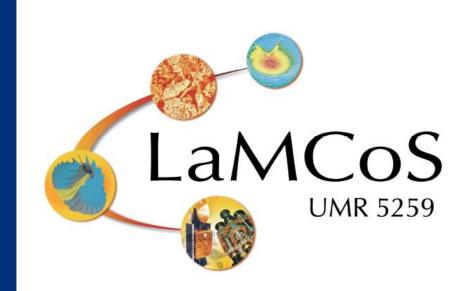
Numerical tools for vascular surgery

Aline Bel-Brunon^{EC}, Benyebka Bou-Saïd^{EC}, Alain Combescure^{EC}, Mahmoud Elhajem^{EC}, Hélène Walter-Le Berre^{EC}

M. Menut^{PHD}, Y. Yang^{PHD}, M. Rebouah^{PostDoc}, C. Dupont^{PostDoc}, W. Pan^{PHD}, B. Helou^{PHD}, J. Gindre^{PHD}



Objective

Developing numerical tools to help clinicians:

- Understand the occurrence and evolution of pathologies,
- Improve the choice of medical device,
- Prevent potential complications

Methods

- Strong collaboration with clinicians (HCL, CHU Rennes)
- Access to preoperative patient data to build patient-specific models and per- and postoperative data to validate simulation results
- Application of various methods of computational mechanics (FEM, FSI, ROM, etc)

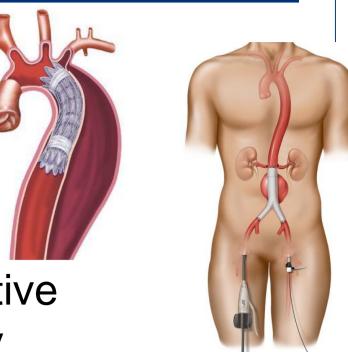
Application: EndoVascular surgery

Context and objective

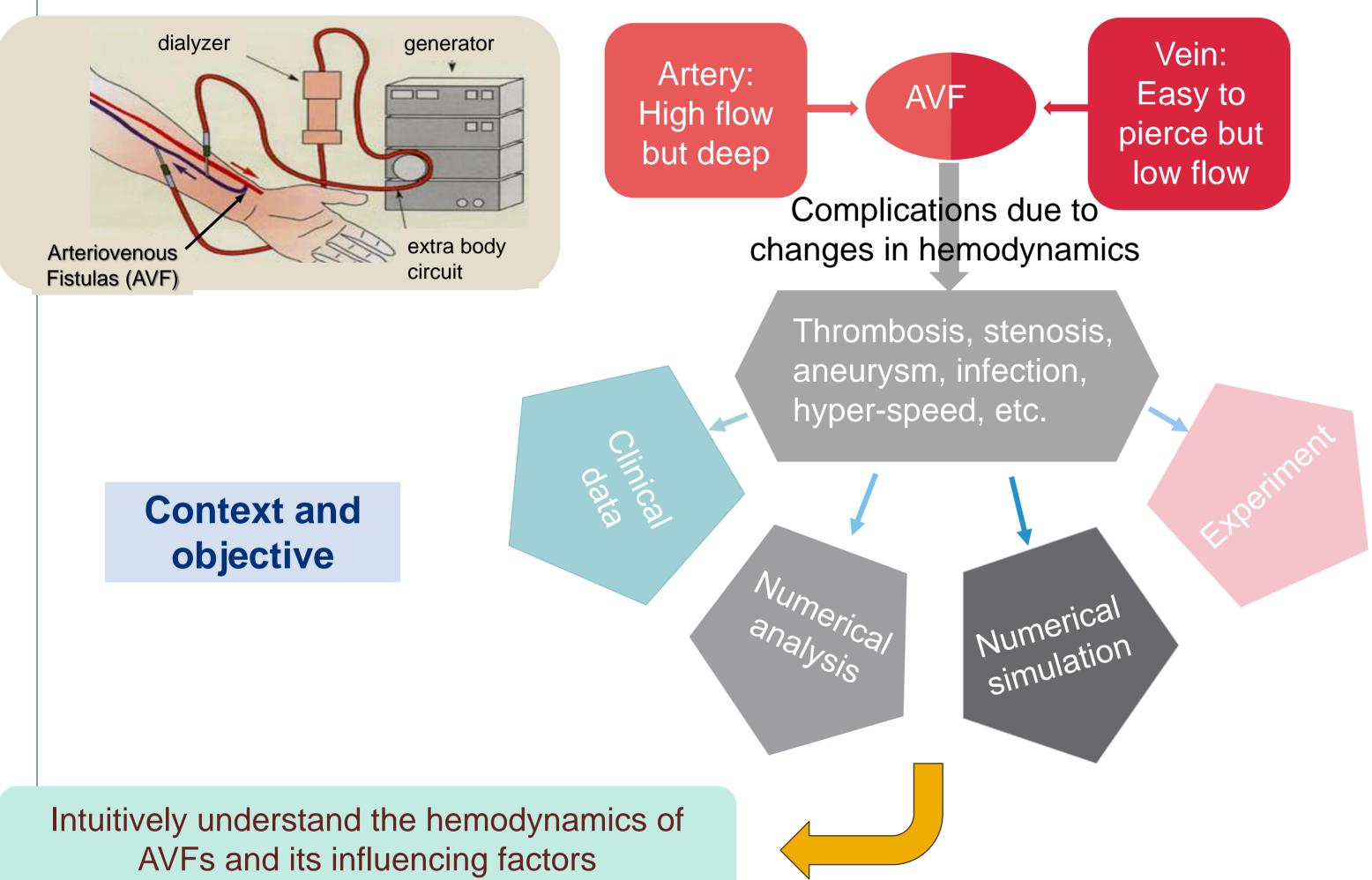
- Mini-invasive surgery for the treatment of several pathologies
- Insertion and deployment of several devices
- Need for intraoperative guiding by enriching peroperative images, sizing recommendation, evaluation of surgery potential complications, etc

