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CALCULATION FOR HEMODYNAMIC INDICATOR VOLUMETRIC FLOW RATE FOR A NARROW STENOSED ARTERY FILLED WITH POROUS MEDIUM SUBJECT TO A SLIP VELOCITY AT ARTERIAL WALL

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Abstract: In the present paper we considered the blood flow through a narrow stenosed artery filled with porous medium subject to a slip velocity at arterial wall and obtained for Hemodynamic Indicator Volumetric Flow Rate.

1. Introduction

A large number of studies have already done to consider the effects of hemodynamics parameters on stenosed artery blood flow. Most of these studies involved the velocity profiles in different pattern and shapes of stenosis without considering the other parameters which have a great influence on blood flow. As Halder and Ghosh(1994), Layek and Mukhopadhyay(2008), Sharma and Bansal (2012, 2014) studied the blood flowthroughstenosed artery under the various physiological conditions. Sanyal*et al.* (2007) studied the characteristic of blood flow in a rigid inclined circular tube with periodic body acceleration under the influence of a uniform magnetic field and conclude that velocity increases with acceleration due to gravity, inclination and womersley parameter and decreases with magnetic number. Singh et al.(2018) dealt with the velocity profiles of blood flow through stenosed artery under magnetic effects and slip condition.

In the present paper we considered the blood flow through a narrow stenosed artery filled with porous medium subject to a slip velocity at arterial wall . Effects of various non-dimensional parameters on hemodynamic indicators are discussed.

2. Calculation for Hemodynamic Indicator Volumetric Flow Rate (Q)

The volumetric flow rate Q of the fluid in the stenotic region is given by

$$Q = 2\pi R_0 \int_0^{R/R_0} uy\,dy$$

$$Q = 2\pi R_0 \int_0^{R/R_0} \frac{\left[\begin{array}{l} \left(\frac{c}{4a} \sum_{m=0}^{\infty} \lambda_m \left(\frac{R(z)}{R_0} \right)^{m+2} + u_s \right) \sum_{m=0}^{\infty} A_m y^m \\ - \frac{c}{4a} \sum_{m=0}^{\infty} A_m \left(\frac{R(z)}{R_0} \right)^m \sum_{m=0}^{\infty} \lambda_m y^{m+2} \end{array} \right]}{\sum_{m=0}^{\infty} A_m \left(\frac{R(z)}{R_0} \right)^m} e^{i\omega t} y dy$$

$$Q = 2\pi R_0 e^{i\omega t} \int_0^{R/R_0} \frac{\left[\begin{array}{l} \left(\frac{c}{4a} \sum_{m=0}^{\infty} \lambda_m \left(\frac{R(z)}{R_0} \right)^{m+2} + u_s \right) \sum_{m=0}^{\infty} A_m y^{m+1} \\ - \frac{c}{4a} \sum_{m=0}^{\infty} A_m \left(\frac{R(z)}{R_0} \right)^m \sum_{m=0}^{\infty} \lambda_m y^{m+3} \end{array} \right]}{\sum_{m=0}^{\infty} A_m \left(\frac{R(z)}{R_0} \right)^m} dy$$

Let Q_0 denotes the flow rate of plasma fluid in unconstricted tube (M=0 and H=0) which is given by

$$Q_0 = -\frac{\pi R_0^3}{8\mu_0} \left(\frac{\partial p}{\partial z} \right)_0$$

where, $\left(\frac{\partial p}{\partial z} \right)_0$ being the pressure gradient of the fluid in unconstricted uniform tube.

$$Q = 2\pi R_0 e^{i\omega t} \left[\frac{ \begin{array}{l} \left(\frac{c}{4a} \sum_{m=0}^{\infty} \lambda_m \left(\frac{R(z)}{R_0} \right)^{m+2} + u_s \right) \sum_{m=0}^{\infty} \frac{A_m}{m+2} \left(\frac{R}{R_0} \right)^{m+2} \\ - \frac{c}{4a} \sum_{m=0}^{\infty} A_m \left(\frac{R(z)}{R_0} \right)^m \sum_{m=0}^{\infty} \frac{\lambda_m}{m+4} \left(\frac{R}{R_0} \right)^{m+4} \end{array} }{\sum_{m=0}^{\infty} A_m \left(\frac{R(z)}{R_0} \right)^m} \right]$$

Thus non-dimensional flow rate $Q = \frac{Q}{Q_0}$ is given by

$$Q = \frac{4}{a} \frac{\frac{\partial p}{\partial z}}{\left(\frac{\partial p}{\partial z}\right)_0} \frac{\sum_{m=0}^{\infty}\left(\lambda_m\left(\frac{R}{R_0}\right)^{m+2} + 4au_s\right)\sum_{m=0}^{\infty}\frac{A_m}{m+2}\left(\frac{R}{R_0}\right)^{m+2} - \sum_{m=0}^{\infty} A_m\left(\frac{R}{R_0}\right)^{m}\sum_{m=0}^{\infty}\frac{\lambda_m}{m+4}\left(\frac{R}{R_0}\right)^{m+4}}{\sum_{m=0}^{\infty} A_m\left(\frac{R}{R_0}\right)^{m}} \qquad (2)$$

Using $c = -\frac{R_0^2}{\mu_0}\frac{\partial p}{\partial z}\frac{1}{e^{i\omega t}}$

If volumetric flow rate of unconstructed tube and constricted tube is same for the closed system then we take $\frac{Q}{Q_0} = 1$,otherwise it may have any arbitrary value like 0.1. 0.2, -----------1, --------.

The expression for the relative pressure gradient can be obtained by

$$\mathrm{P} = \left(\frac{\partial \mathrm{p}}{\partial \mathrm{z}}\right) / \left(\frac{\partial \mathrm{p}}{\partial \mathrm{z}}\right)_0$$

$$\mathrm{P} = \frac{\mathrm{a}}{4}\frac{\mathrm{Q}}{\mathrm{Q}_0}\frac{\sum_{m=0}^{\infty} A_m\left(\frac{R}{R_0}\right)^{m}}{\sum_{m=0}^{\infty}\lambda_m\left(\frac{R}{R_0}\right)^{m+2}\sum_{m=0}^{\infty}\frac{A_m}{m+2}\left(\frac{R}{R_0}\right)^{m} - \sum_{m=0}^{\infty} A_m\left(\frac{R}{R_0}\right)^{m}\sum_{m=0}^{\infty}\frac{\lambda_m}{m+4}\left(\frac{R}{R_0}\right)^{m+4}}$$

(3)

3. Discussion:we consider the velocity profiles and Hemodynamics indicators of Pulsatile unsteady flow of blood through stenosed artery under the influence of transverse magnetic field and slip condition without or with porous medium**,** is focused on study in an artery of circular cross-section and suffered with stenosis and and obtained for Hemodynamic Indicator Volumetric Flow Rate.

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Reference

Haldar, K., 2009, "Application of adomian's approximation to blood flow through arteries in the presence of a magnetic field", Applied Mathematics , 1 : 17-28

Layek, G.C. and Mukhopadhyay, S., 2008, "Numerical modeling of a stenosed artery using mathematical model of variable shape", Int.J. of Applications and Applied Mathematics, 3 : 308-328

Sharma, Madhu and Gaur, R.K.,2017, "Modeling of MHD blood flow in a balloon catheterized arterial stenosis with thermal radiation", Int. J. of Engineering Sci. & Research Technology, 6(10) : 237-247.

Sanyal, D. C. and Maiti, A. K., 1998, "On pulsatile flow of blood through a stenosed artery", Ind. J. Maths, 40(2) : 199-213