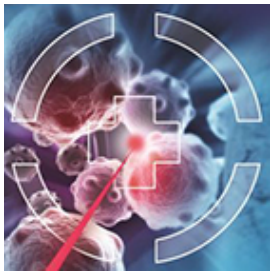

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Organ motion quantification and margins evaluation in carbon ion therapy of abdominal lesions

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In particle therapy, image guidance is vital for planning and treating, especially for abdominal lesions, where the respiratory motion hinders treatment accuracy. In this study, fast acquired interleaved 2D CINE MR images were used to quantify the tumour (GTV) motion over several breathing cycles, to evaluate the clinical approach based on deriving an internal target volume (ITV) from a 4DCT.

Data from seven patients treated with pencil-beam scanning carbon-ion therapy for abdominal lesions at the National Centre of Oncological Hadron-therapy (CNAO, Italy) were considered. For moving targets, a combined approach with abdominal compression, rescanning and gating at end-exhale is employed. The MR scan was performed on the same day of 4DCT acquisition. For 4 patients, an additional MR was acquired approximately after 1 week. The 2D CINE MR (300 frames acquired in 1.13 min) images centered on the target, along with a deformable image registration algorithm were used to quantify tumour motion. Afterwards, two ITVs were defined considering: (1) all the respiratory phases (ITV_FB), (2) only phases within the gating window (ITV_G). The generated ITVs were compared with the clinical ITV (ITV_C) as defined at CNAO using phases within 30%-exhale and 30%-inhale of the 4DCT.

CINE MRI captured images from 12-20 breathing cycles in contrast to 4 from 4DCT. The ITV normalized for the GTV had median(iqr) values of 0.15(0.19), 0.32(0.52) and 0.8(0.97) for ITV_C, ITV_G and ITV_FB, respectively. The median(iqr) Hausdorff distances (p=95%) from the GTV were 3.40(1.57), 2.18(2.23) and 9.71(6.99) mm for ITV_C, ITV_G and ITV_FB, respectively. According to both metrics, the ITV_C was significantly different from the ITV_FB, but not significantly different form ITV_G.

Spatial differences between ITV_G and ITV_C are due to more breathing cycles captured by MR, thought these were not-significantly different, indicating the effectiveness of the adopted gating approach to mitigate tumour motion.

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