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An analytical expression for R50% dependent on PTV surface area and volume: A cranial SRS comparison

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The intermediate dose spill for a stereotactic radiosurgery (SRS) plan can be quantified with the metric R50%, defined as the 50% isodose cloud volume (VIDC50%) divided by the volume of the planning target volume (PTV). By coupling sound physical principles with the basic definition of R50%, we derive an analytical expression for R50% for a spherical PTV. Our analytical expression depends on three quantities: the surface area of PTV (SAPTV), the volume of PTV (VPTV), and the distance of dose drop-off to 50% (Δr). The value of Δr was obtained from a simple set of cranial phantom plan calculations. We generate values from our analytical expression for R50% (R50%Analytic) and compare the values to clinical R50% values (R50%Clinical) extracted from a previously published SRS data set that spans the VPTV range from 0.15 to 50.1 cm³. R50%Analytic is smaller than R50%Clinical in all cases by an average of 15% $\pm$ 7%, and the general trend of R50%Clinical vs VPTV is reflected in the same trend of R50%Analytic. This comparison suggests that R50%Analytic could represent a theoretical lower limit for the clinical SRS data; further investigation is required to confirm this. R50%Analytic could provide useful guidance for what might be achievable in SRS planning.

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