemorrhage and include: microsurgical resection, endovascular embolization and Gamma Knife stereotactic radiosurgery (GKSRS).

## Key Points

- GKSRS is a minimally invasive procedure that results in an average of 80% AVM obliteration within 3 to 5 years of radiosurgery.
- Improvements in headache and seizure activity are probable.
- There is a low morbidity and a rapid return to current activity.

## Gamma Knife Radiosurgery

GKSRS is an established and fundamental neurosurgical procedure with supporting evidence from several hundred peer reviewed publications. GKSRS has been utilized to treat over 86,987 patients worldwide with AVMs during the last 30 years, with 5,352 patients being treated in 2014 alone. In addition, the average cost of treatment over 12 months for GKSRS is 40% less than standard open surgical alternatives (1).

## Clinical Data

<b>AVM Obliteration:</b>	<p>Spetzler-Martin grade I-II AVMs managed with GKSRS have actuarial rates of total obliteration of 58% at 3 years, 90% at 5 years, and 93% at 10 years (2).</p> <p>Spetzler-Martin grade III AVMs after a single GKSRS procedure have actuarial rates of total obliteration of 48% at 3 years, 72% at 5 years, and 77% at 10 years (3).</p> <p>Studies in Europe and North America irrespective of AVM volume support obliteration rates in excess of 69% after a single GKSRS procedure (4,5)</p> <p>Large volume AVMs may require repeat treatment or a staged procedure to obtain obliteration.</p>
<b>Repeat GKSRS:</b>	<p>Patients that require a second Gamma Knife procedure have obliteration of their AVM in 35% at 3 years, 77% at 5 years, and 80% at 10 years (6).</p>
<b>Pediatrics:</b>	<p>Studies demonstrate a similar response rate in the pediatric population. As exemplified by publications from Pittsburgh (USA) and Sheffield (England) in which 72% and 71.3% of patients had obliteration after GKSRS (7,8).</p>
<b>Headaches:</b>	<p>70% of patients with vascular headaches (migraine) will have symptomatic relief ranging from partial to complete (9).</p>
<b>Seizures:</b>	<p>Multiple studies have demonstrated seizure free rates ranging from 60.0-76.7% regardless of obliteration status (10,11).</p>

## Risks

- Adverse reactions to radiosurgery treatment have been reported in 2.1-5.7% of cases based on location, dose and nidus volume (2,6).
- Delayed cyst formation has been identified in 1-3% of patients (2).

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- The risk of hemorrhage remains during the latency period between GKSRS and obliteration, but does not increase.

## Referral Recommendations

- All patients with a new or previously diagnosed AVM.
- Pediatric patients requiring radiosurgery should preferentially be referred for GKSRS due to a significantly higher radiation safety profile than other modalities.

## What your Patient should know

Gamma knife radiosurgery is a safe and proven effective procedure which remains the least invasive of surgical approaches for AVM management. This is a single session painless procedure, designed to slowly eliminate the blood flow through the AVM nidus over a median interval of 3 years. There are no incisions and the patient does NOT experience perceived radiation side effects such cognitive decline or hair loss. Patients do not require an anesthetic and can maintain their current medications.

## Radiosurgery Technique Protocol for AVM

1. Patients are treated in a single outpatient procedure.
2. A Leksell stereotactic frame is applied under mild sedation / local anaesthetic.
3. High-resolution axial imaging (MRI or CT) is obtained.
4. Diagnostic cerebral angiogram is performed.
5. Radiosurgery dose planning (18-24Gy margin dose) is created on the combined MRI and angiographic data emphasizing conformality and selectivity. The planning is based on multifactorial AVM characteristics including location and volume.
6. The patient is positioned in the Gamma Knife unit and the radiosurgery treatment is administered.
7. Patients are usually discharged within 2 hours of a completed procedure.
8. Clinical and imaging follow-up is requested at 6-months, 18 months and 36 months with intervals determined at that point based on AVM obliteration status. AVMs that remain patent can have repeat SRS procedures.

The expanded technical elements of this procedure are detailed in publications (3,10).

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