

Visual Quantification of the Circle of Willis in Stroke Patients

Masterstudium:
Medizinische Informatik

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Introduction

Various cerebrovascular diseases are related to dysfunctions of the Circle of Willis (CoW), which describes the arterial blood circulation of the human brain. A stroke is a common consequence of these anomalies. It is diagnosed via Time-of-Flight Magnetic Resonance Angiography (TOF-MRA) data sets and requires the expertise of radiologists. Considering the urgent nature and time constraints of stroke treatment, computer-aided assistance can potentially save valuable time by automating certain parts of the diagnostic process.

Objectives

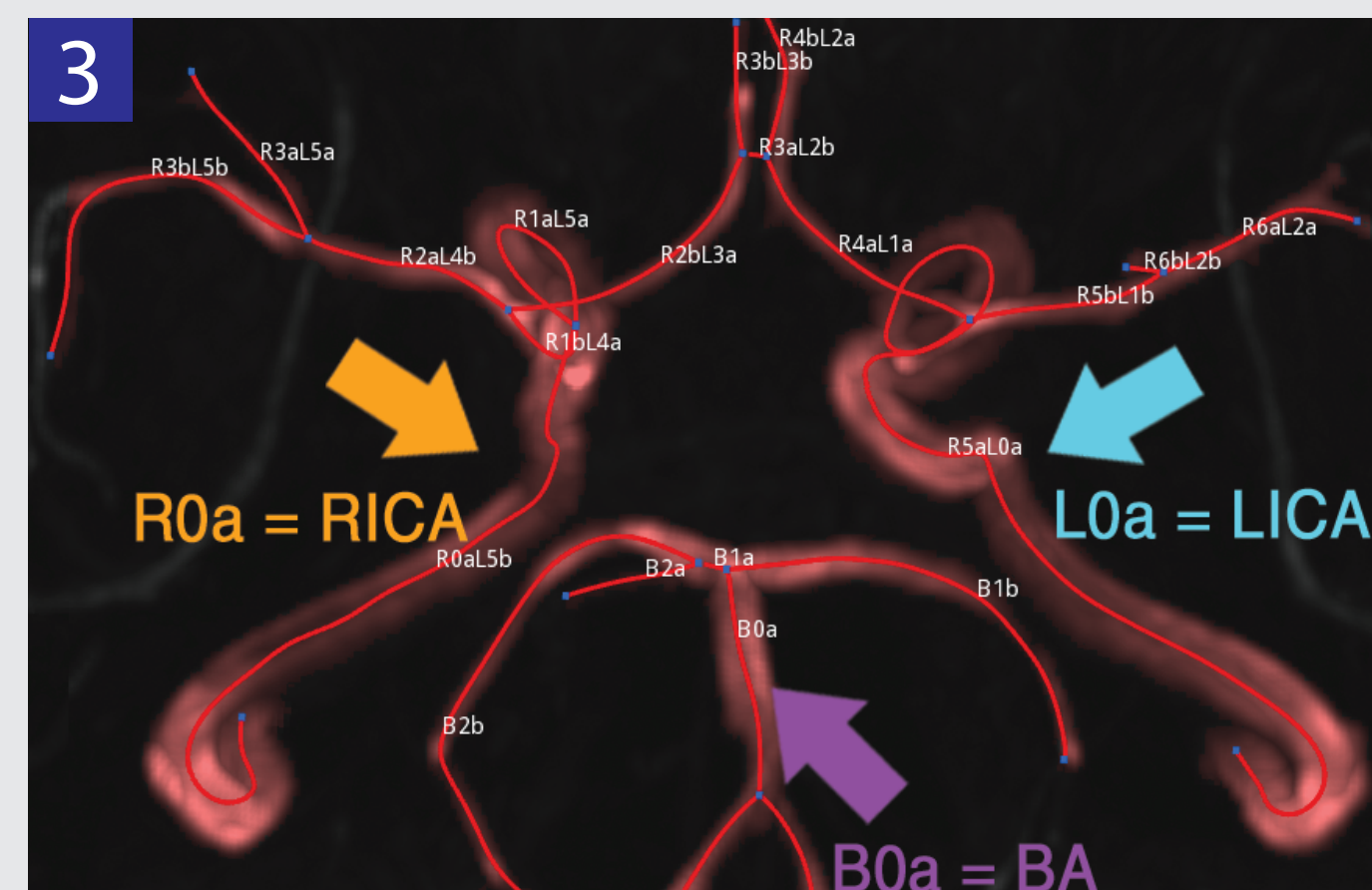
An automated processing pipeline of TOF-MRA data sets is proposed that visually quantifies the CoW in order to:

- a) create a standardized visualization
- b) reduce the time-consuming investigation of the data sets
- c) allow swift and easy comparison between data sets
- d) provide indication of problematic areas (missing arteries)

Visual Quantification of the Circle of Willis



Definition of a super-ellipsoidal Region-of-Interest as an approximation of the CoW's location.



