MR modelling of the rectal dosimeter probe during MR-guided high-dose-rate (HDR) prostate brachytherapy: feasibility and initial experiences

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Purpose: Our aim was to verify the dose delivery to the anterior rectal wall during MR-guided HDR brachytherapy using a custom-made plastic MR compatible dosimeter model for the simulation of a five-fold semiconductor rectum probe.

Material and methods: Eleven patients with intermediate to high-risk prostate cancer were treated with 46-60 Gy of 3D conformal external beam radiotherapy followed by a single or two fraction of 8 Gy MR-guided HDR boost. Template reconstruction, trajectory planning, contouring and 3D conformal treatment planning were based on T2-weighted FSE images. After implantation the patients were left in the original position with the template-obturator system. Within the centre of the obturator a tunnel has been created allowing the exact and reproducible insertion of the recital probe *in vivo*. During the series of the FSE images the model is inserted into the obturator, so that the five plastic "detectors" are clearly visualized by the help of the gel separation. On the final plan the dose delivery in the centre of each detector could be directly visualized and calculated on arbitrary plane. Before treatment, the model is replaced by the real rectal probe. The measured dose values then compared to the calculated ones.

Results: MR-based *in vivo* rectal dosimetry measurements were performed in 9/11 patients. Our dose constraints limits for the rectum are the followings: anterior rectal wall D0.1cc ≤ 85% and anterior rectal mucosa Dmax ≤ 60%. No RTOG Grade 3 or worse acute toxicities were observed. 82-99% of the target volumes received the prescribed dose and D0.1cc for the urethra and anterior rectal wall were consistently under 125-150% and 85%. The average differences with SD between the calculated (mean values in Gy; D1: 1.97, D2: 2.36, D3: 2.20, D4: 1.66, D5: 1.06) and measured dose values (D1: 1.91, D2: 2.29, D3: 2.15, D4: 1.68, D5: 1.13) on each detector level were the followings: +1.9% (11.9); –2,7% (14.2); –4.6% (15.6); –2.8% (11.9); –3.0% (10.3). The probable reason for the relatively

high SD values is the high dose gradient in relation to the positioning accuracy and the size of the detectors.

Conclusions: MR modelling of the rectal dosimeter is a promising technique to provide an accurate prediction of rectal dose delivery. Further experience and longer follow up are planned in the near future.