INFLUENCE OF CONVECTION PARAMETER AND REACTION PARAMETER ON DRUG DIFFUSION THROUGH A STENT

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Abstract:

The diffusion of drug through a stent is analyzed with a convection parameter and drug reaction parameter using one dimensional diffusion equation. The results indicate that convection parameter and drug reaction parameter significantly influences drug diffusion. Hence by adjusting these parameters drug diffusion can be controlled.

Key words: diffusion ,convection parameter, reaction parameter.

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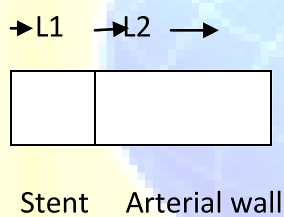
Introduction:

Stents are expandable metallic prosthesis implanted into the arterial wall .The stent provides mechanical support during the healing process and assists in keeping artery open. It is coated with a therapeutic drug. Once the stent is inserted into an artery, drug starts diffusing through the wall. In literature [1-4] different models of drug diffusion process has been analyzed.

The present work studies the influence of convective parameter and drug reaction rate using one dimensional diffusion equation. The equation is solved numerically .The solution indicates drug concentration at different distances in the wall at different time intervals. Hence for sustained drug delivery modifications can be made in the system.

Mathematical analysis:

Geometric model is a rectangle as shown below with a stent near arterial wall. L1 is the stent thickness and L2 the artery wall thickness.



The following assumptions are made in the analysis:

i) As the empty space in artery is larger than the thickness of stent , the stent and wall are considered to be two parts of a rectangular slab.

ii) The diffusivities of stent and wall are constant.

iii) The drug diffuses only in one direction

iv) The outer edge of wall is impermeable to the drug.

v) There are no sources and physical properties are constant.

Differential equation of the problem is

$dc/dt - Dd^2c/dy^2 + \delta\, dc/dy + \beta c = 0$,where D diffusion coefficient ,δ is a convection parameter and β is a drug reaction parameter .

Initial condition

c(x,0)=0 , initially drug concentration is zero.

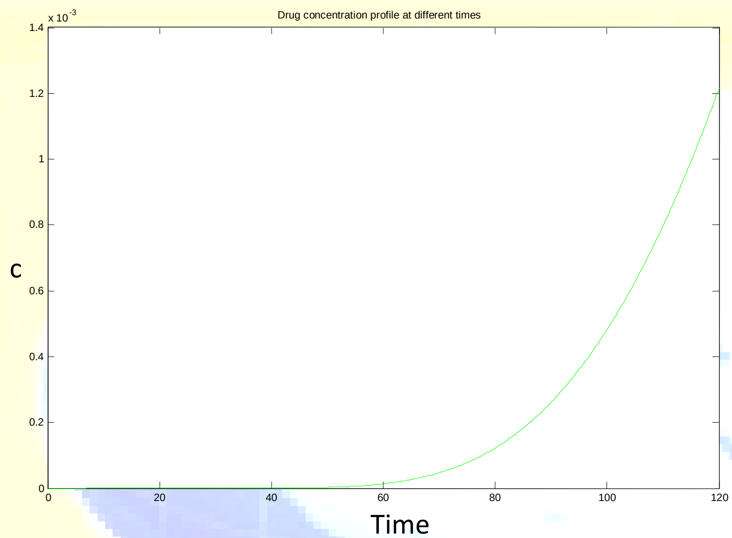
Boundary conditions

$c(0,t) = c_{max}$

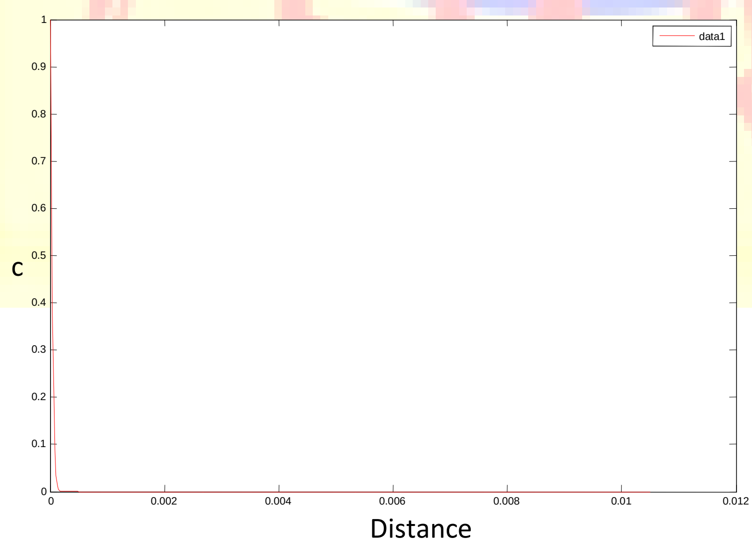
$(dc/dy)(L,t)=0$

Applying the boundary conditions the diffusion equation is solved for various values of β and δ . The solutions are plotted and analyzed.

