Implementation of Linac-based VMAT total body irradiation technique using surface-guided radiation therapy

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Résumé

Introduction: Compared to the extended source-to-skin-distance technique, Total Body Irradiation (TBI) using intensity-modulation techniques increase the patient's dose homogeneity while better sparing the organs at risk (OAR). The objective is to present dosimetric results and workflow efficiency for the first patients treated with a combined volumetric modulated arc therapy (VMAT) and dynamic MLC (dMLC) technique based on surface-guided radiation therapy (SGRT) and a rotatable tabletop to perform the treatment sessions.
Material and Methods: Eight patients having received either 2Gy (n=4), 8Gy (n=1), or 12Gy (n=3) in 2Gy per fraction were included in this study. They were immobilized using a BlueBag vacuum cushion and a three-point mask open over the face and positioned on a rotatable tabletop (IT-V) attached to the treatment table. One headfirst (HF) or two CT scans (HF and feet-first (FF)) were performed depending on the patient's height (140cm). Treatment plans using 2 VMAT arcs or 2-3 dMLC beams, for head-pelvic and legs respectively, were performed on Monaco 6.1 treatment planning system (Elekta). The distances between isocenters were within 20-30cm range. To evaluate the robustness of the plans, dose distributions were perturbed by applying shifts of 5mm on the isocenters coordinates in each direction, separately. Patients were treated on a Synergy (Elekta) Linac, equipped with an Agility multi-leaf collimator. The quality controls were performed with the ArcCheck device (Sun Nuclear) on the thoracic beam only because of its higher modulation degree. Pre-treatment positioning of patients in the HF orientation was made with AlignRT (VisionRT) surface imaging system. Then a pre-treatment CBCT was performed before delivering the thoracic beam. All other HF beams deliveries were preceded by AlignRT-based positioning, and by a check of the Linac table coordinates to ensure that they were within 5 mm compared to the simulation. The same steps were repeated in the FF orientation with a CBCT image on the calf isocenter. Dosimetric data, robustness results and beam delivery times were collected.

Results: Regarding PTV coverage, the mean near-max dose was 107.9% +/-2% and the mean near-min dose was 96.7% +/-1.7%. OAR constraints were met for all patients. The robustness study found a maximum of 3.3% dose deviation for 5mm shifts in all directions

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separately. Homogeneity index were 0.11+/-0.02 and 0.13+/-0.02 for initial and perturbed plans, respectively. With an average duration of 42 to 38 min between the first and last beams (at the first and last sessions), the sessions were comparable in length to those carried out using the old treatment technique.
Conclusions: We showed that VMAT-TBI can be safely implemented: mean lung dose achieved the latest recommendation and plans were robust up to 5mm displacements. Treatment workflow based on SGRT was comfortable for patients and led to a reasonably short treatment time.

Mots-Clés: Total body irradiation, TBI, Surface guided radiation therapy, SGRT