Mechanical ventilation in radiotherapy for intrathoracic tumours: a hypothesis under pressure?

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Introduction

Breathing motion is a challenge in radiotherapy for intra-thoracic tumors in terms of geographical misses and higher radiation exposure to the surrounding healthy tissues. Mechanical ventilation (MV) could achieve a reduction in tumor motion which may result in improved dose-to-target delivery, accuracy and healthy tissue sparing.

Aim

First: finding the optimal settings (and evaluate feasibility) of Continuous or Bilevel Positive Airway Pressure (CPAP/BiPAP) in patients that were planned to receive thoracic radiotherapy. Second: to evaluate the actual effect of MV on tumor motion.

Materials and Methods

First phase: CPAP and BiPAP were tested in 10 patients with intra-thoracic tumours using the following settings: CPAP 5, 10 and 15 cmH_2O and BiPAP 14/10 cmH_2O (with low and high back-up frequency). The lung volumes were evaluated by Electrical Impedance Tomography (EIT), the change of impedance during a tidal breath was used as a measure of breathing amplitude. Feasibility in terms of patient comfort was evaluated using a visual analogue scale.

The (ongoing) second phase of this study aims to evaluate the actual impact of MV on target motion as measured on radiotherapy planning 4DCTs. Radiotherapy plannings 4DCTs were acquired both with and without MV. This procedure was repeated weekly during the course of radiotherapy to measure target motion over time and to evaluate if the MV remains feasible for the patient.

Results

Phase 1: both CPAP and BiPAP settings were well tolerated, 9/10 patients were able to sustain all settings, although the comfort scores worsened with higher pressures (CPAP-15 most uncomfortable for 6/10 patients). Based on EIT, the estimated end-expiratory lung volume increased with higher CPAP pressure, however, no specific setting of CPAP or BiPAP was able to reduce tidal volume and variability in an uniform way. Ultimately, BiPAP with high BURR seemed most promising for the next phase of this study because it was well tolerated and reduced tidal volumes in 50% of patients.

Phase 2: five patients could be assessed in this preliminary evaluation. GTV motion was equal or increased with BiPAP compared to free breathing, lung volumes increased with BiPAP for all patients (see Fig. 1). Further work will be performed to assess GTV motion over the course of radiotherapy and the actual impact on the treatment plan.

Conclusion

Despite a measurable increase in lung volumes with BiPAP, tumor motion was not reduced. Ongoing patient accrual and longitudinal assessment of tumor motion during radiotherapy are planned to enable more robust conclusions regarding the potential of BiPAP as a motion mitigation strategy.

Figure 1. Maximum Gross Tumor Volume (GTV) motion (upper graph) and lung volumes (in cm3, lower graph) during free breathing and during BiPAP.