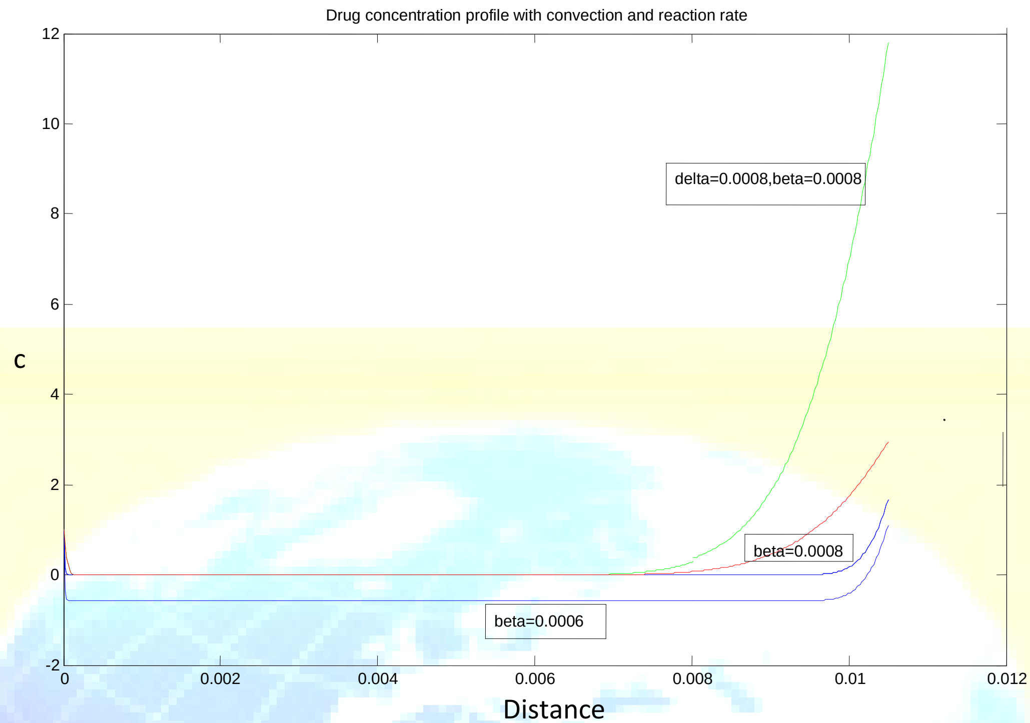
Drug concentartion at various time intervals



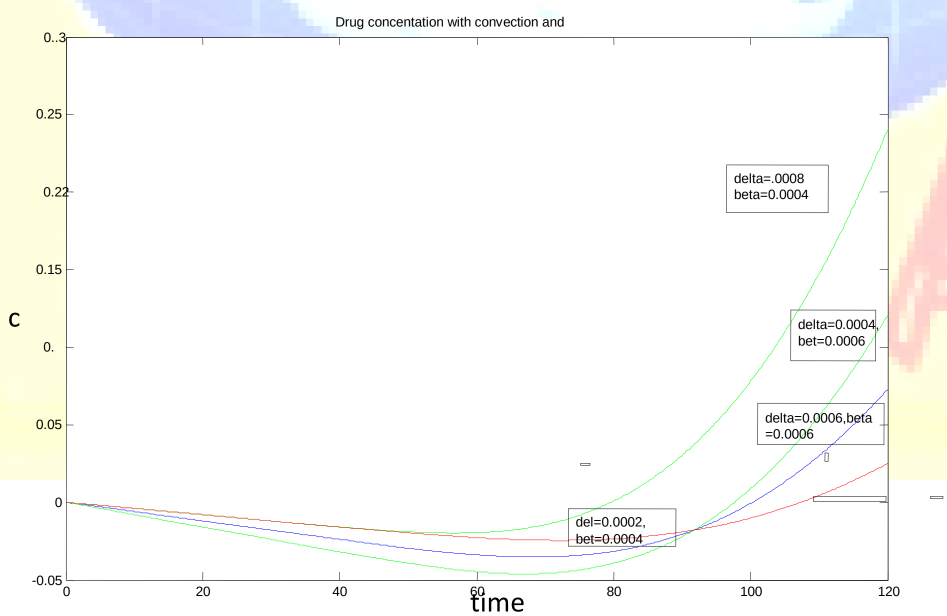
Drug concentration at various distances



Drug concentration at various distances for different δ and β



Drug concentration at different intervals for various β and δ.



Results and conclusions

The figures illustrate that in the absence of convective and reactive parameters the drug concentration suddenly drops after a very short distance from the stent wall. After a certain interval of time the concentration of drug rises from the middle of the wall.

In the presence of beta and delta the concentration falls to zero from a reasonable value at the wall, remains constant and rises to a significant value after a certain distance .The variation of concentration with respect to time intervals is almost similar. This clearly indicates that by adjusting beta and delta the drug diffusion can be controlled.

In the above analysis the parameters δ and β are arbitrary which is not clinically valid.

References

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