Intraoperative Cs-131 Brachytherapy for Recurrent Brain Neoplasms: Initial Experience and Dosimetric Outcomes

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ABSTRACT

Purpose: Re-irradiation of brain neoplasms remains a significant clinical challenge. Resection without adjuvant re-irradiation is associated with a high local failure rate, whereas re-irradiation alone may improve local control but is associated with a high risk of radiation necrosis. Salvage resection combined with cesium-131 (Cs-131) brachytherapy may offer dosimetric and biologic advantages. The purpose of this study is to present our initial experience with Cs-131 cranial brachytherapy and to characterize post-operative dosimetry in patients with recurrent brain neoplasms.

Methods: Patients with recurrent glioblastoma (GBM), brain metastases or meningioma underwent surgical resection of the tumor, followed by intraoperative implantation of Cs-131 tiles. Preoperative estimation of the number of tiles required was performed using MiM Symphony software or a vendor-provided planning tool. Post-implant dosimetric analysis was performed using MiM software and post-operative CT and MRI. A prescription dose of 60 Gy was delivered to a depth of 5 mm from the resection cavity surface. Dosimetric parameters for the clinical target volume (CTV) and the brain tissue were collected.

Results: Twenty patients were treated between October 2023 and January 2026, including 11 GBM, 6 brain mets, and 3 meningioma. Mean tumor volume was 26.5±19.3 cm^3 (range: 7.1-78.7 cm^3. The average number of implanted tiles was 6.1±1.9. Mean CTV D90% was 58.7±15.4 Gy, and mean CTV V100% was 82.8±14.9%. The V10Gy to the brain ranged between 126.5 and 384.6 cc with a mean of 232.2±98.2 cc.

Conclusion: Cs-131 brachytherapy following salvage resection is a feasible re-irradiation strategy for recurrent brain neoplasms. Characterization of implant dosimetry is an essential step toward optimizing this intraoperative technique and informing dose distribution to surrounding brain tissue. Ongoing analysis will evaluate clinical outcomes and treatment-related toxicity.

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INTRODUCTION

Recurrent brain neoplasms remain challenging to manage due to limited treatment options after prior surgery and radiotherapy. In the absence of re-irradiation, local recurrence is common. While re-irradiation with conventional external beam techniques may improve local control, its use is often constrained by prior dose tolerance of the surrounding organs at risk and is associated with an increased risk of radiation necrosis.

Salvage resection combined with cesium-131 (Cs-131) brachytherapy offers a targeted form of intraoperative radiation delivery with potential dosimetric and radiobiologic advantages. This approach enables high local dose deposition to the resection cavity while minimizing exposure to adjacent normal tissues. The relatively short half-life of Cs-131 may also reduce the duration of radiation exposure compared with other commonly used isotopes.

The purpose of this study is to present our initial experience with intraoperative Cs-131 cranial brachytherapy and to characterize post-operative dosimetric outtcomes in patients with recurrent brain neoplasms.

METHODS AND MATERIALS

A retrospective review was performed of patients with recurrent intracranial neoplasms treated at Inova Health since 2024 with maximal safe resection followed by intraoperative implantation of Cs-131 brachytherapy tiles. The Cs-131 tiles consist of a collagen matrix measuring 20 x 20 x 4 mm, each containing four embedded Cs-131 seeds. Figure 1 shows a schematic of a GammaTile.

Prior to surgery, radiation oncologist delineated the anticipated resection volume on the most recent post-contrast T1 MRI to estimate the number of tiles required for adequate resection cavity surface coverage using MiM software or a vendor-provided planning tool. During tile implantation, the radiation oncologist and neurosurgeon collaborated to determine optimal tile placement. Postoperative imaging was obstained within 24-48 hours after surgery. Post-implant dosimetric analysis was performed using MiM software with fused postoperative CT and MRI images by physicists. The provided workflow in MiM consisted of three parts: (1) imaging fusion and contouring of the organs at risk, (2) postoperative cavity contouring, and (3) dose calculation.

The clinical target volume (CTV) and the brain were contoured on the fused postoperative images. The prescription dose was 60 Gy to a depth of 5 mm from the resection cavity surface. Dosimetric parameters were evaluated for the CTV as well as normal brain tissue.

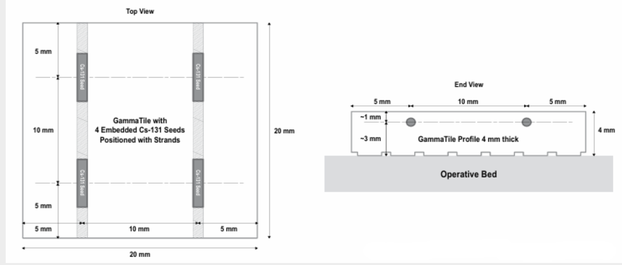

Figure 1. GammaTile seed configuration.

