CLINICAL IMPLEMENTATION OF ELECTROMAGNETIC TRANSPONDERS FOR REAL-TIME TRACKING IN LUNG SBRT

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Introduction

We describe the use of electromagnetic transponders (EMT) in the treatment of early stage non small cell lung cancer with stereotactic body radiotherapy (SBRT) to address intra-fraction motion.

Material/Methods

Two patients (pts) were implanted with lung-specific EMT (Calypso®), Fig 1.

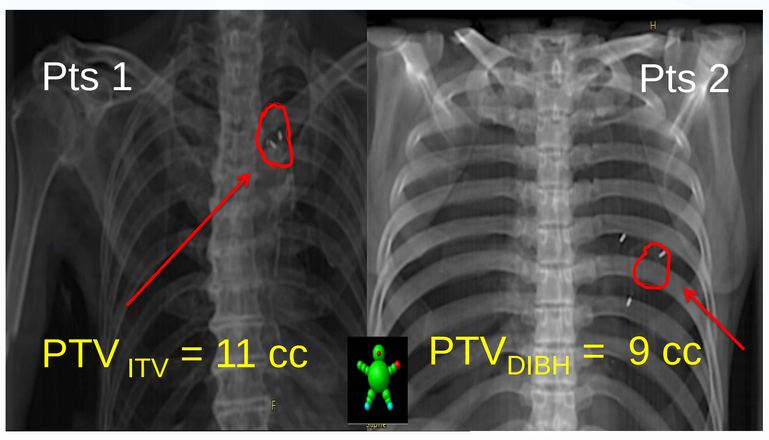

Figure1: Digitally reconstructed radiographies showing EMT and planning target volumes (PTV) outlines.

Planning used 4DCT-scans, free breathing (FB) and deep Inspiration breath hold images (DIBH). The prescribed dose was 60Gy in 8 fractions to the planning target volume (PTV) PTV_{FB}=ITV+5mm, PTV_{DIBH}=GTV+5mm.

Figure2: Patient 1 in treatment position with Calypso ®.

Volumetric modulated arc therapy (VMAT) was used, Fig.2. For planning, setup and SBRT treatment, FB was used for pts1, while DIBH was chosen for pts2. Patient setup at Linac used the mean EMT position calculated from the 4DCT-scan and the fixed position from the DIBH images. A cone beam CT (CBCT) followed, in FB and DIBH respectively for pts1 and pts2, before each treatment to visualize tumor and EMT position, and compare them to planned position (Fig. 3). EMTs motion was recorded real-time, interrupting SBRT when a threshold of 3 mm in any directions was trespassed for the mean EMT position (Fig.4).

Results

The DIBH planning approach for pts2 allowed for better dosimetric results compared to the FB, Fig. 5, and was therefore used to treat.

For both pts, SBRT was successfully delivered with no acute toxicity. Sessions mean duration was smaller than 13 minutes.

