Dynamic Shaped Beam Radiosurgery: A Dose-Volume Study

Recently we commissioned a stereotactic radiosurgery system capable of dynamic field shaping combined with arc delivery. The system consists of a micro-multileaf collimator (mMLC) integrated into a dedicated 6 MV linear accelerator. Leaf positions are obtained from the treatment planning system at ten-degree intervals along the arc through beams-eye-view projections of the target volume. Linear interpolation is performed between leaf segments to allow continuous motion of the leaves and gantry. To determine the clinical efficiency of this approach, we compared dose-volume histograms from conventional arc and conformal (stationary gantry) radiosurgery with dynamic arc. The mean normal tissue dose was determined, and a conformity index (CI), defined as the ratio of the whole brain volume enclosed by the prescribed isodose to the planning target volume, was calculated for various irradiation configurations.

Multiple isocenter radiosurgery can minimize peripheral brain dose at the expense of increasing target dose heterogeneity. With conformal radiosurgery, peripheral brain dose decreases as additional beams are added. For irregularly shaped targets, use of dynamic field shaping significantly reduces whole brain dose compared with static shaped fields, while preserving the target dose homogeneity of single isocenter plans. Dose-volume histogram analysis shows that the dynamic arc approach is superior to the other two in terms of minimizing peripheral brain dose while preserving target dose homogeneity. In addition, the treatment planning tools and delivery technique make dynamic field shaping significantly more efficient than conventional means of stereotactic irradiation.