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NEW EQUATIONS FOR THE DOSE UNDER PULSATIVE CONDITIONS IN THE DESIGN OF COATED STENTS

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Abstract

Stents are used in interventional cardiology to keep a diseased vessel open. New stents are coated with a medicinal agent to prevent early reclosure due to the proliferation of smooth muscle cells. It is now recognized that it is the dose of the agent that effectively controls the growth (cf. for instance [3]). In an earlier paper [2] we focussed on the asymptotic behavior of the dose for general families of coated stents under a fixed ratio between the coated region of the stent and the targeted region of the vessel and set therapeutic bounds on the dose. It generalized the results of [1] for stents made of a sequence of thin equally spaced rings to stents with an arbitrary pattern. It gives the equation of the asymptotic dose for a normal tiling of the target region using the theory of tilings, patterns, and motifs on a cylinder.

In order to integrate the concentration equation with respect to time, the actual velocity is replaced by an effective velocity that is independent

of time. There are many ways to justify this construction. For instance, the flow in the artery is pulsative, but the Strouhal number corresponding to the pulsation frequency with respect to the time of simulation or design horizon is very small. Hence, it is not necessary to retain the non-stationary of the coefficients in the Navier-Stokes equation. A natural question that was raised is whether equations for the dose can still be obtained under general pulsative periodic conditions. This paper presents a major breakthrough by exhibiting the new equations for the dose in the periodic case in arbitrary geometries without assuming that the Strouhal number is small. This is done by introducing a new variable, the *unfolded dose* which is a function of the normalized time over the period. This new variable is the solution of a periodic partial differential equation that depends on the concentration only on the first periodic interval. In other words, it is not necessary to solve the equations for the concentration from time 0 to ∞. Full computational simulations will also be presented.

Of course, the theoretical part of this work is not limited to biomedical problems, and it finds applicatons in many diffusion transport problems where the dose is the meaningful variable.

Key Words: *Stenosis, restenosis, atherosclerosis, bioactive material, dose, modelling, coated stent, interventional cardiology, medical applications.*

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