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EXACTRAC IMAGING FOR PATIENT SETUP IN HYPOFRACTIONATED PROSTATE RADIOTHERAPY

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Introduction: Hypofractionated radiotherapy has been introduced for prostate cases and shows high long-term survival rates. Hypofractionation for geriatric patients allows reducing the treatment time from 9 to 5 weeks, thus increasing the patients' quality of life while preserving the therapeutic outcomes. However, the reduction of the number of fractions combined with dose escalation imposes the systematic application of image guidance (Image-guided radiotherapy, IGRT) to ensure an accurate delivery of the prescribed dose for local tumor control, avoiding significant toxicity. Over the last year, a hypofractioned protocol for low and intermediate-risk prostate cancer patients, prescribing the delivery of 66 Gy in 22 fractions (3 Gy/fraction), was implemented at the Hospital Vitória (Santos-Brazil). This study reports the quantitative assessment of patient setup accuracy on a population of 21 patients who underwent this hypofractionated therapy scheme. For image guidance, the BrainLAB AG ExacTrac system was applied systematically. The short-term clinical follow-up features satisfactory results in accordance to similar studies carried out in other institutions.

Methods: For the setup corrections analysis, data from 21 hypofractioned treatment patients were analyzed. Three patients were between 64 and 68 years old, the others were from 70 to 87 years old. Treatment planning was performed based on CT imaging featuring a voxel size of 0.84 mm, 0.84 mm and 2.5 mm for right-left, anterior-posterior and superior-inferior axes, respectively with an isotropic 7 mm PTV margin. Before each treatment fraction, each patient was positioned on the treatment couch and had his skin markers aligned with in-room lasers. After this initial setup, orthogonal kV x-ray projections were acquired to be compared with digitally reconstructed radiographs from the patient's CT. The rigid image registration (IR) procedure estimated the parameters of a 6 DoF (degree of freedom) correction, based on bony anatomy alignment, which was visually assessed. For these patients, since the prostate is not visible for 2D radiographs or portal images; the bony structure of the pelvis was used as a surrogate. The patients were treated with the Varian high-energy medical linear accelerator Clinac iX 5187, integrated with the BrainLAB AG ExacTrac 5.5.6 system for image guidance. After the treatment, a positioning report was generated; it contains all the 6 DoF corrections applied to the treatment couch for each patient. The corrections of the first day of treatment were discarded due to CT coordinates to isocenter shifts for initial patient setup. In total, 442 6 DoF correction vectors (translation and rotation) were analyzed.

Results and Discussion: The mean and standard deviation (Std) values for the 442 corrections applied to the treatment couch are presented in table 1 for each anatomical direction: RL (Right-Left); SI (Superior-Inferior); AP (Anterior-Posterior). The results are summarized as translations (t) and rotations (r).

Table 1 - Mean and Standard Deviation values of correction vectors applied for patient setup

Corrections	Translation RL (mm)	Translation SI (mm)	Translation AP (mm)	Rotation RL (degrees)	Rotation SI (degrees)	Rotation AP (degrees)
Mean	1.72	0.44	-1.15	0.57	0.27	0.01
Std	5.55	3.50	3.14	1.30	1.00	1.01

The ExacTrac system verifies the position of the patient and applies a correction vector daily, reducing the bony alignment uncertainty to submillimetric magnitude, which is certainly an important requisite in the frame of an hypofractionated radiotherapy protocol. The magnitude of the corrections provided by the ExacTrac system suggests that skin-marks-based patient alignment might not be sufficient to grant the required level of setup accuracy in hypofractionated protocols. The large corrections found especially for translations along the RL direction might be explained by patients' high body mass, which made particularly difficult to obtain an acceptable setup based on skins-markers and laser alignment. Grade 1 reactions were observed for 11 patients, these complications responded well to the applied treatments.

Conclusions: Skin-marks positioning with weekly portal imaging would require a 10mm PTV margin. This study presented random errors, that remain after the mentioned conventional positioning technique, which are reduced by ExacTrac usage. Orthogonal 2D kV projections feature high image quality, spatial resolution and signal to noise ratio. This allows one to exploit automatic image registration procedures for the estimation of 6 DoF corrections to be applied for patient setup refinement. Further margin reductions require fiducial implants or volumetric images. The short-term clinical follow-up (6 months) presents satisfactory results.