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The impact of magnetic field on pulsatile blood flow through multi-stenosed tube

ABSTRACT

The flow of blood via a multi-stenosed blood vessel that is modeled as having two layers and passing through a porous media is altered by an external magnetic field, as stated in this paper. In our current research, the explicit solutions of pressure gradient and both central and peripheral velocities are evaluated using the Frobenius Technique. Pictorial representations of the pressure gradient data for various parameters are produced using MATLAB programming. The study proves that variations in the peripheral layer's thickness have an impact on the pressure gradient. These insights might help in the creation of more potent treatments for blood flow-related disorders.

Keywords: *Frobenius method, pressure gradient, peripheral layer, flux profile, two-layered model.*

1. INTRODUCTION

Stenosis, at times, referred to as arteriosclerosis, is a frequent kind of cardiovascular disease that appears when the thickness of the arterial wall increases excessively and abnormally. It occasionally has serious consequences. For many years, researchers have sought to create theoretical and practical models that simulate blood flow across stenosed arteries. Cholesterol accumulates and connective tissue expands quickly in the artery wall, creating plaques that expand inward and block blood flow.

Although the exact cause of stenosis is unknown, numerous studies have examined how it affects flow characteristics while applying the Newtonian concept to blood. But in smaller-diameter tubes, blood exhibits non-Newtonian behavior at low shear rates [1-11]. Ponalagusamy [3] and Tamil Selvi [9] additionally contributed to the two-layered model that depicts the blood flow. They investigated a two-layered framework that included Newtonian fluids in both the central and the peripheral layers [4]. A two-layered model with non-Newtonian fluids in both domains was utilized as well by Shukla et al. [5] to study the impact of the peripheral layer's viscosity on flow resistance. Srinivasacharya, and Srikanth [7] analyzed the couple stress fluid's flow in several instances. The flow equations are solved in this research, and analytical expressions for pressure gradient and velocities of both the central and peripheral layers are derived. The impact of a magnetic field on the flow of blood via stenosis has been noticed to be mild. The flow properties have been examined and graphically shown.

2. FORMULATION OF PROBLEM

We use the blood flow in a two-layered model to be a constant, incompressible, fully developed flow with varying viscosity. An outline of a composite stenosed artery is given below:

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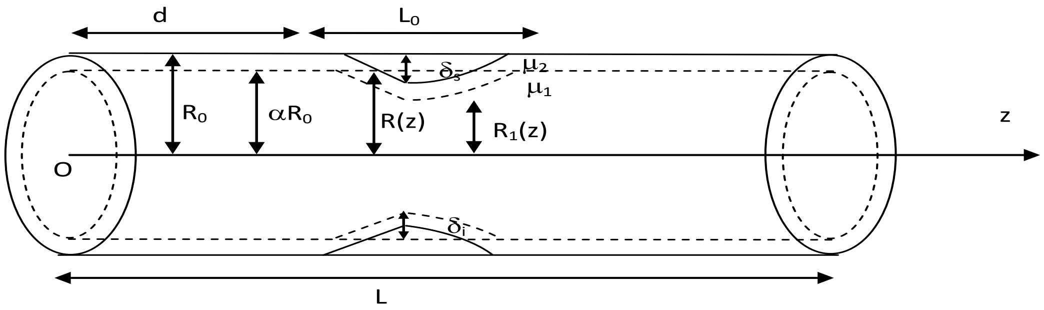

where

$R_1(z)$, the radius of the central layer, and $R(z)$, the radius of a stenotic tube with a peripheral layer, R_0 is the radius of an unobstructed blood vessel. L_0 represents the length of the tube, d being the area of stenosis, δ_s being the height of stenosis, δ_i being maximum bulging of the interface at $Z = d + \frac{L_0}{2}$, α being the ratio between the radius of the central layer and the radius of the artery that is not obstructed.

By substituting the Hematocrit and Einstein relations, we obtain the value of

$$\mu_c = \mu_0 \left[a - k \left(\frac{r}{R_0} \right)^3 \right]$$

where

$$a = 1 + k \text{ and } k = \beta h_m, \qquad (1)$$

Also, h_m the maximum hematocrit, R_o the radius of the unstenosed artery, μ_c, the viscosity of the central layer, μ_0, and the viscosity of plasma, β are constant.

