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To cite this version:

Mounir Lahlouh, Yasmina Chenoune, Raphaël Blanc, Michel P. Piotin, Simon Escalard, et al.. Segmentation and characterization of the aorta and supra-aortic trunks for neuroradiology procedure planning. Colloque Français d’Intelligence Artificielle en Imagerie Biomédicale (IABM), Mar 2023, Paris, France. hal-03932761

HAL Id: hal-03932761
https://hal.science/hal-03932761
Submitted on 4 Apr 2023

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SEGMENTATION AND CHARACTERIZATION OF THE AORTA AND SUPRA-AORTIC TRUNKS FOR NEURORADIOLOGY PROCEDURE PLANNING

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1. Clinical background

Obstacles: aortic arch and carotid arteries
Complex tortuosities and angulations
Difficulty in accessing the supra-aortic trunks

Entry points:
Radial
Femoral

2. Technical background

Task Studies
SEGMENTATION
• Studies are oriented towards the use of CTA volumes.
• U-Net variants are the most used architectures.
• Approaches like multi-view 2D CNNs [2] and multi-stage pipelines were used [3].
• Segmentation is often pathology oriented e.g. segmentation of type B aortic dissection [3].

CHARACTERIZATION
• Generic frameworks with sets of functions for geometric quantification of anatomical features and vessel characterization [4, 5]. These frameworks are suitable for engineers for research but not relevant for clinicians to use in a medical setting.

3. Data

22 patients underwent 3T MR exams of aortic arch, supra-aortic branches and intracranial vessels on Philips imaging system (Ingenia 3T, Best, The Netherlands).

Acquisition parameters: coronal plane covering: 250 slices; active TR/TE = 5.5/0.2 ms; flip angle = 27°; number of excitations = 1; acquisition bandwidth = 476.7 Hz; FOV = 380 x 321; voxel size = 0.5 x 0.5 x 1.0 mm; imaging time = 69 sec; Bolus track injection technique.

Data labeling

Mentalise mimics care suite
Semi-automatic segmentation
3D linear

Validation and correction
Aortic arches only
Semi-automatic measurements
• Artery lengths
• Vessel tortuositites
• Angulations

4. Segmentation and characterization pipeline

Segmentation module
Volume refocusing
Localization CNN
Resampling
Normalization
Segmentation CNN

Geometric characterization module
3D linear
Centerlines

5. Results

➢ Dice score = 88.07%
➢ Precision = 84.10%
➢ Recall = 93.80%

3D reconstruction

Ground truth

Predictions

Artery Length Tortuosity
Pearson RMSE MAPE Pearson RMSE MAPE
RCCA 0.97 5.97 1.75 0.93 0.06 3.32
LCCA 0.92 6.80 1.14 0.95 0.04 2.30

6. Conclusion and perspectives

• Complete analysis pipeline, from MRA images to high-level features: arch type, tortuositites, reverse curves, take-off angles and access difficulty after engaging an artery.
• Quantitative and qualitative validation by comparison to the medical reference (manual measurements and segmentations).

Clinical validation of our features on a diversified dataset in terms of demographic, pathological and imaging data of different modalities.

1) and 2) Aortic arch and supra-aortic branches, 3) and 4) intracranial vessels. Vascular structures of different anatomical characteristics: vessels become more tortuous, and their diameter decreases as they ascend to the brain.

3D extension of our CNN pipeline to better capture vessels of different diameters.

References