

Abstract

Children diagnosed with a condition called Thoracic Insufficiency Syndrome often develop abnormal thoracic anatomy and congenital deformity in the vertebral column, which limits children's pulmonary function and growth of lungs. Implantable medical devices such as the Vertical Expandable Prosthetic Titanium Rib are designed to help pediatric patients with the anomaly in the thorax, but complications follow as the installation of the device is patient-specific. To assist diagnosis and clinical research as well as to establish precise analysis for individual patient's anatomy when installing implantable medical devices, an anatomical finite element baseline model is developed in LS-DYNA[®] to define respiratory biomechanics of 4.5-year-old children. CT-based XCAT 3D geometry obtained from Duke University Medical Center is used as the reference geometry to establish the baseline geometry for mesh construction. Age-associated mechanical properties of the pediatric model are obtained from literature data and PIPER 4.5 YO child model. The anatomical model is divided into three sub-models, Chest Model, Intercostal Model, and Diaphragm Model, for validation through individual subsystem simulations. Simulation results are in good agreement with experimental data and literature results in terms of chest elasticity, rib dynamics, and diaphragm excursion. The 4.5 YO anatomical model serves as a novel baseline model for the future development of a scalable anatomical model used to investigate the respiratory biomechanics of children with challenging thoracic deformity.