AbstractID: 8994 Title: A General Formula Predicting Near-target Dose Fall-off Characteristics for Different Isocentric and Non-isocentric Delivery Modalities

Purpose: To investigate whether a common relationship exists governing the near-target dose fall-off for Gamma Knife, Cyberknife and MLC-based Novalis linac systems.

Method and Materials: Three groups of intracranial patient cases treated with Gamma Knife, Cyberknife, Novalis MLC-based system were selected for the study. Each group contains 10-20 delivered treatment plans. In each case, the target was covered conformally by a peripheral isodose line ranging from 45% (Gamma Knife) to 95% (Novalis) of the maximum dose inside the target. Based on the divergence theorem, the dose fall-off near the target was derived as $V/V_0 = (D/D_0)^{-\gamma}$, where V_0 is volume of the prescribed isodose line covering at least 99% of the target volume, γ is a constant fitting parameter, which measures the steepness of the dose fall-off near the target. The goodness of the fit and the average γ-values were obtained for all cases of each modality.

Results: The formula fitted excellently for all cases with the linear correlation coefficient R^2 exceeded 0.99 in the log-log plot for each case. No obvious dependence was found for the size of the targets, the number of the beams or the isocenters used for each group. An average γ-value of 1.49± 0.13 was obtained for Gamma Knife, 1.48± 0.41 for Cyberknife, and 1.46 ± 0.19 for Novalis group of cases. No statistical significance was found in the mean value differences among the groups. However, Gamma Knife exhibited the smallest range of deviations in the mean value while Cyberknife exhibited the largest range of deviations in the mean value.

Conclusion: A general formula and a common parameter was demonstrated for relating the average dose fall-off near the target for Gamma Knife, Cyberknife and Novalis MLC-based Linac systems. Despite large physical differences, nearly identical dose fall-off was found for these modalities for treating intracranial lesions.