A patient specific technique for the verification of intensity modulated beams based on CT-MR image registration and ferrous sulfate gel dosimetry

Intensity modulated beams (IMBs) pose unique verification problems that may be addressed with the use of integrating continuous 3D dosimeters such as ferrous sulfate gels. A dosimetric technique based on the MR imaging of irradiated ferrous sulfate gels has been developed for the verification of IMBs.

After the patient is CT scanned in the treatment position (with fiducial markers), the target volumes and critical structures are outlined, and the treatment beam geometry is determined. A 3D treatment planning system generates intensity modulation matrices for each beam. The matrices are converted into dynamic or step-and-shoot multi-leaf collimator leaf sequences, or into static compensator dimensions.

An acrylic mold of the patient is constructed, and filled with ferrous sulfate gel. The mold representing the patient's surface contours is then irradiated precisely as the patient would be. The mold is then MR imaged (with fiducial markers) and the MR data set is subsequently converted to dose using a calibration curve method.

The image registration of the MR/dose and CT data sets provide both a qualitative and quantitative evaluation of the delivered dose. Isodose surfaces obtained from the MR/dose data are superimposed on the CT-defined volumes for visual evaluation. Quantitatively, dose/volume histograms of the irradiated volumes can be extracted form the MR/dose data. This technique has the potential to validate the entire IMRT process from treatment planning to delivery.