Mathematical and Mechanical Analysis of Arterial Blood Flow with Porous Effects

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ABSTRCT- *This paper present a mathematical model and physical study of the porous effects of arterial supply developed from the Navier-Stokes equation and certain assumptions..Via the finite difference approach, the governing equations are solved. A very little change mostly in cross-sectional strong evidence the blood flow rate should change significantly. The effects of the porosity effect have been used to prevent movement, which may be useful besides lipid, diabetes, etc. in certain cases.*

Keywords: *Mathematical modeling, Arterial flow, Standard finite difference method, permeability parameter.*

2010 Mathematics Subject Classification: 03C65, 92C10.

I. INTRODUCTION

A number of medical diagnostic devices, especially those used in the prognosis of cardiovascular disease, also commonly used porous-effect flow of blood.

The interaction between these induced currents and the porous effect applied affords a body force (known as the Lorentz force) that further delays blood movement (Sud and Sekhon, 1989). The effect of static on physiological and motivational function at rest and during physiological stress has been explored by Kuipers et al. (2007) and the effect of dynamic permeable wall on pain perception during noxious stimulus has been already investigated.

II. COMPUTATIONAL MODEL

The model describe for a Newtonian and inviscid fluid in equation form is to use the two-dimensional equations of Navier-Stokes and continuity equations.

$$\frac{\partial w}{\partial t}+u\frac{\partial w}{\partial z}+w\frac{\partial w}{\partial r}=-\frac{1}{\rho}\frac{\partial p}{\partial z}+\upsilon\left(\frac{\partial^2 w}{\partial z^2}+\frac{\partial^2 w}{\partial r^2}+\frac{1}{r}\frac{\partial w}{\partial r}+\frac{w}{r}\right)-Kw \tag{1}$$

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial z}+w\frac{\partial u}{\partial r}=-\frac{1}{\rho}\frac{\partial p}{\partial z}+\upsilon\left(\frac{\partial^2 u}{\partial z^2}+\frac{\partial^2 u}{\partial r^2}+\frac{1}{r}\frac{\partial u}{\partial r}+\frac{u}{r}\right)-Ku \tag{2}$$

$$\frac{\partial w}{\partial r}+\frac{w}{r}+\frac{\partial u}{\partial z}=0 \qquad (3)$$

And

$$\eta=\frac{r}{R(z,t)} \qquad (4)$$

Here R(z, t) represents the integrators of a blood vessel.

and

$$\frac{\partial^2 u}{\partial z^2}\le 1;\ \frac{\partial^2 w}{\partial z^2}\le 1;\ \frac{\partial P}{\partial r}\le 1;$$

Than reduce equations (1), (2) and (3) are

$$\frac{\partial u}{\partial t}+\frac{1}{R}\eta((u\frac{\partial u}{\partial z}+\frac{\partial R.}{\partial t})-w)\partial u/\partial\eta+u\frac{\partial u}{\partial z}=-\frac{1}{\rho}\frac{\partial P}{\partial z}+\frac{\upsilon}{R}(\frac{\partial^2 u}{\partial \eta^2}+\frac{\partial u}{\partial\eta})=Ku \qquad (5)$$

$$\frac{\partial w}{\partial t}+\frac{1}{R}\eta((u\frac{\partial w}{\partial z}+\frac{\partial R.}{\partial t})-w)\frac{\partial w}{\partial \eta}+u\frac{\partial w}{\partial z}=-\frac{1}{\rho}\frac{\partial P}{\partial z}+\frac{\upsilon}{R}(\frac{\partial^2 w}{\partial \eta^2}+\frac{\partial w}{\partial\eta})=Kw \qquad (6)$$

$$\frac{1}{R}(\frac{\partial w}{\partial\eta}+\frac{w.}{\eta}+R\frac{\partial u}{\partial z}-\frac{2}{\frac{1}{\eta}}\frac{\partial u}{\partial\eta}\frac{1}{2}\frac{\partial R}{\partial z})=0 \qquad (7)$$

The velocity profile is

$$u=\sum_{k=2}^{n}q_k(\eta^{\frac{4k}{2}}-2) \qquad (8)$$

Thus the velocity distribution in the boundary layer is

$$w=\frac{\partial R}{\partial z}w\eta+\frac{\partial R}{\partial t}\eta t+\frac{1}{N}\sum_{k=2}^{n}q_k(\eta^{\frac{4k}{2}}-2) \qquad (9)$$

