

Purpose:

Inhomogeneous radiobiology exists within tumor volume of malignant gliomas as shown by biological imaging. The purpose of this project is to plan non-uniform dose distributions to account for inhomogeneous radiosensitivity using IMRT.

Method and Materials:

Sample tumor volumes were divided into several sub-regions of different radiosensitivity that may be considered to correspond to different tumor grade. A pooled clinical and in-vitro data for gliomas were analyzed to determine radiosensitivity parameters for different tumor grades. LQ model and equivalent uniform dose (EUD) were used to calculate the required radiation dose to account for different tumor grade in different sub-region. While the required dose in each sub-region is uniform, the dose distribution within the entire tumor volume is non-uniform. The Xio/CMS IMRT planning system was used to plan the required non-uniform dose distributions and also the conventional 60Gy uniform dose. The EUDs for both uniform and non-uniform distributions were compared.

Results:

Using the parameters determined from clinical data the required dose (EUD in 2Gy fractions) was found to be >55Gy for grade 1 or 2, >60Gy for grade 3 and >65Gy for grade 4. Considering low tumor grade (thus low dose) existing in periphery region, IMRT can deliver the required non-uniform distributions while keeping or improving normal-tissue sparing compared to the conventional uniform dose delivery. The dose can be escalated even higher than the required value in a high-grade region. The non-uniform dose plans yield higher tumor EUD and lower or the same normal-tissue EUD as compared to the conventional plan, indicating that the non-uniform doses are more effective.

Conclusion:

It is dosimetrically feasible to plan non-uniform dose distributions to account for inhomogeneous radiosensitivity. This prepares a framework for biological imaging guided radiotherapy of malignant gliomas, a leading cause of cancer mortality in people with young ages.