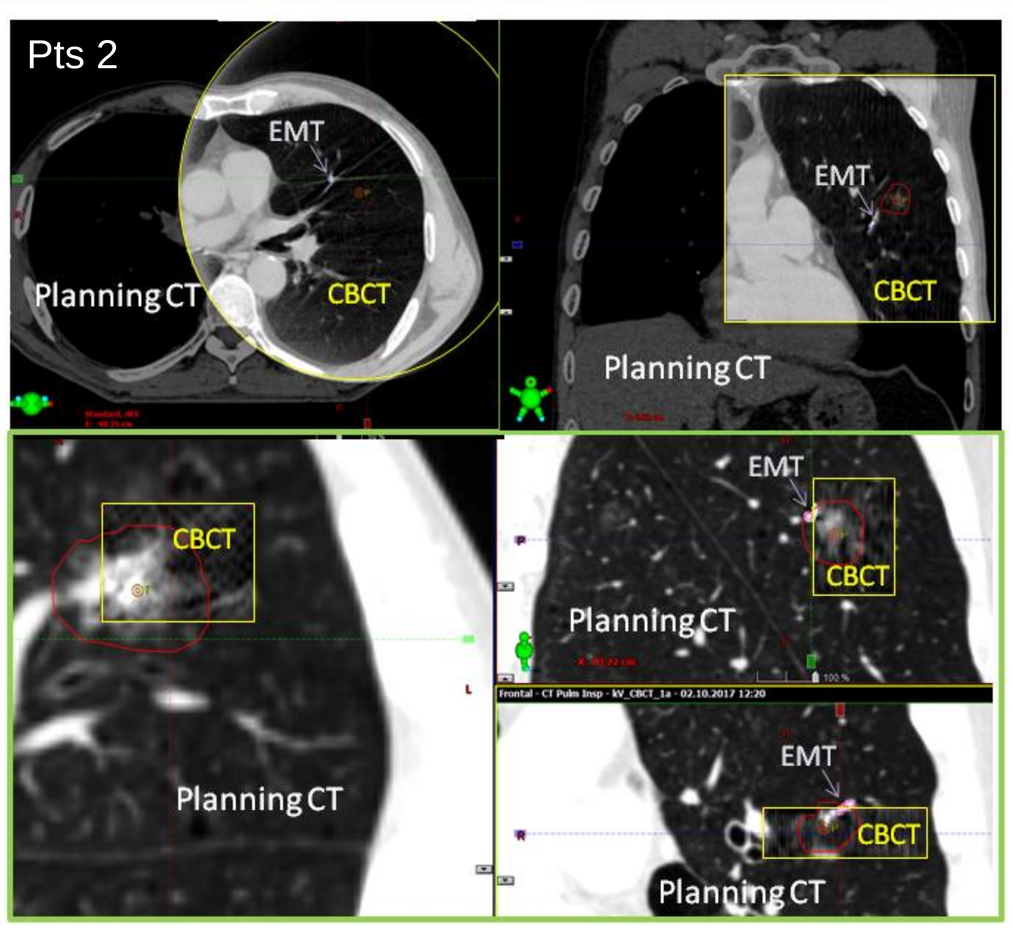

Figure3: Patient 2 CBCT imaging at linac overlaid with reference CT-scan.

Geometrical residual, measured versus planned, mean EMT positions remained stable during SBRT with a max difference of 0.01 cm for pts1 (FB) and of 0.17 cm for pts2 (DIBH).

With FB, in 5/8 fraction our tracking system detected EMT motion beyond tolerance, with automatic interruption of the beam (maximum deviation of 1.1cm). For pts2, beam interruptions caused by patient coughing or releasing of the DIBH, occurred with a median frequency of 5 times per fraction (range 0-14). Twice, a fast realignment with orthogonal kV and EMT positions was necessary.

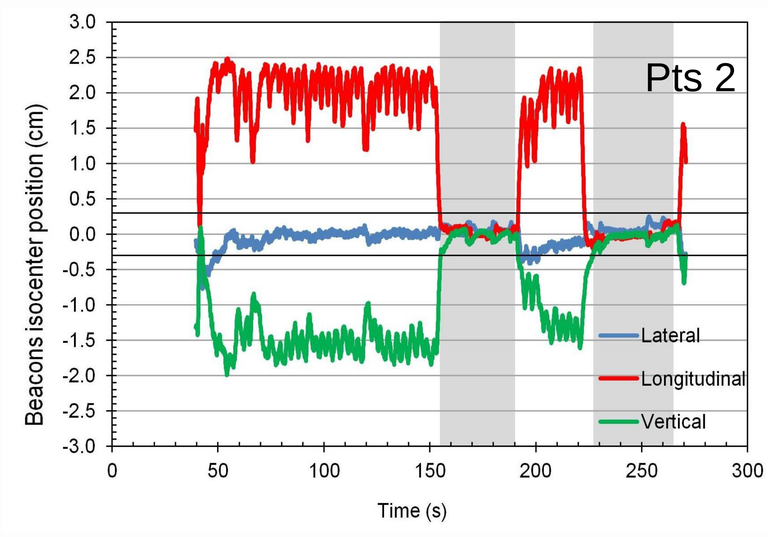

Figure 4: EMT position tracking (Grey =treatment).

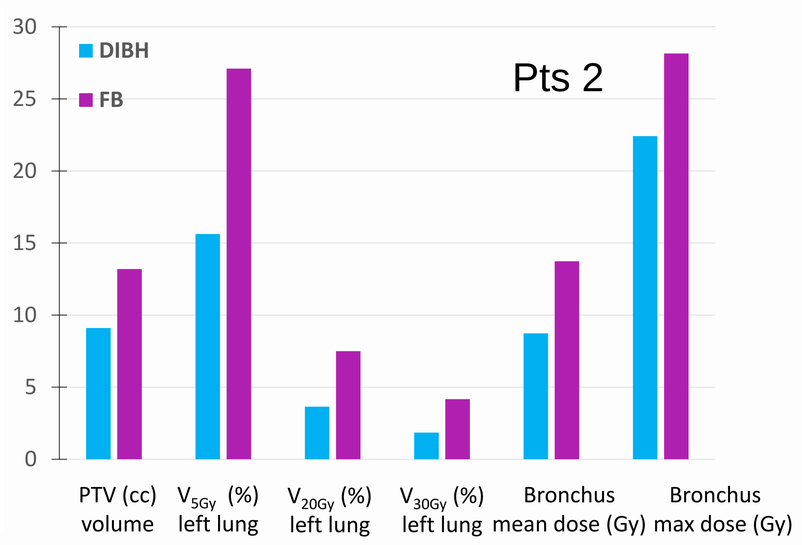

Figure 5: Dosimetric parameters for patient 2.

Conclusions

Using Calypso® allowed to:

- monitor real-time tracking lung SBRT delivery;
- optimize treatment according to patient's breathing capabilities, target motion's and, target location;
- optimize accuracy of high dose delivery to a moving target.

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Physics track: Intra-fraction motion management

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