The S(z, t) cross-sectional region and Q(z, t) blood circulation are described as

$$S=\pi R^2,\ Q=\iint_S ud\eta=\frac{1}{2}\pi R^2 q, \qquad (10)$$

III. COMPUTATIONAL PROCEDUERE

Nonlinear partial differential equations are a system of equations (5)-(6). The discretized formula using the following differential formula is as chooses to follow:

$$\frac{\partial G}{\partial z}=\frac{G_i-G_{i-1}}{\Delta z}\ \text{and}\ \frac{\partial R}{\partial z}=\frac{R_i-R_{i-1}}{\Delta z}, \qquad (10)$$

The gradient for pressure is maintained constant here and the value is prescribed. Fig. 1 depicts the discretization of the artery model.

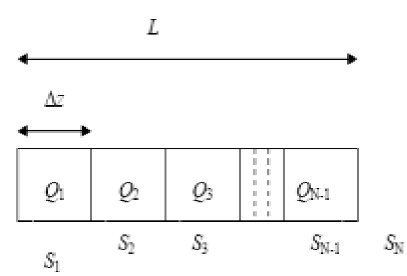

Figure 1.Description of arterial model

The governing equations by linearizing equation form as given below:

$$\frac{\partial Q_i}{\partial t}+\frac{4\pi v}{S_0}Q_i+\frac{S_0}{2\rho}\frac{\partial P}{\partial z}+\frac{S_i}{2\rho}\frac{\partial P}{\partial z}+Ku=0, \qquad (11)$$

Using the built-in MAT Lab ODE-45 function, which is based on the Runge-Kutta procedure, is the simplest and fastest way to improve the situation.

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IV. RESULTS AND DISCUSSIONS

The new algorithm is expense and powerful and accumulates significantly.

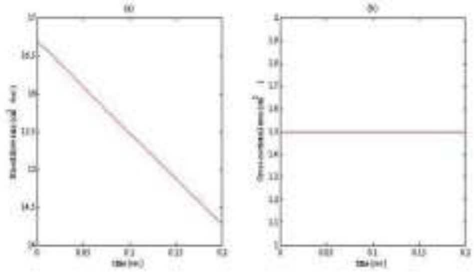

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Fig. 2: (i) Level of bloodstream supply versus timeframe

(ii) Toward time, cross-sectional location.

Figure 2 illustrates the blood supply rate and inter regions by each nodes. The Q1, Q2 and Q3 observations remain roughly the same as described in figure 2 (a). In same manner fig. 2(b), the S1, S2 and S3 values are very similar and are specifications of the process.

Fig. 3 illustrates that the cross-sectional area value is lower, the blood supply rate in a normal state decreased slowly than the blood flow rate.

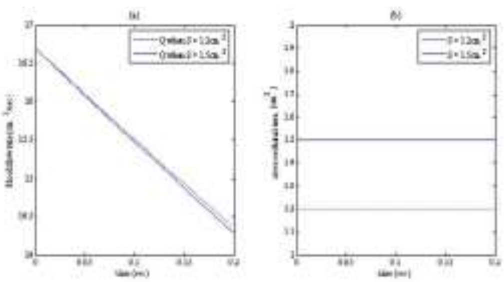

Figure3. Blood flow comparative diagram with various cross-sectional evaluating different with porous impact.

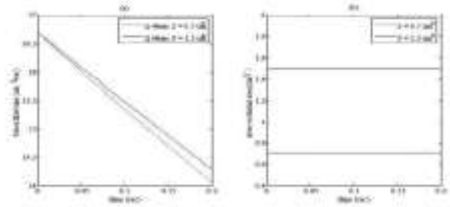

Figure 4: Relation between Q and a much reduced cross-sectional area throughout the usual cross-sectional area.

The blood flow values decreased easier and quicker rate when the cross-sectional area value is below 0.8 cm2, as can be seen in figure 4 above.

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V. CONCLUSION

The new algorithm is expensive and accurate and accumulates considerably. We have developed a mathematical model in this paper that can explain the blood circulation through porous influences in the stenosized arteries. Models like this specifically have a significant role to play in the development of health care policy.

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