AbstractID: 10434 Title: Physics-based respiration modeling for radiation treatment using patient-specific PV curves

Purpose: Respiration caused anatomical deformation is an intractable problem. This paper introduces an innovative method of developing a physics-based respiration model for treatment of lung tumor by considering patient-specific pressure-volume (PV) measurement. **Material and methods:** A finite element model of lung motion was developed from 4DCT images. The end of expiration (EE) state and the end of inspiration (EI) state were selected by the volume of surface mesh defined by the ROIs. NURBS-based CAD surfaces was reconstructed and converted into suitable FE meshes. A generic pressure history curves was used to define intrapleural pressure. This PV curve represents the elastic properties of the lung including the nonlinearity which makes the lung stiffer at higher volumes and hysteresis between inflation and deflation. The sinusoidal curve is used as the pressure history curve. **Results:** The FE model had 66704 tetrahedral elements with 3 independent components and 55947 unknown variables in total. The computation time required for the quasi-static analysis with nonlinear material and contact condition is 1.04 hour. The overall lung motion pattern is found to be physiologically realistic. **Conclusion:** The medical physics community has yet to develop an ability to define and predict the respiratory motion associated with the lung tumor. Physics based models, as shown in this study, are capable of tracking and predicting the lung deformations to the precisions necessary for the clinical needs, however, it is computationally expensive. In particular, this study suggests that the use PV curve data to model the respiration has the following benefits. The PV relationship in the simulation enables a researcher to apply the physiologically correct boundary condition and to increase the accuracy of prediction. Temporal lung and tumor motions afford the opportunity to simulate the specific moment during a full breathing cycle, which will open the door for advanced radiation therapy.