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Chapter 13

Stereotactic lung radiotherapy: Do we need fiducial markers?

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A recent article by Harley et al. described the use of endobronchial ultrasound and navigational bronchoscopy to place fiducial markers (FM) for tumor tracking during stereotactic radiotherapy (1). Their approach resulted in fewer complications than percutaneous FM placement, and more importantly, improved nodal staging. The latter is essential as occult nodal metastases can occur in 10% of patients with negative nodes on the basis of CT and PET-scans (2).

However, their discussion on strategies for managing tumor motion is not a true reflection of the state of the art in radiotherapy. Comments that merit particular attention are that “linear-accelerator based stereotactic treatments are inadequate and will result in larger treatment margins and associated lung damage than treatment with Cyberknife”, and that a system which does not require FM for delivering stereotactic treatments has not been developed, suggesting that tumor tracking is a fundamental component of stereotactic lung radiotherapy.

Four-dimensional CT (4D-CT) scans have been used since 2003 to account for tumor motion in planning lung stereotactic radiotherapy. 4D-CT studies reveal that only a minority of lung tumors move more than 1 cm and that a single scan can reliably identify this (3;4). Consequently, most peripheral tumors do not require respiration-gated radiotherapy or tracking to minimize toxicity. Modern linear accelerators are equipped with a cone-beam CT scan (CBCT), a device that permits the 3-dimensional tumor position to be established immediately prior to, and during, treatment. CBCT allows daily treatment setup to be based on the actual tumor position, thereby avoiding the toxicity and costs of implanting FM.

At present, real-time motion tracking only appears to be essential when treatment delivery times are prolonged to >30 mins (5). This is clearly the case with the Cyberknife system as the median treatment delivery time for lung treatments is 1 hour 40 minutes (range 47–3 h 30 min) (6). In comparison, use of volumetric modulated arc therapy (VMAT) permits treatment delivery on a linear accelerator in less than 12 minutes after position verification using CBCT (7). Software for VMAT delivery is currently being offered by a number of manufacturers, and this allows for faster delivery that minimizes risk of intra-treatment drifts in tumor position, improves patient tolerance and departmental efficiency (7).

Finally, and most importantly to patients, the results reported using Cyberknife do not appear to be superior in terms of tumor control or toxicity than those planned using 4D-CT scans and delivered on linear accelerators (8).

We agree with the authors that patients should be evaluated in a multi-disciplinary team and that endoscopic staging of the mediastinum and hilus should be considered essential for stereotactic radiotherapy. However, we question the necessity of FM, given the frail patient population, need for general anesthetic, cost, 10% miss rate, and small pneumothorax risk. This importance of these risks is magnified as stereotactic treatments are being delivered routinely without FM on linear accelerators with outstanding oncological outcomes and very favourable toxicity.

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Chapter 14

Stereotactic Radiation Therapy: Changing treatment paradigms for stage I non-small cell lung cancer

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