Given below are the governing equations of flow in the central and peripheral layers,

$$\mu_1 \frac{\partial}{\partial t'} (\nabla^2 u_c) + \mu_c \left[\frac{\partial^2 u_c}{\partial r^2} + \frac{1}{r} \frac{\partial u_c}{\partial r} \right] + \frac{\partial \mu_c}{\partial r} \frac{\partial u_c}{\partial r} - \beta_0^2 \sigma_e^c u_c - \frac{\partial p}{\partial z} = 0 \qquad (2)$$

$$\mu_0 \left[\frac{\partial^2 u_p}{\partial r^2} + \frac{1}{r} \frac{\partial u_p}{\partial r} \right] - \beta_0^2 \sigma_e^c u_p - \frac{\mu_0}{K} u_p - \frac{\partial p}{\partial z} = 0 \qquad (3)$$

Where *dp/dz* is the pressure gradient, *K* is the permeability constant, μ_1 is the elastic viscosity coefficient, u_c and u_p are the fluid velocities, σ_e^c and σ_e^p are electrical conductivities for central and peripheral layers, accordingly.

As for the boundary conditions,

$$\frac{\partial u_c}{\partial r} = 0 \quad at \quad r = 0 \qquad (4)$$

$$u_c = 0 \quad at \quad r = 0 \qquad (5)$$

$$u_c = u_p \quad at \quad r = R_1(z) \qquad (6)$$

$$\tau_c = \tau_p \quad at \quad r = R_1(z) \qquad (7)$$

Considering the transformation,

$$x = \frac{r}{R_0} \quad and \quad t = \frac{T}{t_0} \qquad (8)$$

After applying the transformation Eq. 8, the boundary conditions take on the specified form

$$\frac{\partial U_c}{\partial x} = 0 \quad at \quad x = 0 \qquad (9)$$

$$U_p = -h \frac{\partial U_p}{\partial x} \quad at \quad x = \frac{R(z)}{R_0} \qquad (10)$$

$$U_c = U_p \quad at \quad r = \frac{R_1(z)}{R_0} \qquad (11)$$

$$\tau_c = \tau_p \quad at \quad r = \frac{R_1(z)}{R_0} \qquad (12)$$

Using the Einstein Relation, $\mu_c = \mu_0[a - kx^3]$, as a result of Eqs. 2 & 3 is

$$\mu_1 \frac{1}{t_0 R_0^2} \frac{\partial}{\partial t} \left[x \frac{\partial^2 u_c}{\partial x^2} + \frac{\partial u_c}{\partial x} \right] + (a - kx^3) \left[x \frac{\partial^2 u_c}{\partial x^2} + \frac{\partial u_c}{\partial x} \right] - 3kx^3 \frac{\partial u_c}{\partial x} - M_1^2 x u_c = x \frac{R_0^2}{\mu_0} \frac{\partial p}{\partial z} \qquad (13)$$

where, $M_1^2 = \frac{\beta_0^2 R_0^2 \sigma_e^c}{\mu_0}$, M_1 is Hartmann number for the central layer

$$x \frac{\partial^2 u_c}{\partial x^2} + \frac{\partial u_c}{\partial x} - M_2^2 x u_p - \frac{R_0^2}{K} x u_p = x \frac{R_0^2}{\mu_0} \frac{\partial p}{\partial z} \qquad (14)$$

where

$M_2^2 = \frac{\beta_0^2 R_0^2 \sigma_e^c}{\mu_0}$, M_2 is the Hartmann number for the peripheral layer.

