FUNCTIONAL IMAGING ON PATIENT-SPECIFIC LOWER AIRWAYS USING COMPUTATIONAL FLUID DYNAMICS

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Abstract

Adding functional information to anatomical CT-data by means of Computational Fluid Dynamics (CFD) is a non-invasive method for analyzing patient-specific respiratory dynamics. As CFD is based on numerical models, validation is required to obtain reliable results. For this purpose, 2D PIV measurements are performed and compared to the CFD data [3].

1   Introduction

The use of CFD in the biomedical field is becoming more and more widely accepted. In the respiratory domain, the technique is being employed often in both upper and lower airway modeling and in the analysis of treatments for respiratory diseases [1]. Good knowledge about flow in the airways is essential for understanding respiratory (patho)physiology. CFD may help to predict the clinical outcome of therapies that alter the flow in airways and is also a way to assess ventilation and particle deposition in order to optimize inhaled drug therapies [2]. This study aims to investigate the feasibility of using PIV-validated CFD calculations for patient-specific airway analysis in a variety of airway pathologies such as COPD and asthma.

2   Materials and methods

High resolutions CT-scans of a 18 year old female were taken with a multi-slice scanner (GE VCT Lightspeed). The collection of DICOM images were read into a commercial software package (Mimics 10.0, Materialise). Image segmentation of the lower airways was performed and a 3D model up to the third bifurcation was generated. This model was printed for use in the PIV setup and was divided into discrete tetrahedral cells by a commercial mesh software package (Tgrid 4.0.16, Ansys) to form a computational domain for CFD simulations. This domain was read into a Reynolds Average Navier Stokes (RANS) CFD solver (Fluent 6.3.26, Ansys) and proper boundary conditions were set. The results of the numeric calculations were qualitatively compared to the results from the PIV measurements.

3   Results

Steady state calculations using fixed boundary conditions were performed. To be able to make a comparison with PIV measurements, the same boundary conditions and material properties were selected. Preliminary results are shown in Figure 1.
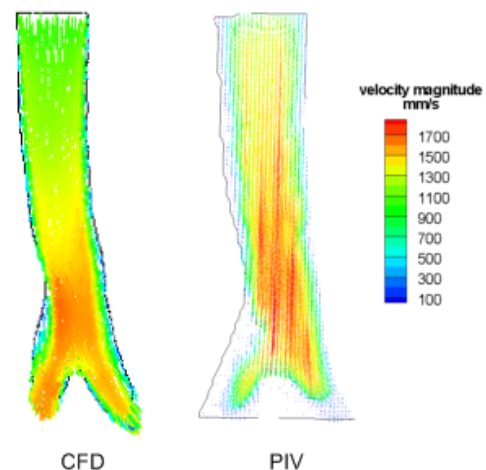

Figure 1: Comparison of velocity vectors in CFD and PIV

The velocity vectors were measured and calculated in the midplane of the trachea.

4   Conclusions & future

The first PIV measurements and CFD calculations were performed. A quantitative comparison between the PIV and CFD results will be made.

References

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