Modelling fluid flow using COMSOL Multiphysics

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Course: Fenomeni di trasporto biologico
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Blood flux in a pipe

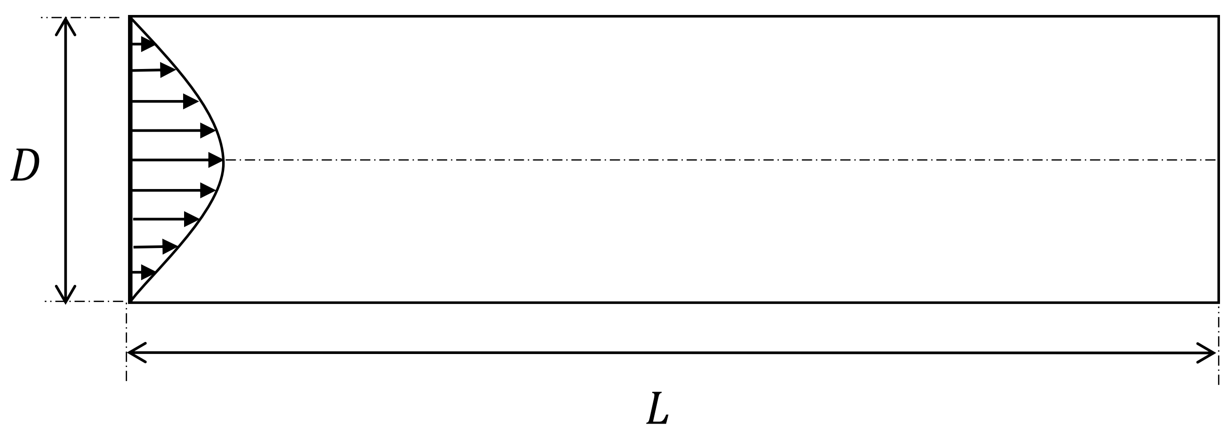
- Steady-state blood flux within a pipe

$$-\eta\nabla^2\boldsymbol{u} + \rho(\boldsymbol{u}\cdot\nabla)\boldsymbol{u} + \nabla p \;= \mathbf{F}$$

$$\nabla\cdot\boldsymbol{u} = 0$$

Incompressible Navier-Stokes equation for a Newtonian fluid

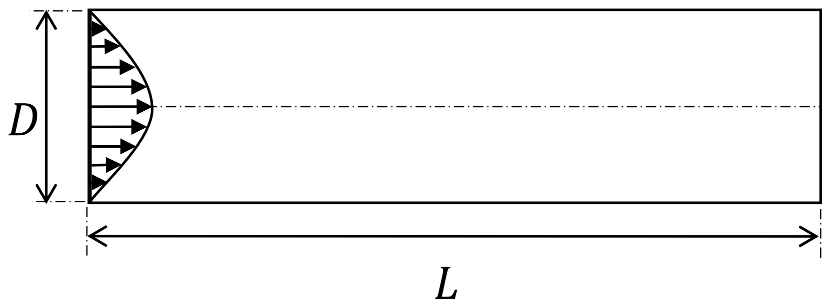
ρ → density = 1060 kg·m^{-3}
η → dynamic viscosity = 4·10^{-3} Pa·s
p → pressure (Pa)
F → volume force field such as gravity (N·m^{-3})

