Purpose

To determine spatially non-uniform dose prescription for brain tumors based on physiological MRI data, we have retrospectively analyzed the correlation between pre-RT MR imaging, delivered dose, and post-RT MR imaging using various multivariate analysis methods.

Materials and Methods

Non-uniform dose prescription using the pre-RT functional imaging can be meaningful only if a correlation between imaging signal to required minimum dose exists. This correlation can be indicated by a separation in the imaging – dose space between clusters of voxels where tumor recurred and those where tumor is sterilized. To determine the correlation, we performed various multivariate analyses including k-means clustering, decision tree, principle component analysis and visual scattering plots on a voxel-by-voxel basis. A separation in the clusters of responsive and non-responsive voxels is sought in the N+1 dimensional space (N= number of physiological imaging modalities + dose). Analyses were performed on co-registered pre- and post-RT multiple physiological MR data (MRSI, rCBV (spin-echo (GE), gradient-echo (SE) and ratio parameters), DTI-derived ADC (apperent diffusion coefficient), and FA (fractional anisotropy)) with delivered dose distributions and tumor recurrence maps based on post-RT imaging for selected brain tumor patients.

Results

Among various combinations of MRI modalities tried, no imaging modality or combination provided strong separation. A weak separation was observable only when multiple MR modalities were considered. Visual separation happened mainly with ADC map and rCBV-GE. Different clustering methods yielded a weak separation (mean within-cluster distance to among cluster distance ratio < 0.5). A decision tree built by the data provided good sensitivity/ specificity (both >0.7), for the high risk region voxels.

Conclusion

The multivariate analyses show a weak correlation for the studied patient cases, which may be attributed to complex tumor dynamics. This indirectly indicates that temporal (update during course of treatment) and spatial non-uniform dose prescription may be helpful for brain tumors.