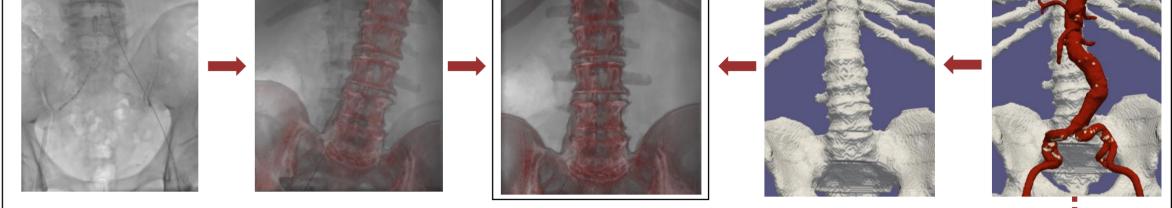
Model construction

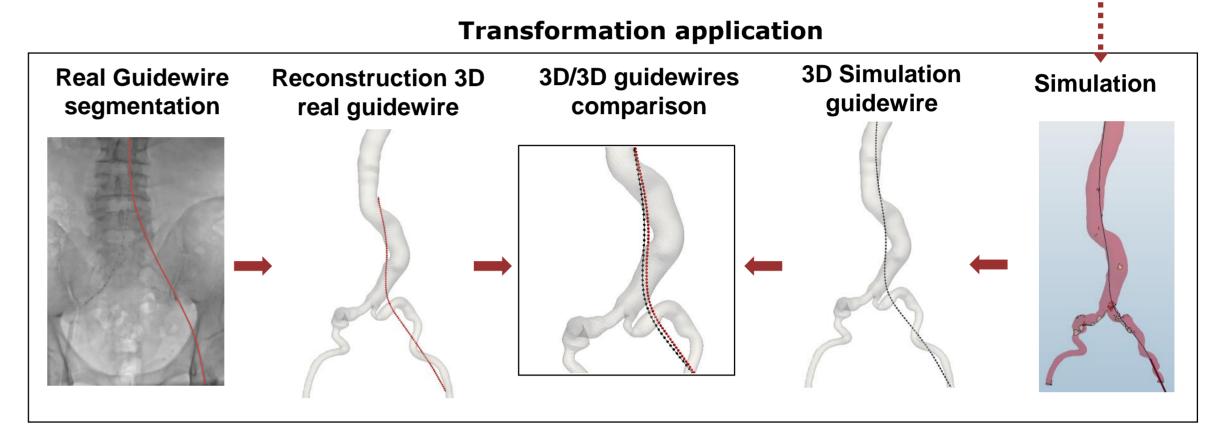




Application: Arteriovenous fistulas (AVF)

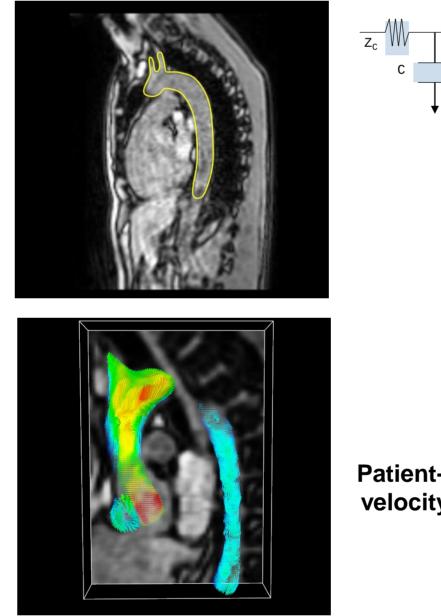




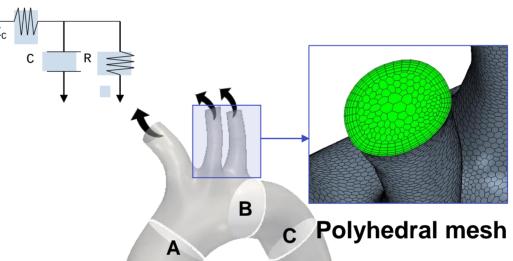


Automated medical imaging processing to build the FE model and compare with peroperative images for AAA [Gindre et al 2016]