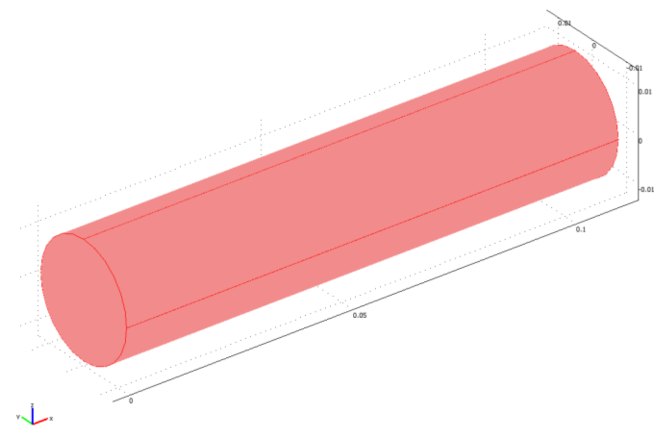


$$D = 25\,mm$$
$$L = 110\,mm$$
$$Q_{in} = 5\,L/min$$

Blood flux in a pipe

- Steady-state blood flux within a pipe



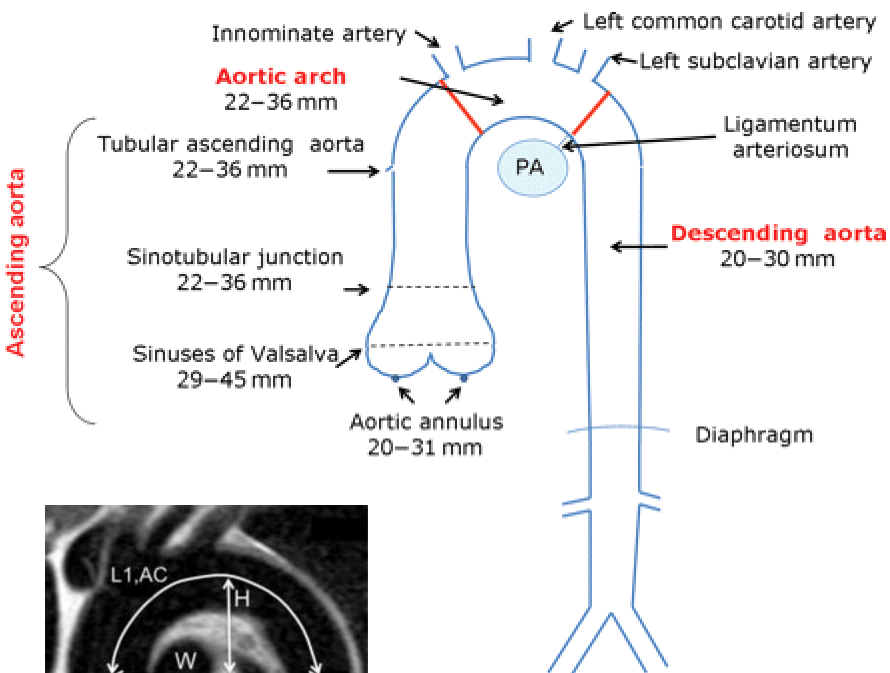


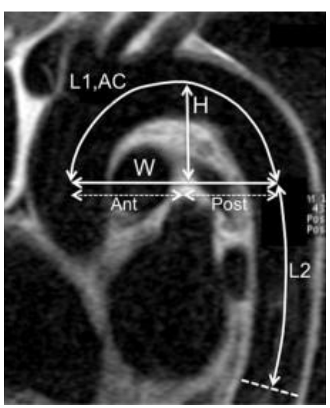
$$D = 25\ mm \qquad L = 110\ mm \qquad Q_{in} = 5\ L/min$$

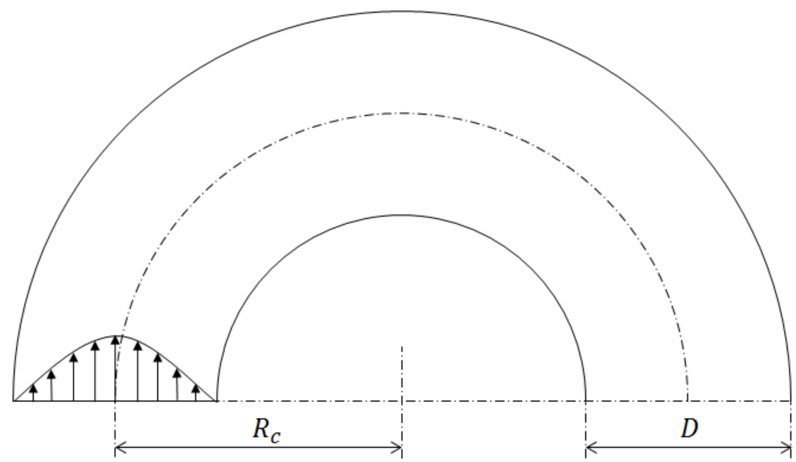
- Solve the problem considering:
  1. Normal velocity inflow (is the flow profile fully developed?)
  2. Poiseuille inflow profile
  3. Gravity effects
- Evaluate wall shear stress

Blood flux in the aortic arch

- Steady-state blood flux within the aortic arch







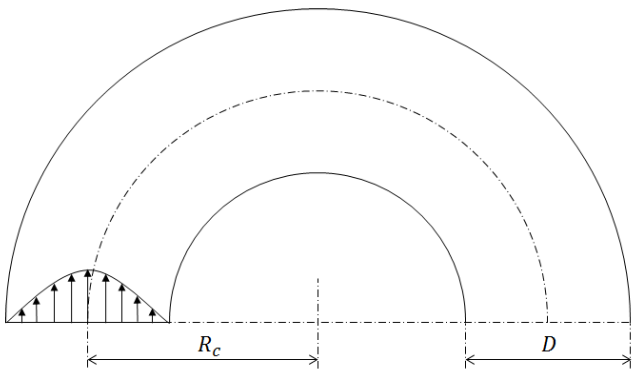
$$R_c = 35\ mm$$
$$D = 25\ mm$$

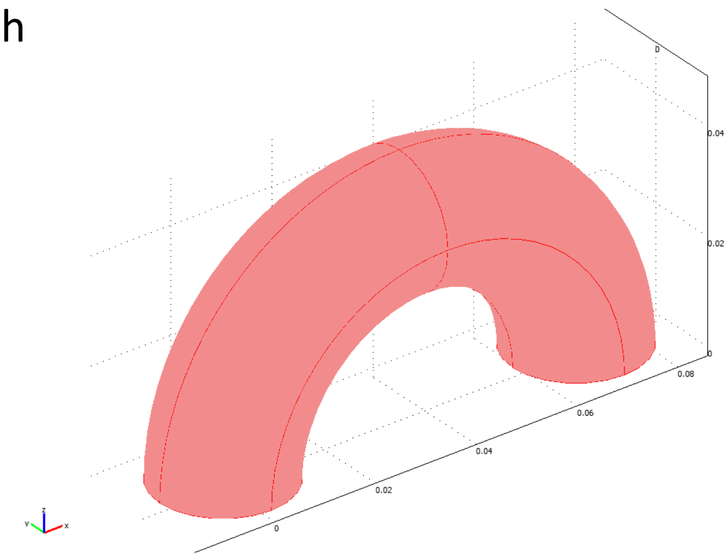
$$Q_{in} = 5\ L/min$$

J Am Coll Cardiol. 2011;58(12):1262-1270. doi:10.1016/j.jacc.2011.06.012

Blood flux in the aortic arch

- Steady-state blood flux within the aortic arch





$R_c = 35\,mm$ $\quad$ $D = 25\,mm$ $\quad$ $Q_{in} = 5\,L/min$

- Solve the problem considering:
  1. Normal velocity inflow
  2. Poiseuille inflow profile
  3. Gravity effects