

Mathematical analization of morphological changes following I-125 brachytherapy with a “polynomial prediction approach”

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Purpose: The aim of our study is to reveal the volumetrical changes in tumor necrosis, reactive zone and edema referred to as “tripple ring” appearing after low-dose rate I-125 interstitial irradiation in 20 inoperable low-grade gliomas. Mathematical expressions are provided to make the volumetrical changes predictable, the derived polynomials show the dynamics of “tripple ring” in the time domain. Multivarial analysis of several different aspects is been carried out.

Material and methods: Volumes of the three regions on image-fused control CT/MRI images were measured for a 48-month period. The delivered dose on the tumor surface was 50-60 Gy. Dose planning and image fusion were done with the BrainLab Target 1.19 software, mathematical and statistical computations were carried out with the Matlab numeric computation and visualization software. To determine the volumes, the control images with the triple rings were fused with the planning images.

Results: Relative volumes normalized with respect to the volume of reference dose were calculated and plotted in the time domain. First the mean values of volumes were determined from the patients' measured data, then polynomials were fitted to the mean values using the polynomial curve fitting method. The accuracy of our results was verified by correlating the predicted data with the measured ones.

Conclusions: The “polynomial prediction approach” proposed reveals the dynamics of the “tripple ring” for 48 months. The derived polynomials and the multivarial analysis carried out afterwards help to (i) design the best treatment, (ii) follow up the patient's condition and (iii) plan reirradiation if necessary.