Contribution ID: **31** Type: **Poster**

Towards Implementing Multiparametric PET/MR for RT Planning in Head and Neck Cancer

Tuesday, 22 May 2018 16:15 (1h 30m)

AIM:
We explore the feasibility of performing PET/MR scans of head and neck cancer (HNC) patients in radiation therapy (RT) treatment position using MR-compatible RT immobilization devices. We develop and test a proper workflow and scan protocol, which can be implemented for daily routine. Finally, to explore the use of multiparametric PET/MR in relation to personalized RT, we compare the quantitative ADC values of two different diffusion weighted imaging (DWI) methods.

MATERIALS AND METHODS:
The feasibility study included 3 pilot patients diagnosed with HNC referred for RT. Patients were PET/MR scanned (Siemens Biograph mMR) in the same position as the planned treatment by using an MR-compatible RT setup, allowing attachment of thermoplastic patient masks, which are also used in routine planning CT and during the RT treatment. The scan protocol included anatomical imaging, DWI, and ultrashort echotime sequences. PET images were reconstructed using E7tools (Siemens) with MR-based AC and CT-based hardware attenuation map.
For comparison of DWI methods, ten patients with HNC referred for surgery were included. Each patient underwent two different DWI sequences on the same PET/MR: A single-shot EPI and a multi-shot EPI. Comparison of the resulting ADC maps was performed in a volume on interest (VOI) delineating the primary tumor. A correlation between the mean ADC values and a voxel-vise Bland-Altman analysis were performed.

RESULTS:
In the pilot feasibility study all three patients were scanned and data were successfully acquired. Total scan time for each patient was approximately 30 minutes excluding DCE-MRI and post contrast imaging, which is to be included in a larger future study. All there patients complained about back pain after the examination, but due to suboptimal workflow the patients spend longer time on the patient table than needed. Proper preparation of the hardware setup prior to positioning the patient is important to optimize patient comfort. For comparison of DWI methods, a strong correlation ($R2=0.78$, $P<0.01$) was seen between the mean ADC values, when excluding one clear outlier. On a voxel basis, the Bland-Altman analysis showed no apparent bias between the methods but limits of agreement of 60%.

CONCLUSION:
Although based on a very small cohort of patients, we have shown that it is feasible to scan patients with HNC on a PET/MR system in the same position as the planned treatment using a complete RT fixation setup. On a voxel basis, the ADC values from the two DWI methods demonstrated a rather large variation, suggesting that quantitative ADC values should be carefully evaluated, especially if RT methods such as dose-painting by numbers is considered. In future work we will investigate whether dose plans can be derived solely from PET/MR data, thus allowing for one-stop-shop PET/MR RT planning.

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Session Classification: Session 8 - Poster Session I