Atlas-Building for Pediatric Airway Analysis

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Young children with upper airway problems are at risk for hypoxia, respiratory insufficiency and long-term morbidity. Surgical treatment for these children is an option. However, if possible one would like to avoid surgery for the children that will likely out-grow their upper airway problems. Identifying the severity of a particular airway malformation is difficult and one would like to understand what should be considered a normal airway at a particular age. (See also the handout on the Virtual Workbench for Planning Treatments of Airway Problems in Young Children.)

We therefore develop methods to summarize normal airway shapes from a population of normal control subjects to form a "normal airway atlas." This atlas allows scoring of airways with respect to what is considered normal at any given age and thereby allows assessing the severity of an airway malformation. Airway data is obtained by computed tomography (CT): a 3D medical imaging modality based on x-rays. Using image analysis the CT image data is processed to automatically obtain measurements of airway cross-sectional area from the nose to the carina. Summarizing these cross-sectional areas for many normal control subjects forms a normal control atlas. This atlas captures a representative average airway and its expected variation at a given age to which a subject with an airway malformation can be compared. This project makes involves aspects of computer science, applied mathematics, medicine, and statistics.
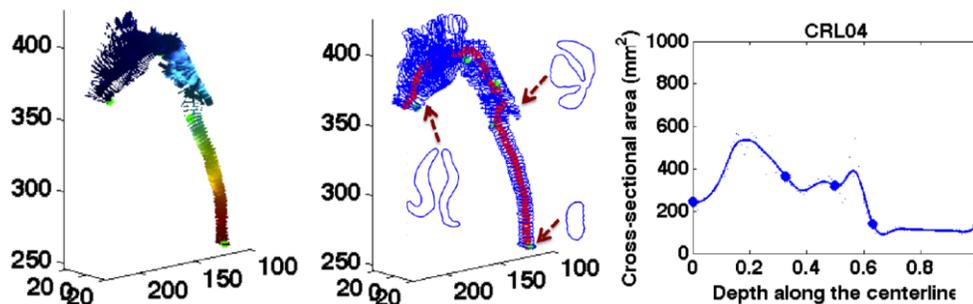

Figure 1: Three-dimensional reconstruction of the airway from CT (left) is used to extract cross-sectional airway areas (middle). This results in a function representing cross-sectional area along the airway (right), which is used to construct the atlas by summarizing functions for many normal control subjects.

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