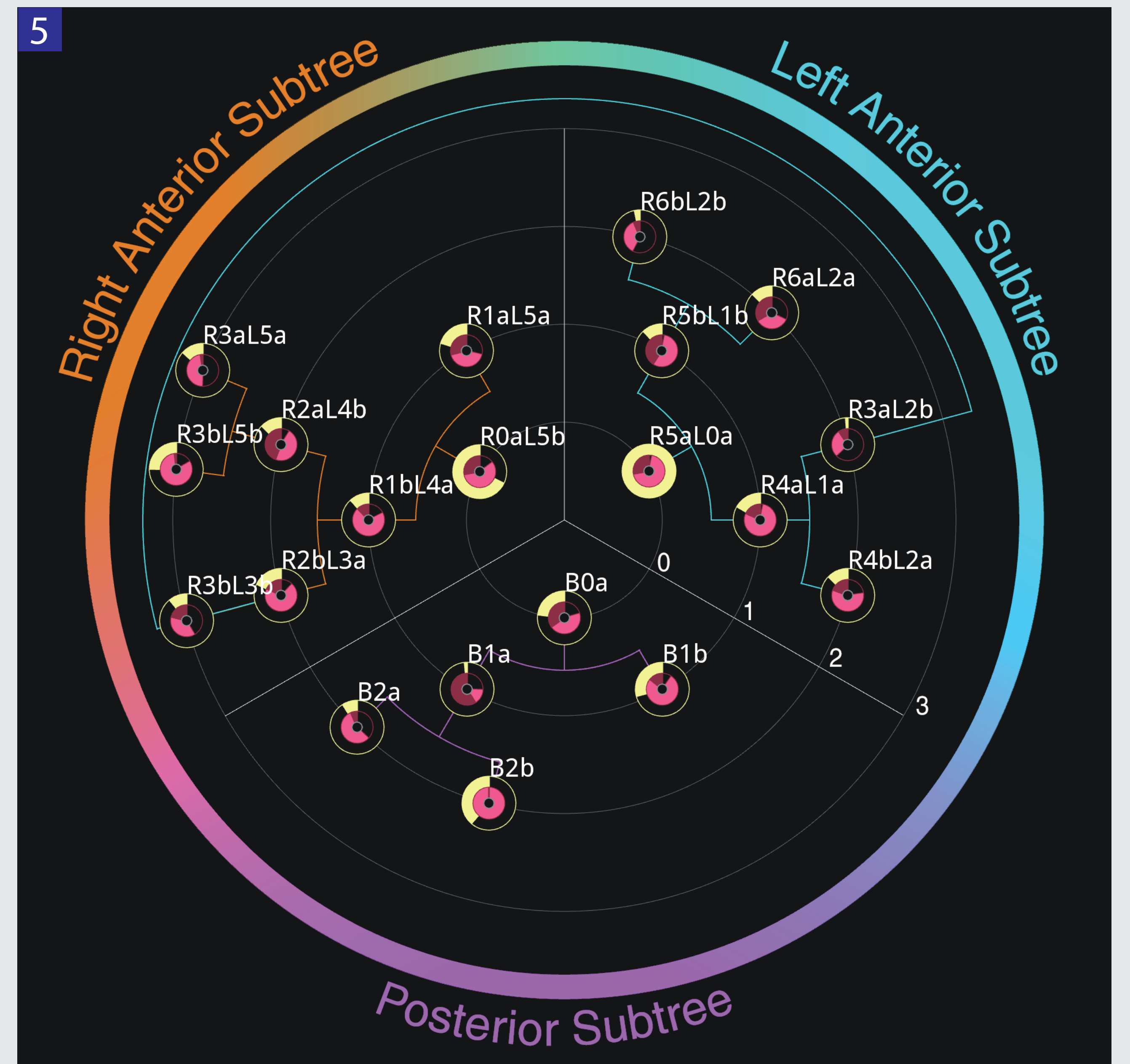
The centerlines are extracted and converted into a vessel tree model, which is labeled from the main arteries.



