bladder base and urethral radiation injuries. Our ability to predict these injuries prior to radiotherapy remains limited, however. For example, rectal dose volumes are a widely used planning tool, but published relationships between irradiated volumes and outcomes are inconsistent. The presentation is a strictly clinical overview of the factors that contribute to ano-rectal radiation injuries and outlines recent progress in their management. Symptomatology resulting from rarely cited injuries, such as to the per-rectal fat and the pelvic floor musculature, are also discussed.

Symposium with Proffered Papers: Immobilisation, localisation and verification during image guided brachytherapy

SP-0032
Influence of immobilisation and implant stability during brachytherapy

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Abstract not received.

SP-0033
Role of target and applicator localisation under treatment delivery conditions

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Since the last 10 years 3D image-guided brachytherapy using CT, MRI, and/or ultrasound (US) has been introduced into clinical practice worldwide enabling conformation of the dose distribution to the target volume and avoidance of high dose to organs at risk (OAR). To be able to optimise the dose distribution in brachytherapy both the anatomy (target volume/OAR) and the applicator(s) should be correctly localised in the images. If the image modality does not enable both of these criteria the dose delivered the patient may be calculated incorrectly. Another important aspect is that the images should reflect the true situation at the time of the treatment. Due to the large dose gradient in brachytherapy, even small changes in the position of the applicator and/or anatomical structures may lead to discrepancies between planned and delivered dose. Usually, this is achieved with as short time as possible between imaging and treatment delivery.

The optimal image modality to use is depending on the site to be treated as well as the geometry and the material of the applicator. For cervical cancer MR imaging is the optimal modality to discriminate soft tissue and tumour. Concepts for image guided cervical brachytherapy have been developed by GEC-ESTRO and T2 weighted MR imaging is the preferred modality. In an interobserver study the mean inter-delineation distance of around 4 mm were found for the high risk CTV (HR CTV). The impact of these uncertainties for D90 and D100 (dose to 90% and 100% of the volume) were 10% and 19%, respectively.

Post-implant dosimetry after permanent prostate seed implantation is usually based on CT imaging. However, MR imaging has superior soft tissue contrast and is some times used nowadays. In an interobserver study the dosimetric consequence of the delineation uncertainty was estimated to be 18% for the prostate D90 when T2 and T1 weighted MR images were used. This figure was increased to 23% when the delineation was done on CT images. Functional MR imaging, such as dynamic-enhanced MR, diffusion weighted imaging and MR spectroscopy, gives the opportunity to image microenvironmental characteristics of a tumour. Specific areas within the target volume with a high burden of disease or with biological characteristics indicating radioresistance may be targeted for higher dose delivery. Even though MR imaging is excellent for target delineation, localisation of the applicators (i.e. the source path) or the seeds could be challenging. Some applicators (e.g. steel applicators or shielded applicators) are not even MR compatible. In general it is easier to visualise the applicator and source(s) in CT images. For rigid MR compatible applicators (e.g. plastic tandem-ring-applicator) so called library applicator file could be used. Then applicator file, including information about the applicator surface dimensions and the source path, can be imported into the MR images and rotated and translated until it matches the images. In some situations the needle tip could be difficult to localise in MR images. Then supplementary imaging could be used (e.g. CT) and image registration should be performed with the aim of matching the applicator geometry and not the bony anatomy. The dosimetric consequences of uncertainties in the applicator localisation are smaller compared to consequences of uncertainties in the target delineation. For the HR CTV D90 an average of 2% change per mm displacement of a ring applicator has been found in all directions.

Transrectal US (TRUS) is extensively used in prostate brachytherapy and gives an excellent view of the prostate gland. However, the presence of needles will preclude the image quality. Additionally, localisation of the needle tip could be challenging during needle reconstruction. TRUS-based brachytherapy procedure offer a method for interactive treatment planning and, thus, short time between imaging and treatment delivery. Several groups have developed methods for “in treatment room” imaging with both CT and MR. However, for the latter method, challenges due to non MR compatible equipment is substantial.

SP-0034
Importance of treatment delivery verification

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Abstract not received.

