related to excessive mucus production, symptoms related excessive gas production gas and symptoms related excessive blood production. A modern scoring system should have two or more atomized symptoms related to each of the six illnesses and appropriate response scales for frequency, intensity and duration.

SP-0019
Measuring anorectal toxicity and function
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Anorectal toxicity is a relevant side effect of pelvic radiotherapy for rectal, anal, gynaecologic and prostate cancer. Toxicity can be scored objectively by the physician according to established systems such as the CTCAE classification. In recent years, patient-reported outcomes (PROs) have received increasing attention when evaluating acute toxicity as well as late effects of cancer treatment. These include information directly obtained from the patient on symptoms and impairment as well as on quality of life. This presentation will focus on validated instruments to measure PROs related to anorectal function, including quality-of-life questionnaires and organ modules, e. g. those developed by the EORTC Quality of Life Group, and symptom questionnaires e. g. to measure continence. Objective measurements to quantify anorectal function such as sphincter manometry and endoscopic scores will be reviewed. The relationship between PROs and objective function assessment with physician-rated toxicity will be addressed. The outcomes for the above endpoints in major trials of pelvic radiotherapy will be presented, with a focus on rectal cancer and the effects of treatment concepts including short-course radiotherapy and long-course chemoradiation. Finally, dose-volume constraints in pelvic radiotherapy treatment planning and potential effects of highly conformal techniques such as IMRT or VMAT on anorectal symptoms, function and quality of life will be examined.

SP-0020
Rectal spacers to minimise morbidity in radiotherapy for prostate cancer
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Radiotherapy is a well recognozed curative treatment option for localized prostate cancer. Optimal tumor control rates can only be achieved with high local doses, associated with a considerable risk of rectal toxicity - regarded as dose-limiting toxicity. Apart from already widely adapted technical advances, as intensity-modulated radiation therapy and image-guided radiotherapy techniques, the application of spacers placed between the prostate and anterior rectal wall has been increasingly used in the last years.
Biodegradable spacers, including hydrogel, hyaluronic acid, collagen or an implantable balloon can create the desired effect. They can be injected or inserted in a short procedure under transrectal ultrasound guidance via a transperineal approach. A distance of about 1.0-1.5cm is usually achieved between the prostate and rectum, excluding the rectal wall from the high isodoses. Several studies have shown well tolerated injection procedures and treatments. Apart from considerable reduction of rectal dose compared to radiotherapy without a spacer, clinical toxiciyt results are favourable. A prospective randomized trial demonstrated a reduction of rectal toxicity after hydrogel injection in men undergoing prostate image-guided intensity-modulated radiation therapy. The results are encouraging for continuing evaluation in dose escalation, hypofractionation, stereotactic radiotherapy or re-irradiation trials in the future.

Symposium: Towards user oriented QA procedures for treatment verification

SP-0021
How to ensure the quality in brachytherapy treatment planning systems?
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Treatment planning systems (TPSs) are of high importance in modern brachytherapy. The users rely on the output of these special software; wrong calculations may result in severe patient harm. Thus it is necessary to systematically check these software programs.
Many checks in TPSs are identical for high-dose-rate brachytherapy with afterloaders and low-dose-rate brachytherapy with seeds. But some differences exist, e.g. as checking of afterloader parameters.
After the installation of the software the acceptance test is to be carried out. This test protocol is typically provided by the vendor and should be passed before further checking. In a second step the commissioning is carried out. In this procedure all clinical relevant data and properties of the TPS must be tested and reported. Examples for items to check are:
- Afterloader characteristics (number of channels, min./max. channel lengths, max. allowed dwell time, …)
- Source characteristics (nuclide, decay, …)
- TG-43 consensus dataFor Model-based dose calculation algorithms, commissioning following TG-186 report
- Applicator checks
To ensure the consistency and data integrity of the TPS periodical tests should be performed after the commissioning. Important points are to validate the integrity of base parameters of the TG-43 data and the recalculation of patient treatment plans.
Most TPSs offer inverse planning algorithms. The algorithm itself is often not fully transparent by the user, thus comparison with manual calculations is not practical. Nevertheless, the consistency of such planning technique can be checked by recalculation of a test plan using a constant parameter set. In addition to the tests above end-to-end tests can be performed to check the whole treatment chain, including imaging, TPS, afterloader, and data transfer.

SP-0022
Imaging
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In the past decade 3D image guided brachytherapy has been introduced into clinical practice worldwide. This enables conformation of the dose distribution to the target volume and avoidance of high dose to organs at risk (OAR) using CT, MR, and/or ultrasound (US) imaging. In such modern techniques sectional images give the relationship of the shape and the position of the applicator(s)/sources in relation to the anatomy of the patients. This means that the quality assurance (QA) programs also should include specific topics related to image quality additional to traditional procedures checking the source strengths and dose calculation issues. QA for image quality is well established in the area diagnostic and many of these procedures can be used also for brachytherapy. However, the procedures should be modified in order to reflect the conditions of use in brachytherapy compared to a diagnostic session.
To optimise the image quality in diagnostic procedures dedicated phantom is often used. Various image quality parameters are tested by evaluation for example slice thickness, spatial resolution, uniformity and noise. In contrast to diagnostic imaging, the ability to reconstruct several points or a geometric structure with high accuracy is crucial in brachytherapy. Therefore, a procedure to check the geometric accuracy have to be included in a QA program.

