

Hierarchical analysis of placenta vasculature through ex-vivo MRA: plug-ins and analysis

Context of the project: Placenta function depends on its vasculature pattern such as spatial arrangement, capillary structure, blood flow rate and capillary numbers, etc. Current studies focus on the histopathological descriptions of placental vasculature. Peculiar microscopic vascularization structure, such as excessive branching or non-branching angiogenesis of placental villi, is believed to lead to impaired placental functionality found in pregnancy complications (e.g. intra-uterine growth restriction). Until now, very limited knowledge of global placental vascularization has been obtained, mainly due to the technical difficulties when imaging the entire human placenta. In our group, we discovered that a stable protocol to image vascularization as complicated as human placenta to understand its vasculature [1]. Recently, we are able to start to characterize human placenta vasculature in a more reliable way [2], and started to have encouraging preliminary results.

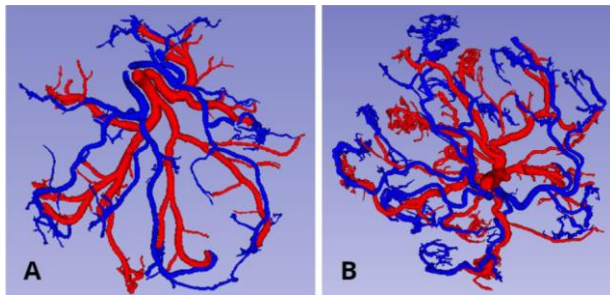


Figure 1: Examples of current results of artery and vein networks of placenta A. physiological B. fetal growth restriction cases

Objective: The overall objective of this project is to segment and characterize the global and local placenta vasculature, by considering the artery and vein separately, and analyze in a hierarchical way with the placental vasculature data acquired with the clinical study MAPLE. Therefore, two sub tasks are listed as below:

1. to improve the current 3D slicer plug-in from both the algorithmic and software point of view so that the user interactive would be greatly reduced
2. Characterise the fine scale vessels via a statistic method by understanding the distribution pattern, in a way similar to radiomics.

Reference: [1] B. Chen, J. Duan, A.-C. Chabot-Lecoanet, H. Lu, R. Tonnelet, O. Morel, M. Beaumont, Ex vivo magnetic resonance angiography to explore placental vascular anatomy, *Placenta*. 58 (2017) 40–45. doi:10.1016/j.placenta.2017.08.002.

[2]. Kneib, Antoine, Matthieu Dap, Marine Beaumont, et al. ‘« Moulage Par Corrosion » Virtuel Pour l’analyse Hiérarchique de La Vascularisation Du Placenta Humain Frais Avec l’Angiographie Par IRM Ex Vivo : Pipeline Automatique et Plug-In’. Paper presented at 7th meeting of French MR society SFRMBM, Saint-Malo, France. 2025.

Required skills:

- Be able to work with anatomical samples; basic understanding of MR imaging; Know how to program with matlab and python; Teamwork spirit; can closely work with a team with physicians, mathematicians, and computer scientists ;
- Be curious, can learn fast and self-organized

Duration: 6 months

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