TITLE: Quantifying changes in vascular structure in development and disease

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RESEARCH PROJECT DESCRIPTION (brief overview of background, hypothesis, methods, role of medical student, funding and relevant publications)

The purpose of this work is to introduce noninvasive quantification of pulmonary vascular tree structure and function for improved diagnosis of disease, monitoring disease progression and assessment of the efficacy of emerging drugs and interventions. We have recently developed software programs to better extract and traverse complex vascular trees, and optimize branch sizing. We are now collecting 100’s of repeat CT image data sets and beginning to apply these techniques to three classes of patients: 1) adults with chronic pulmonary hypertension (and a rat model thereof); 2) pediatric patients with underdeveloped or congenitally abnormal lung structure; and 3) patients receiving radiation to the lung.

There are several populations of pediatric patients for whom PAH is common and of particular clinical concern; these include 1) children with a congenital heart disease (CHD); 2) newborns with persistent pulmonary hypertension (PPHN); and 3) children who are born in extreme preterm gestation. Most congenital heart diseases involve persistence of one or more cardiac shunts and, when detected, these are typically treated successfully with surgery. PPHN is defined as the failure of the circulatory system to reduce the fetal pulmonary vascular resistance and extrapulmonary shunting of blood that normally occurs soon after birth. With inadequate pulmonary perfusion, neonates are at risk for developing refractory hypoxemia, respiratory distress, and acidosis. For prematurely-born infants, the advances in neonatal intensive care now enable most of them to survive. However they often develop bronchopulmonary dysplasia (BPD) that is characterized as structurally abnormal, underdeveloped pulmonary vasculature and bronchoalveoli, which may or may not be associated with clinically measurable pulmonary hypertension. We are collaborating on this project with UF pediatric pulmonologists.

In patients receiving radiation for the treatment of cancers of the lung, the concern is for radiation damage to the surrounding, healthy lung tissue and vasculature. For these projects, we seek student-researchers who are comfortable working with computers and with a sufficient background in these diseases to help us process additional data sets, and identify and interpret new metrics of vascular structure that will most benefit the clinician. We are also beginning to apply these techniques to characterize lung airways with application to chronic obstructive pulmonary disease (COPD), asthma and cystic fibrosis.

Kheyfets VO, O’Dell WG, Smith T, Reilly Jr. JJ, Finol EA
Computational Hemodynamics of the Pulmonary Circulation – A Focus on Pulmonary
Hypertension