A phantom with known geometry should be used, either including markers with known relative coordinates or test objects with known shapes and volumes. The design of the phantom will be depend of the modality to be tested.
For ultrasound imaging the AAPM Task Group 128 includes a list with 8 elements of a phantom that allow for all the recommended tests [1]. It is referred to a commercial phantom that include nylon monofilaments in a N-shaped pattern and spherical and non-spherical volume in order to test key imaging parameters such as depth of penetration, axial and lateral resolution, distance, area and volume measurements and geometric consistency.
Roué et al used a commercial PMMA phantom with 25 stainless steel markers with known relative position to check the geometric accuracy of CT and conventional x-ray imaging [2]. A phantom including several inserts with different density can be used to check the volume reconstruction accuracy for CT. Several commercial phantoms are available.
It is well known that geometrical distortions can frequently occur in MR images. The magnitude of the distortions should be investigated by using phantoms with markers or tubes filled with for example Cu2+-doped water solution. Additional, the influence of an applicator should also be investigated since for example the presence of a titanium applicator may produce geometric distortion in a high field MR machine.
The slice thickness will also influence the ability to reconstruct the geometry correctly. With too large distance between the slices the partial volume effect will influence the accuracy of the volume reconstruction [3]. On the other hand, de Brabandere et al showed that too small distance between the slices decreased the accuracy of seed detection in a dedicated phantom with agarose gel and 60 iodine seeds with known position using MR imaging [4].
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SP-0023
Dose verification
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Any radiotherapy delivery is associated with uncertainties and with risk of misadministration/error. Misadministration/error refers to treatment incidents/accidents which can be prevented, while uncertainties can only be controlled to a certain degree and the residual variation must be accounted for through tolerances and treatment margins. Patient safety through prevention of radiation dose misadministration is highly prioritised and several authorities and societies worldwide are focusing on radiation safety and medical events. In 2004, the International Commission of Radiation Protection (ICRP) reported an analysis of 500 radiation events in BT. This investigation and others have shown that a significant share of radiation events are caused by human errors related to the manual procedures of BT. Verification in radiation therapy means the whole process of proof that planned dose is delivered to the patient within a specific level of accuracy. During the last two decades enormous developments and technological innovations in the field of external beam radiotherapy (EBRT) treatment verification have taken place. These developments have focussed on imaging technologies for 2D and 3D (and very actually also 4D) localization and anatomy reconstruction under treatment delivery conditions. Striking innovations have been imaging technologies such as flat panel detectors, cone beam CT (CBCT), and most recently MRI, which is integrated with the linear accelerators. The combination of 3D-imaging techniques and dose measurements enables the estimation of the daily 3D-dose delivery in the patient anatomy. In contrast, on-board or real-time treatment verification of BT is currently not performed, simply because adequate tools are not available. There is currently a striking unbalance between the availability of treatment verification technology for EBRT and BT, and consequently a different level of safety. Adding even further to this unbalance, BT is related with higher risk of major dose misadministration than EBRT, since BT involves: 1) more manual procedures (e.g. assembly and implantation of applicators, catheter reconstruction, and guide tube connection), 2) mechanical equipment with a higher susceptibility to malfunction (e.g. source cable drive and applicators), 3) more frequent application of hypo-fractionation schedules, and finally 4) steeper dose gradients. New methodologies for treatment verification are highly warranted. Dose and source geometry are closely linked entities in brachytherapy. Dose calculation with TG43 is the current standard of dose calculation in brachytherapy, and has excellent accuracy in most clinical scenarios. TG43 is based on geometry. Given a direct correspondence between brachytherapy source geometry and dose, a geometric verification is nearly equivalent to a dosimetric verification. There are only few error scenarios where source geometry would be correct, but not dosimetry – e.g. source mis-calibration. Therefore several novel “on-board” treatment verification tools are focused on verification of geometry: EM tracking of catheters, flat panel monitoring of source progression, fluoroscopy, and real-time in vivo dosimetry. Given the source geometry is correct, the next important step is to secure that the relation between sources and anatomy is correct. This last step is typically explored with imaging. Combinations between different verification tools may be the way to proceed to reach a higher level of treatment verification in brachytherapy which address geometry, patient anatomy and consequent dose delivery to the patient. The presentation will outline current developments in “on-board” treatment verification tools. The table below shows the current status of treatment verification in EBRT and BT, and indicates visions that can bring brachytherapy treatment verification forward.

Symposium: Robust and accurate functional MRI for radiotherapy

SP-0024
Needs and technical requirements for functional MRI in radiotherapy
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Anatomical imaging with T1 and T2-weighted MRI is increasingly used in combination with CT for precise delineation of tumors and normal structures. MRI also offers functional techniques, such as diffusion-weighted MRI (DWI) and dynamic contrast-enhanced MRI (DCE-MRI). These can be applied in radiotherapy for tissue classification, monitoring of treatment response as well as for dose painting. In the diagnostic setting, these sequences are often part of routine scanning protocols. However, as for anatomical MRI sequences, there are some specific issues that need to be considered when applying these techniques in radiotherapy. For image registration with the planning CT, patients need to be scanned in treatment position. If the functional images are used for target delineation, their geometrical fidelity needs to be verified. In particular diffusion-weighted MRI is prone to geometrical distortions. Methods to reduce these distortions will be discussed. The spatial resolution of functional imaging tends to be lower than that of anatomical imaging. Although acquisition with small imaging voxels is feasible, this doesn’t mean that the functional quantity (apparent diffusion coefficient for DWI and tracer kinetics parameters for DCE-MRI) can be reliably determined in a