OC-0035
Catheter displacement and dosimetry for single fraction MRI guided focal prostate HDR brachytherapy

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Purpose/Objective: The aim of this study is to analyze the effect of catheter displacement and anatomical variations (prostate and organs at risk) on the dose distribution in MRI guided single fraction high dose rate (HDR) focal brachytherapy of the prostate.

Materials and Methods: Twenty-two patients were treated with MRI guided focal HDR brachytherapy (iridium-192) in a single fraction of 19 Gy. A multiparametric MRI was used to define the tumor region and was matched with the intraoperative ultrasound (US). For the treatment, self-anchoring umbrella catheters were used (1). For dose
planning purposes, a 1.5T MRI was made directly after US guided catheter placement. Two sets of 3D MR images were acquired using balanced steady state free precession sequences with fat suppression; SPIR (spectral presaturation with inversion recovery) in sagittal and SPAIR (spectral presaturation inversion recovery) in transverse direction. These planning scans were used for catheter reconstruction and generation of the intra-operative HDR brachytherapy plan (Figure 1a,b). After treatment (before removal of catheters), a second MRI was performed. Regions of interest were also delineated on the post-treatment MRI scan and the catheters of 6 patients were reconstructed . The displacement of catheters between the MRI scans were analyzed. The intra-operative dose plan was applied to the post-operative MRI scan to assess the influence of catheter migration and anatomical variation on the dose delivered to the target and the organs at risk.

Figure 1. A: sagital SPIR image, B: transveral SPAIR image, C-F: dose differences in CTV and organs at risk between intra-operative (Intra-op) and post-operative plan (Post-op)

Results: In total, the displacements of 87 catheters were investigated in the x,y and z direction (Table 1). A displacement of 4-5 mm was seen in the z-direction of 2 catheters. In most catheters, a migration of only 0-2 mm was observed. The differences in DVH parameters between the intra-operative plan and the post treatment plan are small and seem clinically irrelevant. Preliminary results in this study show that the intra-operatively planned dose resembles the actual delivered dose.

Conclusions: There is minimal displacement of catheters during a single fraction focal MRI guided HDR brachytherapy. The differences in dose to the CTV and the organs at risk between the intra-operative and post treatment plans are small and seem clinically irrelevant. Preliminary results in this study show that the intra-operatively planned dose resembles the actual delivered dose.


OC-0036
The effect of catheter displacement on acute and late toxicity in fractionated HDR monotherapy of prostate cancer
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Purpose/Objective: In our department, HDR brachytherapy as a monotherapy is performed in 4 fractions of 9.5 Gy within 36 hours for low and intermediate risk prostate cancer (PCa). Although the implanted catheters are fixed in a template, displacement of catheters does occur between the fractions. A simulation study performed in our department showed a substantial influence of implant displacement >3 mm on organ at risk constraints and target coverage. Therefore, displacements >3 mm were corrected.

We investigated the influence of correction of displaced implanted catheters on acute and late toxicity in prostate cancer treated by HDR brachytherapy.

Materials and Methods: Between 2007 and 2013 158 PCa patients treated with HDR monotherapy were included. The implant displacement was assessed after each fraction for every patient according to a set-up protocol using a lateral X-ray to check the position of the catheter tips relative to the implanted markers. Displacements ≤3 mm were not corrected. The cumulative gastrointestinal (GI) and genitourinary (GU) acute and late toxicities were assessed using both the clinical record forms and the self-assessment patients questionnaires. Toxicity occurring within 100 days was defined as acute and after 100 days as late.

Significance of difference in acute toxicity between the two groups (with and without displacement) was tested using Pearson’s chi-squared test. Cox regression analysis was applied to compare the incidence rate of late toxicity.

Results: Implant displacement was reported in 72 patients (DP). 57 (80%) DP shows one displacement during the treatment course, 15 DP (20%) showed more than one displacement. DP were divided into 3 groups: implant displacement ≤3 mm (4 patients, 5.7%), >3-5 mm (44 patients, 61%), >5mm (24 patients, 33.3%). No displacements were seen in 86 patients (NDP). Acute GI toxicity was reported in 25.6% NDP and 30.6% DP (p=0.49). Acute GU toxicity was reported in 36% NDP and 44.4% DP (p=0.28).

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