Master Thesis Experiment Report VIII : Clot dissolution

Jérémie Guy

November 24, 2024

Abstract

Dissolving the clot

1 Context

Now that we have a fully stable and functioning branching system with a clot, we will attempt to dissolve it progressively.

2 Description

The clot is defined by a force field $K(x, y, t)$ which forces the PDFs in the opposite direction. The dissolution in the case of Thrombolysis comes form a coagulant such as tPA, which binds to fibrin and facilitates the conversion of plasminogen to plasmin, a molecule that cleaves the fibrin strands. The amount of tPA present in the system can be considered proportionnal to the flow of the fluid :

$$flow(x, y, t) = \|\mathbf{u}(\mathbf{x}, \mathbf{y}, \mathbf{t})\|_2 * \rho(x, y, t) \tag{1}$$

where $u(x, y, t)$ is the velocity at coordinate (x, y) and time t, and ρ the density. As in a 2DQ9 lattice the velocity is bi-directionnal, we use here norm2 to compute the total amount of velocity in any given cell. Using said proportionality, we implemented a first equation to determine the amount of dissolution for each clot site :

$$\tau(x, y, t) = d * flow(u, x, t) * K(x, y, t) \tag{2}$$

where d is the dissolution rate. The new clot resistance value K is then computed following the equation :

$$K(x, y, t) = K(x, y, t-1) - \tau(x, y, t) \tag{3}$$

In addition, we now added a systematic control: if the result K after equation 3 is smaller than 0, we cap it to 0 as no clot means $K = 0$.

3 Experiments

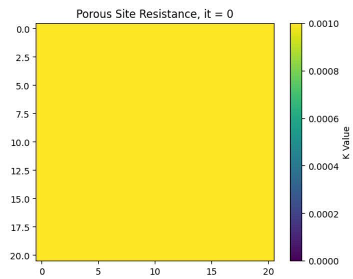
3.1 Experiment 1

3.1.1 Description

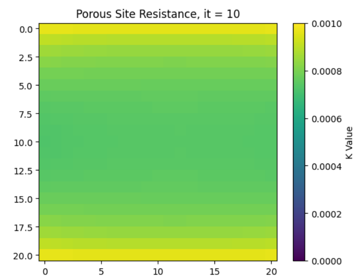
To test the dissolution method, we started from a stable system state which was obtained using viscosity $\nu = 0.01$, initial density $\rho = 2.5$, pulse field acceleration $F = [0, -0.001]$ and initial clot resistance $K = [0.001, 0.001]$ after running for 60'000 iterations. To make the dissolution faster for testing purposes, we set $d = 2$.

3.1.2 Results

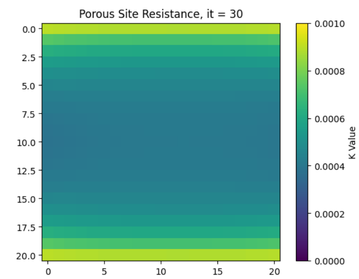
To monitor the dissolution, we displayed the K values within the clot and followed the results every 10 iterations. Figure 1 shows the results. We can see that the clot dissolves starting from the center : as the fluid follows a Poiseuille parabola, the particle density is higher in the center than in the border of the tube. As such, the clot dissolves from the center to it outside layer.



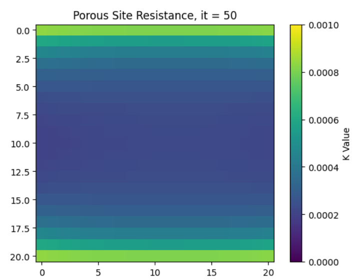
(a) Clot resistance field at iteration = 0



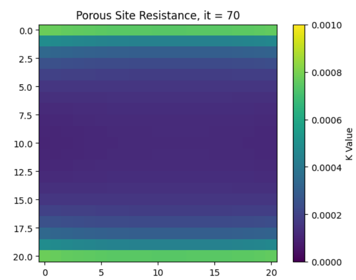
(b) Clot resistance field at iteration = 10



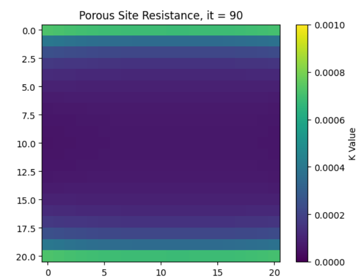
(c) Clot resistance field at iteration = 30



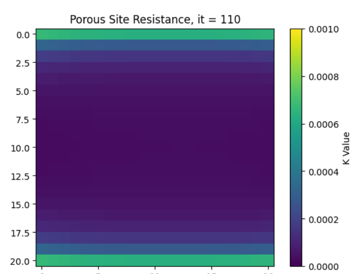
(d) Clot resistance field at iteration = 50



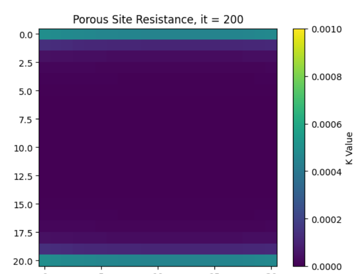
(e) Clot resistance field at iteration = 70



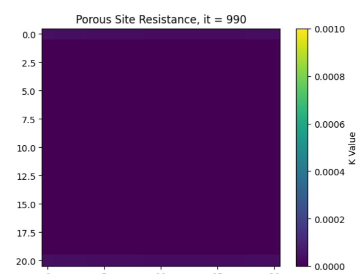
(f) Clot resistance field at iteration = 90



(g) Clot resistance field at iteration = 110



(h) Clot resistance field at iteration = 200



(i) Clot resistance field at iteration = 990

Figure 1: Clot dissolution

4 Conclusion

5 References