Motion management strategies for complex Lung SABR patients

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Introduction

Treating large or anatomically complex lung lesions with stereotactic ablative radiotherapy (SABR) is challenging due to respiratory-induced tumor motion and the proximity of critical organs at risk (OARs). Excessive motion can lead to enlarged internal target volumes (ITVs), compromised dosimetry, and increased toxicity risk. To address these issues, our department developed a structured, risk-stratified workflow incorporating phased respiratory gating as a selective motion-management strategy.

Aim

To describe the implementation of a phased-gating decision pathway for large lung SABR lesions, outlining the criteria used for patient selection, the workflow developed, and the early learning gained from clinical use.

Materials and Methods

All patients undergoing SABR for large or lower lobe lung lesions received a 4D-CT scan as the initial assessment of respiratory motion. The magnitude of tumour displacement and any deformation across phases were evaluated to determine whether motion significantly increased the ITV. Adjacent OARs including heart, oesophagus, stomach, trachea and bronchus were reviewed in relation to the ITV to assess whether motion-related proximity could compromise planning feasibility.

Patients were stratified according to motion amplitude and anatomical complexity. Phased gating was reserved as a last-resort option for cases where free-breathing ITV expansion resulted in unacceptable OAR doses. For selected patients, respiratory coaching was performed using a visual coaching device (VCD) to promote reproducible breathing. Gating phases were identified at the contouring stage based on tumour stability, phase-specific position and OAR relationships.

During treatment delivery, intermittent kV imaging was used to verify tumour position within the selected gating window and to detect any gross deviations or patient-related motion.

Results

Implementation of this workflow enabled safe and effective SABR delivery in patients with large tumour motion or complex anatomical relationships. This allowed us to offer SABR to patients who otherwise would not have been suitable for any other radical treatment options. Furthermore, whilst phased gating was used sparingly, it proved valuable in cases where conventional motion-management strategies were insufficient. Intermittent imaging confirmed good reproducibility of the gated position and supported confidence in treatment accuracy.

Conclusion

Phased gating provides a robust and clinically useful option for managing large or highly mobile lung lesions in SABR. Our structured, risk-stratified workflow supports consistent decision-making, improves motion control, and expands treatment feasibility for patients with challenging anatomy or significant respiratory motion.