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Ultrasound image guided radiotherapy for prostate cancer using a transperineal probe
M. Fargier-Voiron1, B. Presles1, P. Pommier2, S. Rit3, D. Sarrut3, M.C. Biston1
1Université de Lyon CREATIS CNRS UMR5220 Inserm U1044 INSA-Lyon Université Lyon 1, Centre Léon Bérard, Lyon, France
2Université de Lyon, Centre Léon Bérard, Lyon, France

Purpose/Objective: Pre-treatment imaging based on ultrasound (US) images was first developed using transabdominal probes but several issues linked to image quality and probe pressure were reported. The aim of this work was to evaluate a non-invasive transperineal (TP) US probe comparing its registration results with cone beam CT (CBCT) on patients treated for a prostate cancer, with prostate in situ or after prostatectomy.

Materials and Methods: 10 prostate patients (cohort A) and 14 post-prostatectomy patients (cohort B) were imaged with the TP probe (Clarity, Elekta), which acquires 3D images using an automated motorized sweep. During the planning CT session, a reference US (USref) image was acquired with the patient in the same position as that of the CT acquisition. A reference positioning volume (RPV) was delineated on the USref image (Figure 1). For each treatment session, a daily US (USday) image was acquired and manually registered on the USref image using a RPV projection. A CBCT image was acquired right after and registered on the reference CT. The differences between CBCT and TP-US shifts were analysed on 320 and 453 paired USday/USref and CBCT/CT images for the cohorts A and B, respectively. Finally, the systematic difference found between CBCT and US shifts was retrospectively calculated on the first 5 sessions and applied to the US shifts of the following sessions.

Results: The US system was well tolerated by the patients. All images were of good quality for the registration of the two cohorts. On the raw data, shifts agreements at ± 5 mm were above 80 %, with the best agreement obtained in the lateral direction for both localizations (≥ 97.6 %). Average differences between the 2 modalities were 2.2 ± 3.2 mm, -0.2 ± 2.5 mm and -0.3 ± 2.7 mm for the cohort A, and 1.5 ± 2.6 mm, -1.6 ± 3.2 mm and -0.5 ± 2.3 mm for the cohort B, in the axial, longitudinal and lateral directions respectively. These results were comparable to other inter modalities, e.g., CBCT soft tissue registration versus fiducial markers with MV-EPI registration. Correcting the systematic shifts between the 2 image modalities on the base of the first 5 fractions enabled the percentage of agreement to be greater than 93 % for all directions and localizations and the average differences to be close to 0 mm (≤ 0.3 mm whatever the direction or localization). Therefore, correcting systematic shifts drastically improved the results.

Conclusions: TP-US based localization of the prostate or the prostate bed is a feasible method to ensure accurate delivery of treatment plans. This device represents an attractive alternative to invasive and/or irradiating imaging modalities.

References:

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Beam delivery time reduction in breath-hold treatments for left-sided breast cancer using FFF technique
T. Koivumäki1, J. Heikkilä1, A. Väänänen1, J. Seppälä1
1Kuopio University Hospital, Cancer Center, Kuopio, Finland