Simple physics: fluid mechanics

An artificial lacrimal gland device has been proposed to treat the "dry eyes syndrome"[1]. It consists of a pump and reservoir implanted in the abdomen, with a subcutaneous silicone tube driving the liquid to the eye, through 3 holes at its ocular end. A similar device has been proposed and extended by EPFL students[2].

Build a 3D model of the ocular part of the tub. The cylindrical tub has a length of 16 mm, an inner diameter of 0.8 mm, and a thickness of 0.2 mm. The three holes have a diameter of 0.4 mm. They are separated by a distance of 4 mm from each other, and from the two sides of the tube. Consider water for the artificial tear fluid. The boundary conditions are the following: a flow rate of 1.5 ml/day at the inlet and an external pressure of 1 atm at the 3 outlets. Take advantage of the symmetry of the system, and consider only half of the system. Find the stationary solution of the problem.

Verify that the sum of the flow rate of the three outlets holes is equal to the one of the inlet.

What is the required pressure at the inlet?

What could be done to have a more homogeneous deliver of the artificial tear on the surface of the eye with this device?

[1] *Murube J, Geerling G. Mechanical Pump Dacryoreservoirs. Dev Ophthalmol. 2008*

[2] *Brondel M, Guex A, Kayser S, Mousty F. Artificial Tear Delivery Device. Artificial Organs, EPFL, 2011*