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

2. Technical background

<table>
<thead>
<tr>
<th>Task</th>
<th>Studies</th>
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| 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 engineering research but not relevant for clinicians to use in a medical setting. |

3. Data

- Acquired parameters: coronal plane covering: 250 slices; active TR/TE = 5.5/2.0 ms; flip angle = 27°; number of excitations = 1; acquisition bandwidth = 476.7 Hz; FOV = 380 × 321; voxel size = 0.5 × 0.5 × 1.0 mm; imaging time = 69 sec; Bolus track injection technique.

- Data labeling:

4. Segmentation and characterization pipeline

- Segmentation module:
  - Localization CNN
  - Resampling
  - Normalization

- Geometric characterization module:
  - Arch type (I, II or III)
  - Lengths and tortuositities
  - Radii, take-off angles and reverse curves
  - Vertical distance to first major curvature

5. Results

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

- Geometric characterization:
  - Artery Length
  - Tortuosity
  - Pearson
  - RMSE
  - MAPE

- Artery Pearson RMSE MAPE
  - RCCA 0.97 5.97 1.75
  - LCCA 0.92 6.80 1.14

6. Conclusion and perspectives

- Complete analysis pipeline, from MRA images to high-level features: arc 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.
- 3D extension of our CNN pipeline to better capture vessels of different diameters.

References