(GKRS) for Large Cerebral Arteriovenous Malformations (AVM): A single institution experience

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INTRODUCTION

Gamma knife radiosurgery (GKRS) is an established treatment for small (<3cm), or complex arteriovenous malformations (AVMs). However, large AVMs pose a significant therapeutic challenge due to their higher risk of post-radiosurgical complications, including hemorrhage, radiation necrosis, and perilesional edema. Single-fraction stereotactic radiosurgery (SRS) is often not feasible due to dose constraints imposed by adjacent eloquent brain structures. Fractionated GKRS with mask immobilization has emerged as a potential alternative, offering improved dose distribution and enhanced safety. This study presents our institution's experience with mask-based fractionated GKRS for large AVMs, analysing treatment outcomes and associated risks.

METHODS

- Between 2018 and 2023, 11 patients with large cerebral AVMs were treated with mask-based fractionated GKRS at our centre.
- Patient selection criteria included:
  i. AVMs deemed unsuitable for single-fraction GKRS due to size (>3 cm) or eloquent location.
  ii. Cases with prior embolization or microsurgical intervention were included if residual nidus persisted.
- Pre-treatment imaging magnetic resonance imaging (MRI) including gadolinium-enhanced axial T1 images with 1 mm slice thickness, and Computed Tomography angiography (CTA) were performed without a stereotactic frame and fused for accurate AVM nidus delineation.
- Treatment plans were done using Leksell Gamma Plan (LGP). Patients were immobilized using a thermoplastic mask and a simulation reference 6.3 mGy cone beam computed tomography (CBCT) was acquired to confirm positioning before treatment initiation.
- The median margin dose of 25 Gy (range: 20Gy-30Gy) at the 50% isodose line was delivered over 5 consecutive days in Leksell Gamma Knife Icon (Elekta A.B., Stockholm, Sweden).
- Patient motion was monitored real time by high-definition motion management (HDMM) system with 1 mm displacement threshold.

RESULTS

Table 1: Demographic and AVM Characteristics

Characteristic	N=11
Median Age, Years	32 years old (median)
Median Nidus size, cm	3.7 cm (median)
Spetzler Martin Grade	3 (median)
Eloquent location involvement	6 (54.5%)
Deep Venous drainage	6 (54.5%)

Table 2: Clinical and Radiological Outcomes

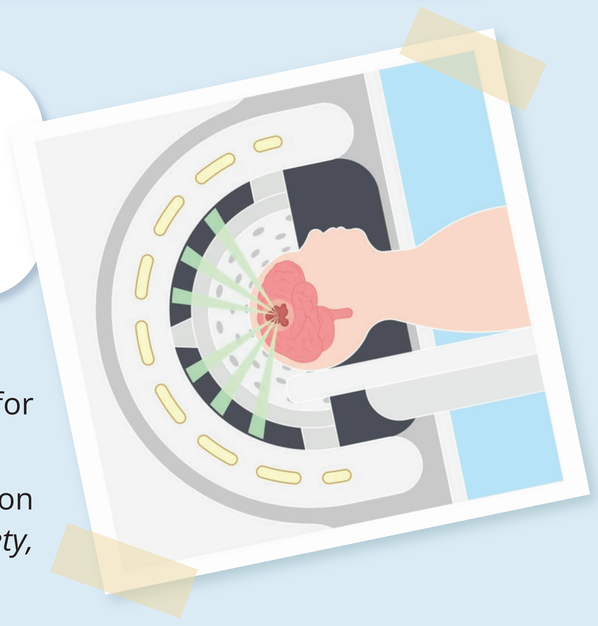
Characteristic	N=11
AVM obliteration outcomes	Complete obliteration was achieved in 4 patients (36%) over three years
Reduction in nidus size	Observed in 5 patients (45%)
Stable nidus size	Noted in 2 patients (18%)
Adverse events	No cases of post-treatment hemorrhage, radiation necrosis, or symptomatic perilesional edema were recorded

DISCUSSION

Mask-based fractionated GKRS has shown promising results for treating large AVMs. The fractionation approach helps reduce the risks of radiation-induced complications while maintaining efficacy. Our findings show favourable obliteration rates and minimal side effects. Compared to microsurgical resection, which carries a higher risk of procedural complications, and embolization, which often requires multiple sessions with incomplete obliteration, fractionated GKRS offers a safer and effective non-invasive alternative. The use of a thermoplastic mask improves patient comfort and allows for precise dose delivery while avoiding the constraints of a rigid stereotactic frame. Overall, this approach expands treatment options for patients with large AVMs, particularly those unsuitable for traditional single-fraction GKRS.

CONCLUSION

Mask-based GKRS offers significant advantages over frame-based techniques, including improved comfort and the ability to deliver fractionated doses. This approach expands the eligibility of patients for radiosurgical intervention, particularly those with large AVMs unsuitable for single-fraction radiosurgery.



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