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A numerical analysis of rhegmatogenous retinal detachment

J.O. Pralits[1], D. Natali[1], R. Repetto[1], J.H. Tweedy[2] and T.H. Williamson[3]

[1] Department of Civil, Chemical and Environmental Engineering, Via Montallegro 1, 16145, Genoa, Italy, jan.pralits@unige.it, damiano.natali@gmail.com, rodolfo.repetto@unige.it

[2] Department of Bioengineering, Imperial College London, South Kensington Campus, SW72AZ, London, UK, j.siggers@imperial.ac.uk

[3] Retina Surgery, St Thomas' Hospital, Westminster Bridge Road, SE17EH, London, UK, retinasurgery.co.uk@gmail.com

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Rhegmatogenous retinal detachment (RRD) is a common pathology of the human eye, with an incidence of 1 every 10,000 subjects. It originally develops from the accumulation of subretinal fluid that induces tractions on the retina. However, traction alone does not seem to explain further detachment, which has thus been attributed to the forces induced by fluid currents generated by saccadic motion of the eye. This phenomena, however, is far from being clearly understood and has not been extensively investigated. In the present study numerical simulations have been applied to investigate two different configurations of retinal detachment, Giant Retinal Tear (GRT) and Retinal Hole (RH), in order to assess which one is more prone to further detachment.

This fluid–structure interaction problem has been analysed using a Navier-Stokes solver, for two-dimensional incompressible flow, and the geometry is treated using the Immersed Boundary (IB) approach, see Peskin [1]. In order to study the detachment propension due the clamping forces and torque exerted by the filament on the underlying substrate, the Winkler theory [2] has been borrowed from Geotechnics. In our case the still attached portion of retina is modelled as a semi–infinite foundation beam with external loads exerted by the flaps applied at its finite end. The two cases of RRD have been studied parametrically changing the length of the detach retina, its angle with the underlying substrate, and the hole diameter. Results clearly point out that the tendency to detach in the case of RH is 3 times larger than in the GRT case. Moreover, a sensitivity analysis shows that the tendency to detach increases with flap length, while there is a value of the clamping angle for which the tendency to detach is maximised.

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