technique is regarded as the most accurate calculation method in the dose calculations for kV beams. The Monte Carlo user code, BEAMnrc/DOSXYZnrc was used to simulate x-ray sources. The detailed x-ray tube geometry was simulated, including the anode x-ray tube specifications, target design, beam definition, beam filtration systems, and incident electron energy. Each simulated realistic kV beam with respect of an image acquisition procedure was stored in a phase-space file. The simulated beam specific to an image procedure was individually calibrated by using anl ion chamber in which the air kerma calibration factor is traceable to national standards. When a Monte Carlo simulated beam is calibrated it allows the user to calculate both relative and absolute absorbed doses to patients. Patient dose calculations were done using the Monte Carlo generated kV beam as an incident beam on patient CT based images. The dose resulting from a radiograph image procedure was calculated by incident the source from a fixed incident angle (AP, RL, etc.) while the dose resulting from a kV-CBCT scan was calculated by rotating the X-ray source around the patient based on the specific scan procedure.

Results: The Monte Carlo simulation provides realistic beam details such as energy spectra, particle fluence, and the mean energy distributions. The simulation accuracy was validated by benchmarking the Monte Carlo simulations against measurements of the beam's half-value layers and dose distributions. Patient dose calculations showed that the imaging doses to the eyes for representative head images are 0.05-0.2 cGy and 0.1 cGy; doses to the bladder for representative pelvis images are 1.6 cGy and 0.07 cGy; while doses to the heart for representative thorax images are 0.4 cGy and 0.07 cGy; when using kV-CBCT scans and kV radiographs, respectively. In contrast, organ doses increase by a factor of 2-4 if bow-tie filters are not used during kV-CBCT acquisitions.

Conclusion: The excellent agreement between Monte Carlo calculations and measurements demonstrates that Monte Carlo techniques yield accurate results for kV dose calculations. Current on-board kV imaging devices result in much lower imaging doses compared to the conventional MV portal imagers. There are a variety of approaches available to significantly reduce the image doses. It is feasible to estimate and account for organ dose by using tabulated values based on scan procedure and site because organ doses from imaging procedures are only modestly dependent upon scan location and body size.

Symposium: Innovations in functional imaging for radiotherapy

SP-0602
PSMA ligands for diagnosis and therapy

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Since the prostate-specific membrane antigen (PSMA) is frequently over-expressed in prostate cancer (PCa) several PSMA-targeting molecules are under development to detect and treat metastatic castration resistant prostate cancer.

In 82.8% of 319 patients investigated with ^{68}Ga-PSMA^{HBED}-PET/CT at least one lesion indicative for PCa was detected. Tumor detection was positively associated with PSA level and androgen deprivation therapy. Amongst lesions investigated by histology, 30 were false-negative in ^{68}Ga-PSMA^{HBED}-PET/CT (one local relapse in one patient and 29 lymph nodes in another patient), all other lesions (n=416) were diagnosed true-positive or -negative. Fifty of 116 patients available for follow-up received local therapy after ^{68}Ga-PSMA^{HBED}-PET/CT.

A comparison of ^{68}Ga-PSMA-ligand with ^{18}F-fluoromethylcholine PET/CT revealed 78 PC-suspicious lesions in 32 patients using ^{68}Ga-PSMA-PET/CT and 56 lesions in 26 patients using Choline-PET/CT. The higher detection rate in ^{68}Ga-PSMA-PET/CT concerning PC-suspicious lesions was significant (p=0.04). All lesions detected by ^{18}F-fluoromethylcholine-PET/CT were also seen by ^{68}Ga-PSMA-PET/CT. In ^{68}Ga-PSMA-PET/CT SUV_{max} was clearly (>10%) higher in 62 of 78 lesions (79.1%) and tumor-to-background ratio was clearly (>10%) higher in 73 of 78 lesions (93.6%) when compared to ^{18}F-fluoromethylcholine-PET/CT.

Since the ligand bound to PSMA is internalized, the target may also be used for endoradiotherapy. We used a small molecule inhibitor of PSMA ((S)-2-(3-((S)-1-carboxy-5-(3-(4-[^{131}I]-iodophenyl)ureido)-pentyl)ureido)-pentanedioic-acid; MIP-1095) for therapy in men with mCRPC. Dosimetry estimates for I-131-MIP-1095 revealed that the highest absorbed doses were delivered to the salivary glands (3.8 mSv/MBq, liver (1.7 mSv/MBq) and kidneys (1.4 mSv/MBq). The absorbed dose calculated for the red marrow was 0.37 mSv/MBq. PSA values decreased by >50% in 60.7% of the men treated. 84.6 % of men with bone pain showed complete or moderate reduction in pain. Hematological toxicities were mild. 25% of men treated had a transient slight to moderate dry mouth. No adverse effects on renal function were observed.

In order to increase the therapeutic flexibilty we designed a novel theranostic PSMA ligand coupled to DOTA which allows coupling to Ga-68 for diagnostic use or to Lu-177 or Ac-225 for therapy. Especially for alpha therapy with Ac-225 promising results were found in the first 10 patients.

SP-0603
MR spectroscopic imaging at high field for tumour characterisation

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Abstract not received.

SP-0604
A visual computing approach towards integration of multi-parametric imaging into radiation oncology workflows

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The integration of the full analytical power of today's multi-modal and multi-parametric imaging techniques into workflows of radiation oncology has not yet reached daily clinical routine. Reasons for this are manifold and range from simple data integration problems to the question, how the relevant information distributed over different images or over several parameters can be fused in the best way to provide a more complete and comprehensive image of the current situation.

The EU project Software for the Use of Multi-Modality images in External Radiotherapy – SUMMER(*) is addressing these problems with the aim to extend the current set of imaging modalities integrated into radiotherapy planning. In this talk, I will give an overview over faced challenges and results achieved over the last 3 years from a Visual Computing perspective. I will show how visualization, data fusion, and alternative ways in data representation can be used to gain