RESULTS

Due to a recent software upgrade, some database records were lost, limiting the number of patients available for analysis. Fourteen patients treated between June 2024 and June 2026 were included in the study. The cohort consisted of six patients with glioblastoma, five with brain metastases, two with meningioma and one with anaplastic ependymoma. Each underwent implantation for a single resection cavity. Lesions were located in both the left and right hemispheres. Table 1 summarizes the dosimetric results. Figure 2 shows an example of a postoperative dosimetric analysis in MiM.

The mean pre-operative resection volume was 24.4 c.c., ranging from 0.68 to 84.4 c.c. The average number of tiles used was 5 tiles with a maximum of nine tiles. The post-operative CTV volume had an average value of 17.4 c.c. with a standard deviation of 6.6 c.c. The D90% of the CTV was 57.0 ± 15.5 Gy; CTV V100% was 80.8 ± 16.6%. The V10Gy to the brain was 191.2 ± 91.7 c.c.

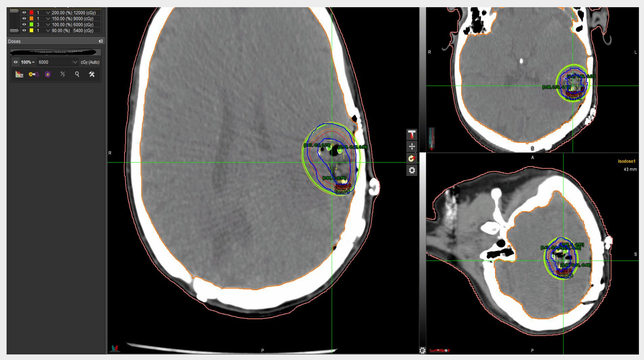

Figure 2. Dose distribution of a postoperative dosimetric evaluation in MiM..

Table 1. Mean osimetric statistics and standard deviation of the fourteen GammaTile patients..

	Average	Standard Deviation
Resection Vol [cc]	24.4	24.3
Number of Tiles	5.0	2.1
Post-Op CTV [cc]	17.4	6.6
CTV D90% [Gy]	57.0	15.5
CTV V100% [%]	80.8	16.6
Brain V10Gy [cc]	191.2	91.7

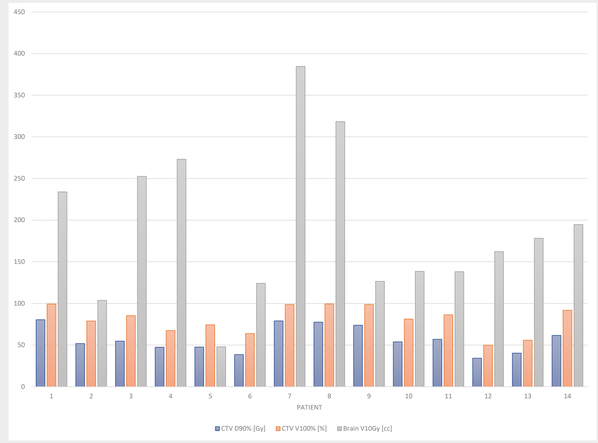

Figure 3. Dosimetric analysis of the CTV and brain for each patient..

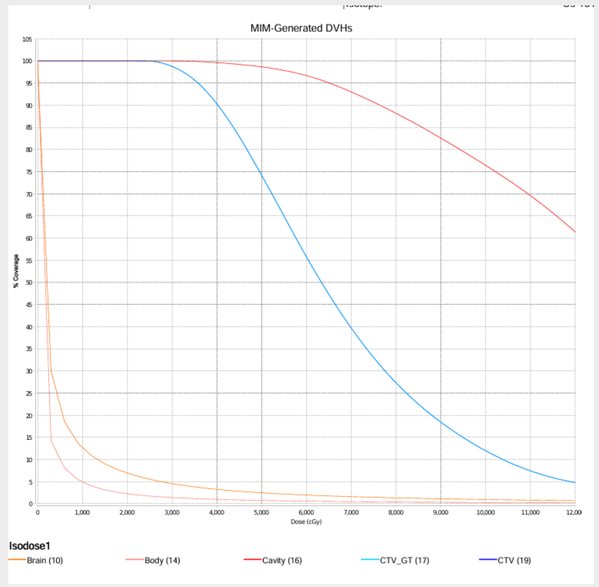

Figure 4. DVH generated in MiM software.

DISCUSSION AND CONCLUSION

GammaTile therapy represents an innovative convergence of brachytherapy physics and neurosurgical oncology, enabling immediate, conformal radiation delivery at the time of tumor resection. This study presents our initial experiences with Cs-131 GammaTile brachytherapy and postoperative dosimetric evaluation following implantation.

The analyzed cases showed variable CTV coverage and normal brain dose distributions, likely reflecting differences in resection cavity size, tumor location, and the number of tiles implanted. Overall, postoperative dosimetric analysis demonstrated adequate target coverage with acceptable dose to normal brain tissue. These findings highlight the importance of individualized planning and intraoperative collaboration between neurosurgery and radiation oncology.

FUTURE WORK

Future work includes expanding the study cohort through continued data, incorporating dosimetry metrics for additional organs at risk, such as the brainstem, optic nerves, and optic chiasm, and performing subgroup analyses to evaluate differences across treatment characteristics.