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Abstract

Dose Homogeneity in Stereotactic Radiosurgery: Physical Aspects

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Abstract

Objective(s): Stereotactic radiosurgery (SRS) is an established therapeutic option for the treatment of intracranial tumors and metastases. Doses in SRS are traditionally inhomogeneous, e.g. 20 Gy as 65% isodose for brain metastasis or 13 Gy as 80% isodose for acoustic neuroma. The successful practice of inhomogeneous dose prescription is now also recognized by the ICRU in Report 91, but without going into its physical background [1].

The aim of this study is to investigate the influence of dose homogeneity in the target volume on the width of the therapeutic window.

Methods: The aim of radiosurgical treatments is the generation of focal dose distributions with a steep dose fall-off in the surrounding healthy tissue. For the isotropic and aberration-free superposition of small photon fields a relationship between the dose profile of the individual fields, OCR(r), and the dose profile D(R) of the focal dose distribution was given by Hellerbach et al. [2].

Focal dose profiles D(R) were calculated from the measured dose profiles of the circular collimators of the Cyberknife. From this, the influence of the prescribed isodose level and the collimator size on dose gradients and on resulting dose-volume histograms was investigated.

Results: The maximum dose gradient of the dose profiles D(R) decreases with increasing collimator size. For small fields with a diameter of less than 30 mm, the maximum dose gradient is 20 - 10 % / mm with the maximum at the 60 - 70 % isodose.

The four smallest collimators of the Cyberknife, 5 mm, 7.5 mm, 10 mm and 12.5 mm, selected for the treatment of a target with a diameter of 8.9 mm (volume 3.7 ml), yield isodose levels of 90%, 79%, 50% and 34% at the target rim. These isodose levels and a marginal dose of 20 Gy in the target result in an increased therapeutic window of 0.86 ml for V12 and 1.11 ml for V10 and 5.46 Gy for 1 ml surrounding brain and 3.6 Gy for 2 ml surrounding brain.

Conclusion(s): Homogeneous dose prescriptions in SRS are inevitably associated with increased exposure of the surrounding tissue. The therapeutic window can be significantly increased by choosing lower prescription isodoses and should always be considered for target volumes that

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do not contain healthy tissue.

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