Segmentation of the arteries via hysteresis thresholding followed by the clustering into the left and right anterior and the posterior subtree.



The labeled vessel tree is converted into a graph representing the structure of the CoW.

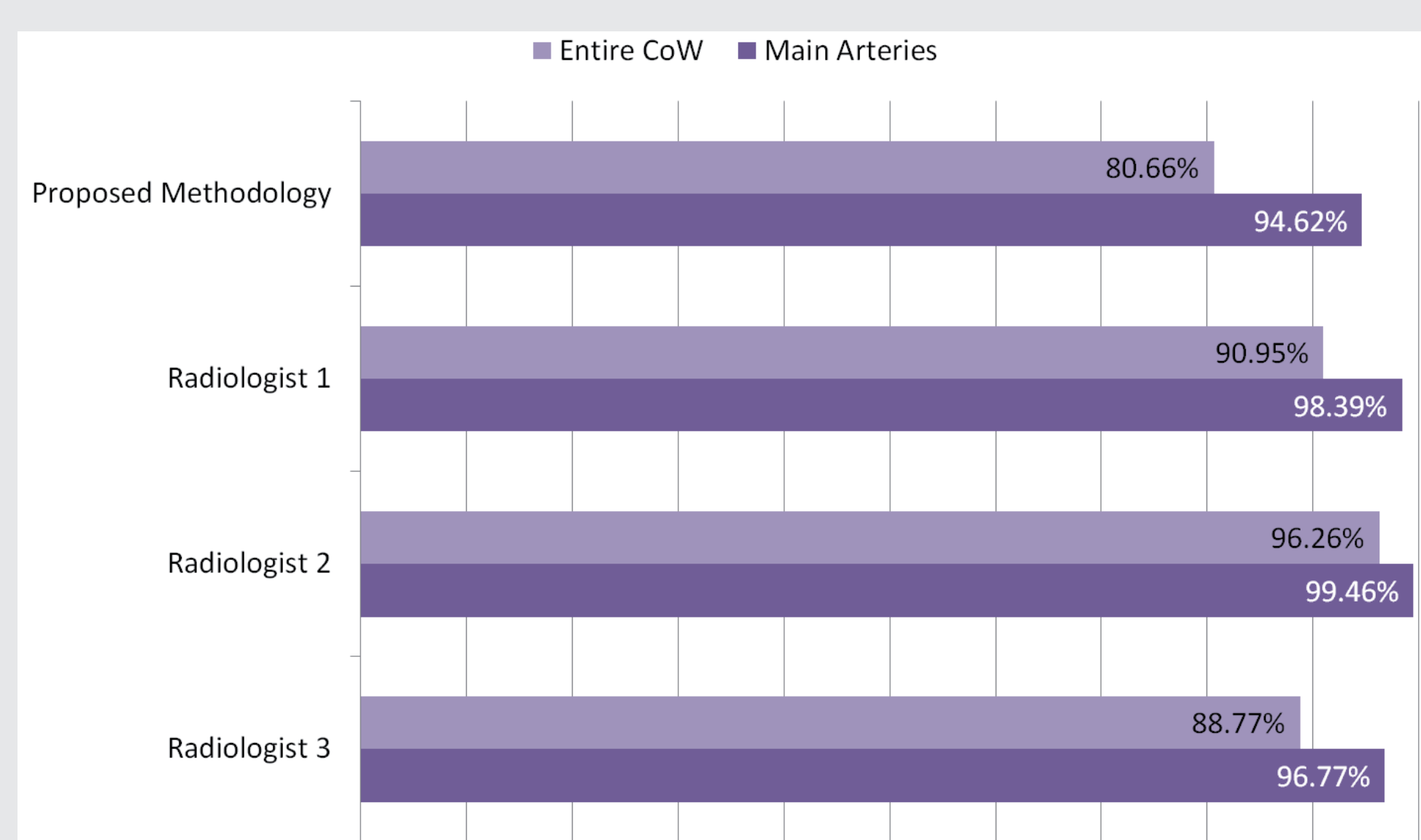


Visual quantification using a radial vessel graph. The attributed nodes represent the arterial segments and the edges illustrate the branching structure. The anterior and posterior subtrees, which indicate that both of the posterior communicating arteries are missing.

