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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 tortuositities and angulations
- Difficulty in accessing the supra-aortic trunks

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

- 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

  - Aortic arch + supra-aortic trunks
  - 3D linear
  - Aortic arches only
  - Semi-automatic segmentation

- Validation and correction

- Semi-automatic measurements:
  - Artery lengths
  - Vessel tortuositities
  - Angulations

4. Segmentation and characterization pipeline

- Segmentation module
  - Volume refocusing
  - Localization CNN
  - Resampling
  - Normalization
  - Arch type (I, II or III)
  - MRA Volumes
  - Geometric characterization module
  - Centerlines
  - Radii, take-off angles and reverse curves
  - Vertical distance to first major curvature
  - 3D reconstruction

5. Results

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

- Artery
- Length
- Tortuosity

<table>
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<th>RMSE</th>
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6. Conclusion and perspectives

- Complete analysis pipeline, from MRA images to high-level features: arch type, tortuositities, reverse curves, take-off angles and access difficulty after engaging an arching.
- 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.
- 3D extension of our CNN pipeline to better capture vessels of different diameters.