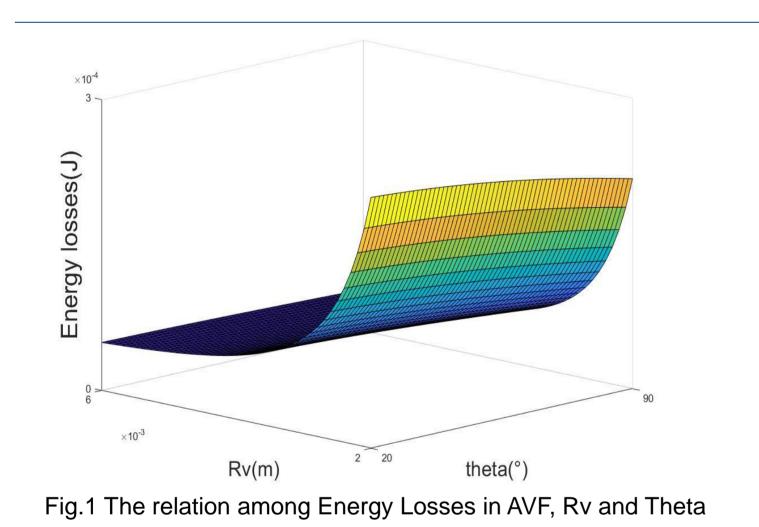
Flux measured by MRI-PC 2D and 4D



Patient-specific modeling and boundary conditions



CFD model based on patient specific geometry and flux validation data for aortic dissection treatment [Menut et al 2018]

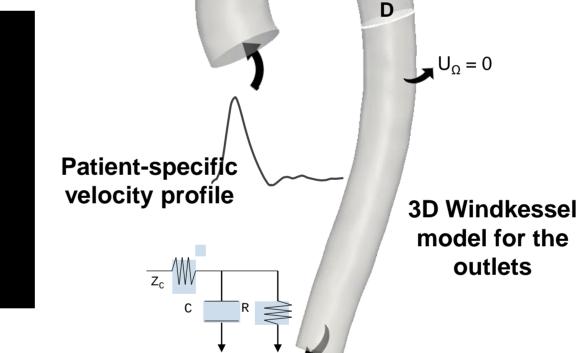


Numerical simulation Pression = 0 Pa **AVF Model** Vein (V) R۷ **Proximal Arterv** Distal Artery The simulation with clinical data:

Numerical analysis

Eloss = Efriction + Emetabolism + Edirection + Eelbow $= Eloss(Rv, \Theta)$

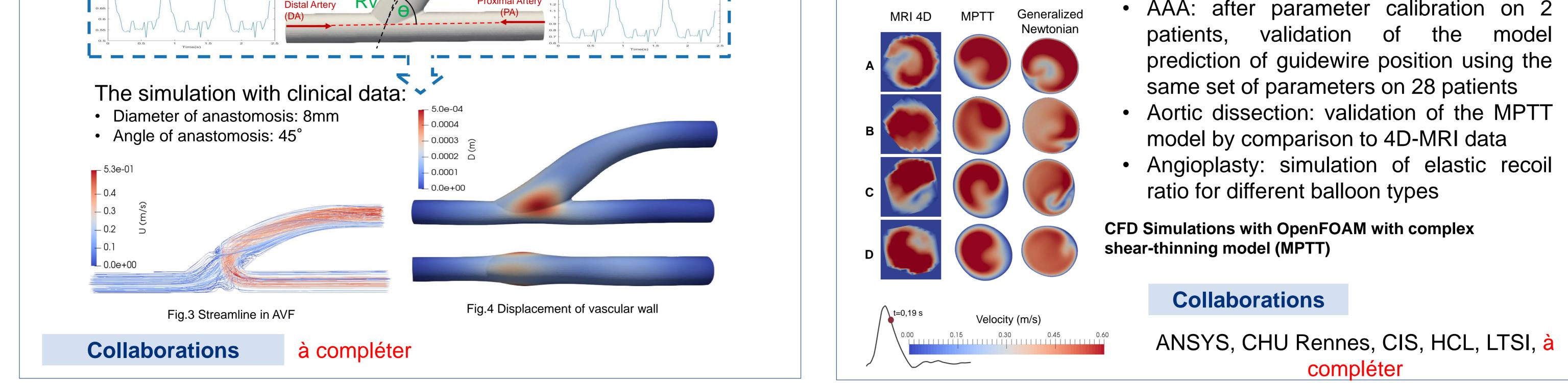
Energy conservation $\frac{\rho Q_{PA}^2}{2A_{PA}} + \frac{\rho Q_{DA}^2}{2A_{DA}} = \frac{\rho Q_{\nu}^2}{2A_{\nu}} + \text{Eloss}(\mathsf{Rv}, \Theta)$



Plastic FE model based on CT data segmentation for angioplasty simulation [Helou et al 2019]

ст scan Uncalcified plaque Calcified plaque Arterial wall (AW)

Results



- AAA: after parameter calibration on 2



Laboratoire de Mécanique des Contacts et des Structures