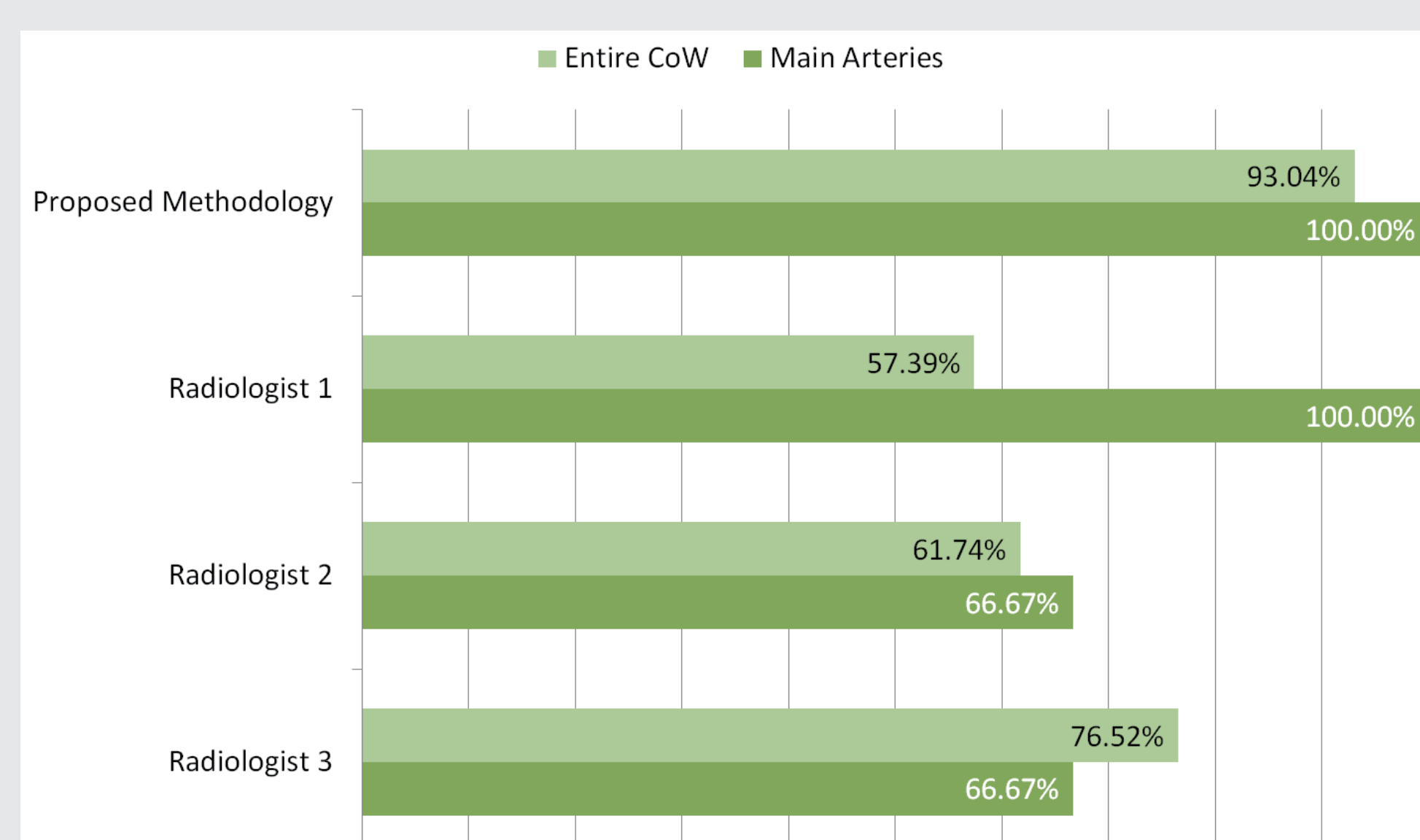
Evaluation

We conducted an evaluation using 63 TOF-MRA data sets, provided by the Universitätsklinikum Tulln. The task was to identify the arteries of the CoW. We evaluated the results of our proposed methodology against a gold standard that was provided by an expert neuro-radiologist. In addition, three radiologists participated in this study and we compared our result against theirs. As demonstrated below, the performance of our approach is close to the radiologists'.

Sensitivity



Specificity



Negative Predictive Value

