

Completeness of Circle of Willis in patients with acute ischemic stroke: a predictor for functional outcome?

Project Proposal

An acute ischemic stroke occurs when an intra-cranial artery is partially or completely occluded by a thrombus (or clot) causing a decrease in the supply of oxygen and nutrients to the brain ^[1]. This can lead to the formation of two zones: core (cerebral tissue that cannot restore function) and penumbra (cerebral tissue that can restore function on reperfusion) ^[2]. The survival of penumbral tissue depends on the cerebral collateral circulation mostly due to the Leptomeningeal Anastomoses (LMAs) ^[3]. LMAs allow retrograde filling when there is an acute vascular occlusion ^[4]. Secondary collateral capacity is an important factor in selection of patients who may benefit from intra-arterial treatment ^[5-7] and it can be quantified with an established measure called collateral score ^[8].

The primary collateral arteries, the Circle of Willis (CoW) are relatively understudied. Previous studies show that complete CoW is present in no more than 50% of the population. It may include partially or completely missing anterior or posterior blood vessels. However, the effect of incomplete CoW on retrograde filling and functional outcome after stroke treatment in this situation is not clear.

In this project, you will analyse baseline CT angiography images to grade the completeness of Circle of Willis. Furthermore, you will identify the associations between variations in CoW models and the secondary collaterals via LMAs and functional outcome in patients with anterior circulation proximal artery occlusions.

Research Questions:

- What is the status of the completeness of Circle of Willis (CoW) in patients with acute ischemic stroke?
- Is there an association between the completeness of CoW and the secondary collaterals graded by Collateral Score and functional outcome?
- Is this association dependent on the location of occlusion?

Contact

Praneeta Konduri
Dept. Biomedical Eng. and Physics
Email: p.r.konduri@amc.uva.nl

Henk Marquering
Dept. Biomedical Eng. and Physics
Email: h.a.marquering@amc.uva.nl

References

1. Ischemic Stroke
https://www.strokeassociation.org/idc/groups/stroke-public/@wcm/@hcm/documents/downloadable/ucm_309725.pdf
2. The Ischemic Penumbra
<http://www.strokecenter.org/professionals/brain-anatomy/cellular-injury-during-ischemia/the-ischemic-penumbra/>
3. Campbell, Bruce CV, et al. "Failure of collateral blood flow is associated with infarct growth in ischemic stroke." *Journal of Cerebral Blood Flow & Metabolism* 33.8 (2013): 1168-1172.
4. Shuaib A, Butcher K, Mohammad AA, Saqqur M, Liebeskind DS. Collateral blood vessels in acute ischaemic stroke: a potential therapeutic target. *Lancet Neurol* 2011; 10: 909–921.
5. Berkhemer OA, Jansen IGH, Beumer D, et al. Collateral Status on Baseline Computed Tomographic Angiography and Intra-Arterial Treatment Effect in Patients with Proximal Anterior Circulation Stroke. *Stroke*. 2016;47(3):768-776. doi:10.1161/STROKEAHA.115.011788.
6. Boers AMM, Sales Barros R, Jansen IGH, et al. Quantitative Collateral Grading on CT Angiography in Patients with Acute Ischemic Stroke. In: Cardoso M, ed. *Molecular Imaging, Reconstruction and Analysis of Moving Body Organs, and Stroke Imaging and Treatment*. CMMI 2017, SWITCH 2017, RAMBO 2017. Lecture Notes in Computer Science. 10555th ed. Cham: Springer; 2017:176-184. doi:10.1007/978-3-319-67564-0_1
7. Boers AMM, Sales Barros R, Jansen IGH, et al. Quantitative Collateral Grading on CT Angiography in Patients with Acute Ischemic Stroke. 2017:176-184. doi:10.3174/ajnr.A5623 8.
8. Tan, I. Y. L., et al. "CT angiography clot burden score and collateral score: correlation with clinical and radiologic outcomes in acute middle cerebral artery infarct." *American Journal of Neuroradiology* 30.3 (2009): 525-531