Fully-Automatic Determination of the Arterial Input Function for Dynamic Contrast-Enhanced Pulmonary MR Imaging (DCE-pMRI)

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Purpose

- Perfusion is important functional parameter for diagnosis of lung diseases
- Contrast agent (CA) administration combined with MRI allows quantitative assessment of pulmonary perfusion
- Arterial input function (AIF) necessary for calculations
- Conventional AIF definition: Manual drawing of region-of-interest (ROI) within the pulmonary artery
- Potential benefit of proposed automatic determination:
  - Precalculation of perfusion parameter maps during data import
  - Improved reproducibility of the calculations (e.g., for comparability of baseline and follow-up examinations)
Material

MR Perfusion Imaging & Subjects

- MR perfusion imaging
  - CA: Intravenous injection of paramagnetic gadolinium chelate
  - Sequence: FLASH (fast low-angle shot) - T1-weighted gradient echo technique with short repetition time (TR) and short echo time (TE)
  - Voxel size: ~ 2x2x5 mm³
  - Temporal resolution: ~ 1.3 sec

- Subjects: 7 male patients (14 DCE-pMRI data sets) from ongoing study
  - 6x chronic obstructive pulmonary disease (COPD) GOLD I-IV
  - 1x mild asthma
  - 24h repeatability
**Methods**

**Calculation of Perfusion Parameters**

- Calculation of perfusion parameters (blood flow, blood volume, mean transit time) based on singular value decomposition technique (see: [1][2])

![Perfusion image](image1)

![AIF definition](image2)

![Blood flow parameter map](image3)

Methods

Automatic AIF Determination

- Successive image-processing techniques for extraction of pulmonary artery
  - Removal of unlikely voxels (I)
  - First refinement step (II)
  - Second refinement step (III)
  - Skeletonization and graph analysis (IV)
Methods

Automatic AIF Determination (cont.)

- AIF definition
  - Branching position of pulmonary artery centerline detected by image processing steps
  - Extraction of circular or spherical region around this position
    Current implementation: circular, including 32 voxels (~ 610 mm³)
  - AIF curve consists of mean values of these voxels in every time step
Results and Discussion

Exemplary Results

- Results of presented method for baseline examinations (A,C) and corresponding follow-up examinations (B,D) of two patients.
**Results and Discussion**

**Accuracy & Performance**

- Correct identification of pulmonary artery branching point in all 14 data sets
- Presented method not intended for exact segmentation of pulmonary artery (but might provide valuable input for segmentation algorithms)
- Fixed size and shape of ROI which includes AIF voxels in current implementation; study needed to evaluate if this is a valid assumption
- Only few seconds computation time of automatic AIF detection on standard PC
Conclusions

- This work eliminates influence of person who draws AIF manually on outcome of quantitative pulmonary perfusion analysis
- Further study needed to evaluate a better comparability of longitudinal perfusion examinations and examinations of different patients with proposed method
- Automation of AIF determination allows generation of perfusion parameter maps in preprocessing step already during data import

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