Techniques in Dosimetry and 3-D Treatment Planning for Stereotactic Radiosurgery/Radiotherapy

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Contents

Abstract

The success of stereotactic radiosurgery (*SRS*) as an effective radiation technique for treating intracranial lesions is dependent on the geometric accuracy of the dose delivery. This is because in this technique a high dose (normally 10 to 30 *Gy*) is released by a small field, in a single-fraction, to destroy the lesion located in a generally critical region. Accurate dosimetry of *SRS* fields is difficult because of lateral electronic disequilibrium and steep dose gradients which are characteristics of these fields. Accurate dosimetry of *SRS* fields is most likely to be achieved using a high resolution tissue-equivalent detector.

Monte Carlo techniques and *PTW* diamond detectors are added to the commonly used detectors (namely silicon diodes, ionization chambers, film and thermoluminescence dosimetry) to calculate and measure *SRS* treatment planning requirements and dose distributions. Monte Carlo techniques have been confirmed as reliable references for dosimetry of *SRS* fields. Also, it will be shown that diamond detectors are potentially ideal for *SRS* and yield more accurate results than the above traditional modes of experimental dosimetry. This was demonstrated by comparing the diamond response, after correcting for dose rate dependence, with the corresponding results of the ionization chamber (for large fields) and Monte Carlo (for small fields).

Advanced techniques in stereotactic radiosurgery and radiotherapy are introduced. Using radiobiological principles it has been shown that *SRS* is appropriate for treating arteriovenous malformations and most benign lesions, while stereotactic radiotherapy (as a fractionation scheme) is highly recommended for malignancies and large tumours. Bioeffect planning as a new means for assessment of the treatment plans is introduced, by which treatment plans can be assessed according to the bioeffect distribution rather than a physical dose distribution.

A method of calculating beam data using sector-integration of Monte Carlo-generated pencil beam kernels has been proposed. This technique can be used both for circular and irregular fields, however it is more useful in calculating dosimetry parameters for irregular fields–where the shape of treatment fields is determined during planning.