AbstractID: 8416 Title: Analysis of respiratory signals from a motion tracking system

Purpose: To evaluate signals from a real-time respiratory tracking system in order to estimate the uncertainty of the prediction algorithm used to compensate for system latency and to propose possible modifications of the planning and tracking strategy.
Method and Materials: Respiratory signals of 53 patients who had lung or liver treatments by means of the Cyberknife robotic radiosurgery system were analyzed. Treatments were performed by means of the Synchrony motion tracking system, based on the correlation between position and velocity of external infrared markers and the corresponding quantities of internal markers randomly imaged throughout the treatment. Patients were neither trained nor asked to breath regularly. The external marker data were collected for all patients. Respiratory signals were characterized by means of a metric based on the frequency power spectrum, as recently proposed by other authors. Correlations were investigated between such descriptors and inaccuracies of the prediction algorithm used by the tracking system.
Results: Prediction errors above 2 mm, lasting for periods longer than 5 seconds were observed for irregular breathers. These episodes correlated significantly with the presence of a bimodal distribution in the power spectral density analysis, with a relative weight of very low frequencies similar to the dominant frequency of respiration. From the analysis of signal patterns this was interpreted as a negative influence of baseline variations over several breathing cycles, affecting the recovery performance of the prediction algorithm.
Conclusion: This analysis was conducted on a higher number of patients compared to previously published studies. A simple method to account for the observed discrepancies could be the definition of PTV margins on a patient-by-patient basis. A more refined approach would include a personalized choice of the prediction algorithm based on the very first minutes of treatment, or the implementation of bandpass or "notch" filters to remove unwanted frequencies.