

Using Three-Dimensional Modeling to Analyze the Vascular System and Radiation-Induced Lung Damage

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Lung cancer is the leading cause of cancer-related deaths in men and women. In addition, many patients with progressive lung cancer develop latent radiation-induced respiratory damage. The purpose of this investigation was to use three-dimensional modeling techniques in java to create an interactive environment through which researchers can study lung structure and identify early markers of vascular injury such as pulmonary arterial hypertension (PAH). PAH is a condition that can result in heart failure and is difficult to diagnose because its symptoms are common in other diseases such as asthma. This program reconstructs the vascular lung system from CT scans using techniques such as automatic and snake-based segmentation, manually-selected seed points, pixel intensity thresholds, 3D skeletonization, the gatortail method, distance transformation, and recursive in-order tree traversal. Vascular characteristics that have not been studied in-depth since the 1970s such as bifurcation angle, area and volume ratio, branch radius, and tortuosity were also calculated and graphed for analysis. With this data, we found that some traits such as bifurcation angle remain constant, while others, such as branch radius, decrease with distance from the center. When comparing healthy lungs to those with PAH, we discovered that the tortuosity in patients with PAH was slightly higher than in healthy lungs, likely as a result of the increased pressure in the vessels caused by obstructions such as scar tissue and inflammation. Using this data, this research has the potential to optimize diagnosis of vascular damage and further the understanding of the human lungs.

Awards Won:

Fondazione Bruno Kessler: Award to participate in summer school "Web Valley" in Trento, Italy