

THE MEAN ACINAR VOLUME SHOWS AN UNPROPORTIONAL GROWTH COMPARED TO THE TOTAL LUNG VOLUME

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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 to 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 [Haberthür, 2010] we developed a method to estimate the volume of single acini throughout postnatal lung development.

Methods

Large, high resolution tomographic dataset of rat lungs (obtained at postnatal days 4 to 60) were acquired at the beamline TOMCAT (Swiss Light Source, Paul Scherrer Institute, Villigen, Switzerland). For $N=23$ animals airway segments were extracted using a region growing algorithm. Up to 107 individual acini per animal (total extracted acini $N=1009$, average per animal $N=44$) were isolated by closing the transition between conducting and gas-exchanging airways bronchioles semi-automatically with three-dimensional discs (segmentation breakpoints nicknamed manhole covers, see Figure 1). The volume of each acinus was determined by subsequent voxel counting.

Results

While the volume of the right lower lung lobe increases approximately ten-fold during postnatal lung development from day 4 to 60 [Tschanz, 2003], we detected a smaller increase in the volumes of the single acini (approximately 5.5-fold) for the same time-span and an unproportional decrease in volume from day 36 to 60.

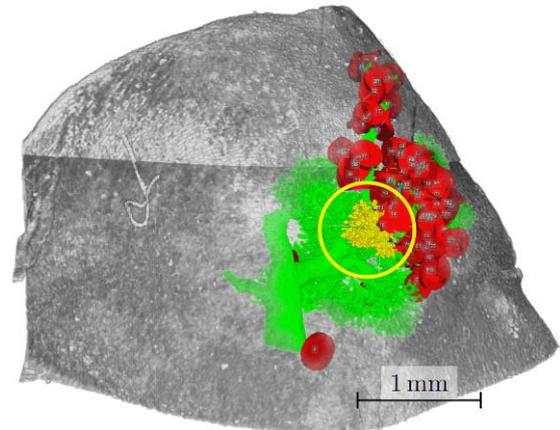


Figure 1: Two stacked X-ray tomographic wide field scans [1] of a rat lung (gray) were merged to one dataset. One large airway segment (green) has been extracted using a threshold based region growing algorithm. The red circular structures represent the manhole covers separating individual acini from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

Conclusions

During postnatal lung development from days 4 to 60 the mean volume of the acini increases from days 10 to 21 to 36. Between days 4 and 10 as well as days 36 and 60 we did not detect any difference in acinar volumes, despite the fact that the lung is growing.

We hypothesize that at days 10 and 60 a larger number of acini are present or that the growth of the acini is unproportional in regard to its location in the lung lobe (central or peripheral parts of the lobe).

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References

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- Tschanz *et al*, Pediatr Res, 53(1):72–80, 2003