During postnatal development the mean acinar volume shows a much lager increase than the total lung volume. An x-ray tomographic microscopical study.

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Introduction

The pulmonary acinus (gas-exchange area which is ventilated by one purely conducting airway) represents the functional unit of the lung parenchyma. Due a restricted availability of high resolution three-dimensional imaging methods the knowledge about the development of the pulmonary acini is limited. Using synchrotron radiation based tomographic microscopy [1] we developed a method to estimate the volume of single acini throughout postnatal lung development.

Methods

Large, high resolution tomographic dataset of rat lungs (postnatal days 4 to 60) were scanned at the beamline TOMCAT (Swiss Light Source, Paul Scherrer Institut, Villigen, Switzerland). Airway segments were extracted using a region growing algorithm. Up to 80 individual acini per segment were isolated by closing the transitory bronchioles semi-automatically with three-dimensional discs (segmentation breakpoints nicknamed manhole covers, see Figure 1). The volume of each acinus was determined by voxel counting.

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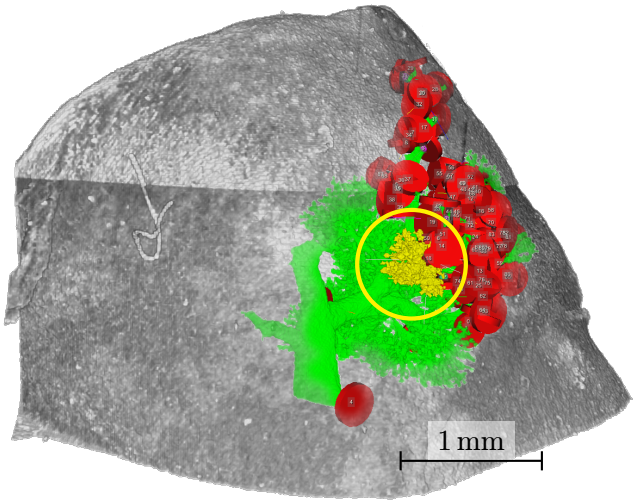

Figure 1: Two stacked X-ray tomographic wide field scans [1] of a rat lung (gray) were merged to one dataset. One large airway segment (green) has been extracted using a threshold based region growing algorithm. The red circular structures represent the manhole covers separating individual acini from the conducting airways. One segmented acinus is shown inside the yellow circle.

Results

We observed an approximately eighty-fold increase of the mean acinar volume during postnatal lung development (days 4–60, 0.0029 µl–0.236 µl). During the same period the total lung volume increases only approximately ten-fold [2], which results in an eight time lager growth of the acini than the total lung volume.

Conclusions

We hypothesize that this large increase of the acinar volume can only be achieved by a conversion of the 2–4 most distal purely conducting airways into alveolar ducts between birth and adulthood. As a consequence 4–16 small acini have to be merged to a larger one. We expect that the increased complexity of the adult acini influences both ventilation and particle deposition.

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References

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