A numerical study on the drug release from a PLGA based drug eluting stent

Jose Augusto Ferreira[†], **Jahed Naghipoor**[*], **Paula de Oliveira** [†], **Timon Rabczuk** [*]

[†] CMUC, Department of Mathematics, University of Coimbra, 3001-454, Coimbra, Portugal
Address
e-mail: {ferreira, poliveir}@mat.uc.pt
[*] Institute of Structural Mechanics, Bauhaus University of Weimar, 99423, Weimar, Germany
Address
e-mail: {jahed.naghipoor, timon.rabczuk}@uni-weimar.de

ABSTRACT

Cardiovascular disease such as atherosclerosis is one of the leading causes of the death in the world. Balloon angioplasty with stenting as a non-invasive technique was considered as a well established and effective tool to reduce the severity of atherosclerotic stenosis. Having information about the spatial and temporal drug release from drug-eluting stents and drug uptake in the arterial wall could be a useful tool to investigate in-stent restenosis, re-narrowing the lumen after stenting, which is experimentally expensive to study. Mathematical modeling together with numerical simulation facilitates the improvement of stent efficacy by understanding its functionality. To not being exhaustive, see [1]-[5].

In this work, the local delivery of a therapeutic agent from a PLGA based bioabsorbable stent implanted in a coronary artery is mathematically modeled and numerically simulated for prediction and investigation of the drug release and spatio-temporal drug distribution in an atherosclerotic plaque. The mathematical model includes the transport of the dissolved drug in the viscoelastic polymeric coating and the uptake of the drug with reversible binding in the viscoelastic arterial wall. Anisotropic vascular drug diffusion coefficient is used in different layers of the arterial wall. The effect of the plaque stiffness and the embedding depth of the stent on the drug uptake in the arterial wall are also investigated.

References

[1] J.A. FERREIRA, J. NAGHIPOOR AND P. DE OLIVEIRA, *Analytical and numerical study of a coupled cardiovascular drug delivery model*, J. Comp. Appl. Math. **275** (2015) 433-446.

[2] J.A. FERREIRA, J. NAGHIPOOR, AND P. DE OLIVEIRA, *A coupled non-Fickian model of a cardiovascular drug delivery system*, Math. Med. Biol. **275** (2015) 1-29.

[3] S. MCGINTY, *A decade of modelling drug release from arterial stents*, Math. Biosci. **257** (2014) 80–90.

[4] J. NAGHIPOOR, J. A. FERREIRA, P. D. E. OLIVEIRA, AND T. RABCZUK, *Tuning polymeric and drug properties in a drug eluting stent: a numerical study*, Preprint n. 15-52, Department of Mathematics of Universidade de Coimbra (2015) 1–32.

[5] P. ZUNINO, *Multidimensional pharmacokinetic models applied to the design of drug-eluting stents*, Cardiov. Eng. Int. J. **4 (2)** (2004) 181–191.