Dynamic MR measurements of brachytherapy caused microenvironmental changes in cervical cancer

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Purpose: The change of tumor volume is not significant enough for representing the alteration caused by the irradiation. Signal intensity in Dynamic Magnetic Resonance (DMR) image visualizes the activity of the tumor and its vascular permeability. In cervical cancer patient, the response to radiotherapy shows individual contrast material enhancement changes in DMR as well as radiotherapy induced DNA damage. The goal was to determine the quantity of intensity in "good responders" and its change in time as a predictor for radio sensitivity.

Material and methods: Our DMR study based on contrast enhancement comparison. Thirteen patients (age 31-77, stage I/b-III/a) with cervical cancer took part in a prospective DMR study. The pharmacokinetics of 0.1 ml/kg Gadopentate-Dimeglumine was studied with one Tesla Shimadzu MR to measure the tumor and the healthy muscles- and uterine tissues. The enhancement was detected in axial view fast field sequence (TR: 180, TE: 10, FLP: 60, with: 5 mm, Pitch: 8 mm) in 30 seconds intervals, 8 times. The region of interest was 4 mm^2 in the tumor as well as in the healthy endometrial and myometrial tissues. To get proper data to compare we used the postcontrast Signal Intensity Ratio (SIR) method and we figured out a new formula: the Rate of the Signal Intensity Increase (RISI). The calculated RISI and SIR were compared by matching the proper DMR dates before and after radiation therapy. These were compared with operation histology in 10 cases. Changes after 3 × 6 Gy high dose rate intrauterine brachytherapy and consecutive

50 Gy Cobalt external beam irradiation 10 patients were searched.

Results: The Magnevist enhancement in DMR examination reflects the tumor activity. Significant differences were found in the first 60 sec RISI and in the SIR in all cervical cancer. We experienced that the SIR and RISI values differ in every patient and are characteristic. Still there is a tendency that the infiltrated and non-infiltrated territories are in different segment of enhancement scale and the diminishing of the RISI of the tumor and the healthy tissues differ from each other. The most significant change is in the enhancement between the first and second measurements, so that might suggest taking the first SIR and RISI as a basis of the following. The average of SIR in tumor was 100.84%, in the healthy tissues 52.93% and in the control muscles 14.82%, average of RISI in cervical cancer was 19.37/sec, in normal stroma 11.11/sec and 2.34/sec in muscles. The average of SIR change in the tumor was 55.20%, while in the corpus 16.5. The RISI became slower in all-patient average decrease 7.07/s. With DMR measurements one can clearly show that the tumor regression does not significantly correlate with collapse of the tumor, but only very early RISI (within 30 sec) can safety be accepted as a reference. In 10 cases, histological analysis of the tumor helped the more precise demonstration of our preliminary results. Our RISI and SIR values demonstrate the changed tumor permeability, active and necrotic parts of cervical cancer and represent the effect of radiotherapy. Our preliminary results demonstrate individual differences in irradiation induced changes in the cervical cancer and the histological and control examination findings are in strong correlation with our DMR measurements.

Conclusions: The assessment of the cervical cancer biological aggressiveness is important factor to indicate the different therapy combinations. Tumor characterization with DMR is a new quantitative assessment to detect the cervical tumor and healthy tissues as well as irradiation induced changes in contrast enhancement. This means that the effectivity of the radiotherapy can be well monitored by comparing the enhancement changes of the tumor. DMR has a current and potential value in the indication of radiation dosage, which is in strong correlation with the risk organ sparing.