This work is concerned with analyses of lung parenchyma based on a detailed micromechanical model of pulmonary alveoli against the background of ventilator-induced lung injuries. For this purpose a multi-scale approach combining globally known parameters e.g. pressure–volume curves with the mechanics of the underlying microstructure is employed. A representative volume element of the human lung is defined as an assemblage of pulmonary alveoli. Three-dimensional artificial random geometries based on tetrakaidecahedral cells are generated with the help of a novel labyrinthine algorithm. Preservation of overall minimal mean pathlength is a priori guaranteed – a feature that seems very reasonable in view of effective gas transport in the lung. The behavior of alveolar parenchymal tissue is described with the help of a polyconvex hyperelastic material model incorporating general histologic information. The strain-energy density function accounts for an isotropic ground substance including elastin fibers and the collagen fiber families. Each...
function fulfills the principles of objectivity and material symmetry as well as the requirements of polyconvexity and the stress-free reference state. Interfacial phenomena stemming from surface-active agents (the so-called surfactant) covering pulmonary alveoli are also incorporated into the micromechanical model. Instead of explicitly modeling the liquid lining its influence on the overall mechanical behavior is considered by enriching interfacial structural nodes of the finite element model with additional force and stiffness terms. The highly nonlinear and dynamic nature of surfactant is taken into account with the help of an adsorption-limited model relating surface stresses to the interfacial concentration of surfactant. It can be shown that interfacial phenomena influence the overall mechanical behavior of alveoli significantly. In this talk we will present the micromechanical model of pulmonary alveoli along with numerical examples as well as first approaches towards multi-scale analyses of lung parenchyma based on a concurrent or integrated approach.

Stichworte: pulmonary alveoli, interfacial phenomena, surfactant, labyrinthine algorithm, hyperelasticity, polyconvexity

Dewey Dezimalklassifikation (Liste):
620 Ingenieurwissenschaften

Kongress- / Buchtitel:
ECCOMAS Thematical Conference on Multi-scale Computational Methods for Solids and Fluids

Jahr:
2007

Revied:
ja

Sprache:
en

Publikationsform:
Print

Semester (für SAP-Datenerfassung):
WS 09-10

Format:
Text

Occurences:

Einrichtungen > Fakultäten > Fakultät für Maschinenwesen > Institut für Werkstoffe und Verarbeitung > Lehrstuhl für Numerische Mechanik (Prof. Wall) > Inproceedings > 2007

entries: