



# How the Number of Brain Metastases Correlates with Normal Brain Exposure in SRS?

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## Purpose

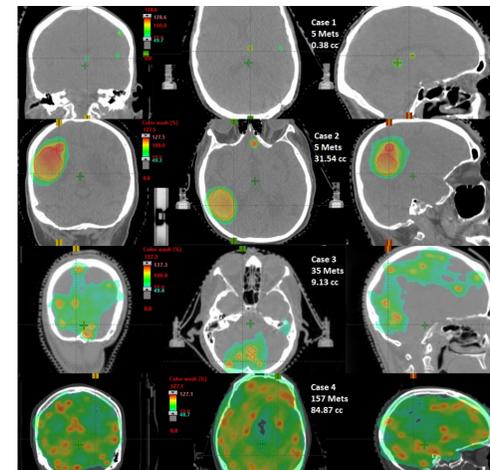
The maximum number of brain metastases treated with SRS keeps on increasing, from 4 to 15, 20, 30, and 40...In our clinic, SRS was recently prescribed and planned for a patient with over 150 metastases, although the patient did not receive treatment in the end due to co-morbidity. This study aims at investigating the correlations between SRS normal brain dose and the number of metastases treated.

## Materials and Methods

- Cohort: Under IRB approval, 43 brain SRS patients with a total of 851 brain metastases were included in the study. The number of metastases per patient/SRS plan was from 5 to 157 with a median of 13.
- Clinical SRS plans were retrospectively analyzed for these patients. Of the 43 cases, 29 (67%) were planned using Brainlab MME DCA with VMC dose calculation and 14 (33%) were using Varian Eclipse VMAT with AXB. All plans were single-isocenter and for a Varian Edge with 6FFF. A GTV to PTV margin of 1 mm was used for all cases.
- The original prescription was 27Gy/3fxs in 31 cases (72%), 24Gy/3fxs in 10 (23%), and 21Gy/3fxs in 2 (5%). Plans with the latter two prescriptions were renormalized to 27Gy/3fxs in this study for data analysis.
- From each plan, the total number of targets, the cumulative PTV volume, the volume of normal brain tissues (defined as non-GTV brain tissues) receiving at least 23 Gy (V23Gy), and the volume of normal brain tissues receiving at least 18 Gy (V18Gy) were collected. Their correlations were studied with scatter plots and linear regression.

## Results

Figure 1 shows sample dose distribution from 4 patients, with 5, 5, 35, and 157 metastases, respectively (Table 1). As expected, normal brain tissue dose increases with both the number of metastases and the total PTV volume. Case 1 and Case 2 has the same number of 5 metastases, but Case 2 resulted in higher normal brain dose because of one large lesion. Although Case 3 has less total PTV volume than Case 2, it has higher V23Gy and much higher V18Gy because of the number of lesions. Case 4 has very high normal brain dose because of a very high number of metastases and total PTV volume.



	Number of Mets	Total PTV Volume (cc)	V23Gy (cc)	V18Gy (cc)
Case 1	5	0.38	0.86	1.72
Case 2	5	31.54	24.50	41.15
Case 3	35	9.13	26.64	114.91
Case 4	157	84.87	726.98	1277.5

Figure 1: Sample dose distribution of 4 different cases. Table 1: Statistics of the sample cases in Figure 1.

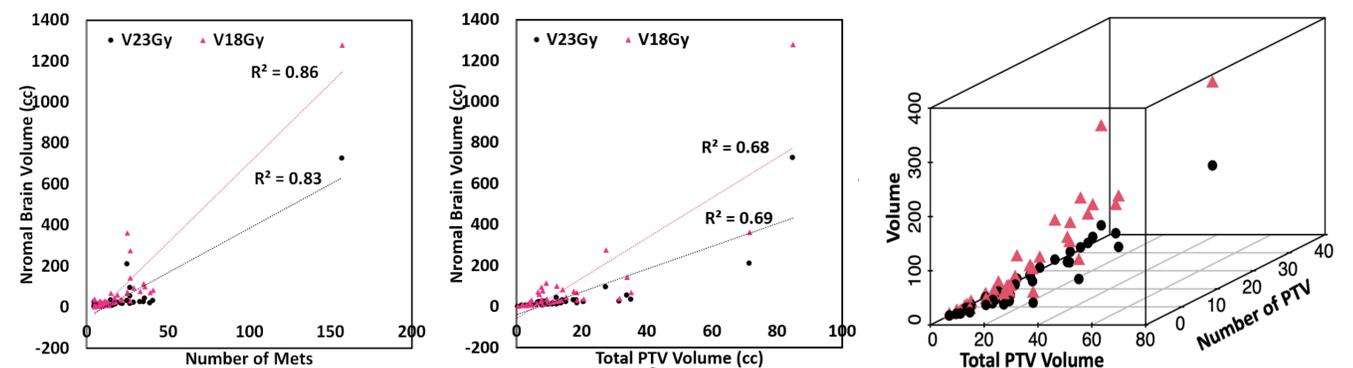


Figure 2: V23Gy and V18Gy both increase with the number of mets, with correlation  $R^2=0.86$  and  $0.83$ , respectively (left); they also increase with the total PTV volume, with lesser  $R^2=0.68$  and  $0.69$  (middle); a 3D scatter plot, excluding the far point of the patient with 157 mets to facilitate visualization, clearly shows the positive correlation between the normal brain dose and the two contributing factors.

## Conclusion

Normal brain dosimetry from single-isocenter, multi-metastases SRS plans was studied on a cohort of SRS patients with 5-157 metastases each. With increasing number of metastases and increasing total PTV volume, normal brain dose increases. This study shed light on how the number of metastases correlate with normal brain exposure in SRS.