

AbstractID: 13797 Title: Physics-Based Respiration-Simulating Model Incorporating Pressure-Volume Parameters for Lung: What Can We Learn From the Biomechanical Modeling Community?

**Purpose:** A lung tumor moves during radiation therapy as a result of respiratory motion, discrepancies between planned and actually delivered radiation doses can be significant. It is desirable to accurately model the lung motion and the tumor location so that the radiation dosimetry involving such a moving target can be evaluated. This paper describes, in collaboration with mechanical engineers, the development of a patient-specific, physiologically relevant respiratory motion model which is capable of predicting lung tumor motion over a complete breathing cycle.

**Method and Materials:** Each patient specific non-linear finite element (FE) lung model was developed under physiologically relevant conditions. The modeling was based on 4D CT data set of four lung cancer patients. Each 4D CT data was categorized according to multiple breathing phases. Non-Uniform Rational B-Spline (NURBS)-based surfaces were reconstructed and converted into suitable FE meshes. A hybrid anatomical modeling method was employed to integrate the deformable lung model with other organs adopted from a whole-body anatomical model consisting of 140 internal organs.

**Results:** The FE simulations took more than 3 hours on an Intel Core2 Quadcore 2.83-GHz CPU machine with 8-GB RAM. Expert-based validation using 48 landmarks of anatomical points in the lungs from the 4D CT data sets was summarized. The mean position errors between the FE model and 4D CT data are within 3 mm over the complete respiratory cycle.

**Conclusion:** Working with a team of mechanical engineers, we have developed true physics-based respiration model of the lung using a non-linear finite element method. The FE model has been validated shows good agreements between simulated motion and measured motion in 4D CT. A 4D respiratory motion simulating phantom has been demonstrated for the future study of complex radiation interactions in tissues and dose distribution patterns for various radiation delivery strategies using advanced Monte Carlo simulations.