Let $u(x,t) = U(x) e^{\iota \omega t}$ *and* $-\frac{R_0^2}{\mu_0} \frac{\partial p}{\partial z} = c e^{\iota \omega t}$ (15)

Partially differentiating Eq. 15 to x & t, and by putting the values in Eq. 13, we get

$$\gamma^2 \left[x\frac{\partial^2 U_c}{\partial x^2}+\frac{\partial U_c}{\partial x}\right]+(a-kx^3)\left[x\frac{\partial^2 U_c}{\partial x^2}+\frac{\partial U_c}{\partial x}\right]-3kx^3\ \frac{\partial U_c}{\partial x}-M_1^2 x\, U_c=-xc \quad (16)$$

where $\gamma^2 = \mu_1 \frac{1}{t_0 R_0^2} \iota\, \omega$

3. SOLUTION OF THE PROBLEM

We use the Frobenius approach for second-order differential Eqs. 14 & 16. Now, we take the homogeneous form of Eq. 16

$$\boldsymbol{\gamma^2 \left[x\frac{\partial^2 U_c}{\partial x^2}+\frac{\partial U_c}{\partial x}\right]+(a-kx^3)\left[x\frac{\partial^2 U_c}{\partial x^2}+\frac{\partial U_c}{\partial x}\right]-}$$

$$\boldsymbol{-3kx^3\ \frac{\partial U_c}{\partial x}-M_1^2 x\, U_c=0} \quad (17)$$

Let's assume,

$$U_c=\sum_{n=0}^{\infty} A_n x^{n+l} \quad (18)$$

where $l, A_0 \neq 0, A_1, A_2, A_3 \ldots, A_n \ldots$ are constants.

Differentiating twice the Eq. 18, we get

$$\frac{\partial U_c}{\partial x}=\sum_{n=0}^{\infty}(n+l)\, A_n\, x^{n+l-1} \quad (19)$$

$$\frac{\partial^2 U_c}{\partial x^2}=\sum_{n=0}^{\infty}(n+l)(n+l-1)\, A_n\, x^{n+l-2} \quad (20)$$

By substituting the relations in Eq. 17, we have

$$(\gamma^2+a)\, l^2\, A_0\, x^{l-1}+(\gamma^2+a)(l+1)^2\, A_1\, x^l+(\gamma^2+a)(l+2)^2\, A_2\, x^{l+1}-M_1^2 A_0\, x^{l+1}+$$

$$+\sum_{n=3}^{\infty}[(\gamma^2+a)(n+l)^2 A_n-k(n+l)(n+l-3)A_{n-3}-M_1^2 A_{n-2}]\, x^{n+l-1}=0 \quad (21)$$

Comparing the like power coefficients on both sides,

$$A_0=1,\ A_1=A_3=0,\ A_2=\frac{M_1^2 A_0}{(\gamma^2+a)(l+2)^2} \quad (22)$$

Substitute the relation from Eq. 22 in Eq. 18,

$$\boldsymbol{U_c(x)=\sum_{n=0}^{\infty}\left[\frac{k\,(n+l)\,(n+l-3)\,A_{n-3}+M_1^2 A_{n-2}}{(\gamma^2+a)(n+l)^2}\right]x^{n+l}} \quad (23)$$

by putting $l=0$ in Eq. 23, we get

$$U_c(x)=\sum_{n=0}^{\infty} A_n\, n \quad (24)$$

where,

$$A_n=\frac{k\, n\,(n-3)\, A_{n-3}+M_1^2 A_{n-2}}{(\gamma^2+a)\, n^2} \quad (25)$$

Expanding Eq. 23 by using Eq. 22, we get

$$U_c(x)=x^l\left[1+\frac{M_1^2}{(\gamma^2+a)\,(l+2)^2}x^2+\frac{M_1^4}{(\gamma^2+a)\,(l+4)^2\,(l+2)^2}x^4+\cdots\ldots\right] \quad (26)$$

The linearly independent solution is obtained by differentiating Eq. 26, we have

$$U_c(x)=log x\left[1+\frac{M_1^2}{(\gamma^2+a)\,2^2}x^2+\frac{M_1^4}{(\gamma^2+a)\,4^2.2^2}x^4+\cdots\ldots\right]-\left[\frac{1}{4}\frac{M_1^2}{(\gamma^2+a)}x^2+\frac{3}{256}\frac{M_1^4}{(\gamma^2+a)}x^2\ldots\ldots\ldots\right] \quad (27)$$

A linear combination of Eq. 24 and Eq. 27, provides the complete solution of Eq. 18,

$$U_c(x)=A\sum_{n=0}^{\infty}A_n x^n+B\, log x\left[1+\frac{M_1^2}{(\gamma^2+a)\,2^2}x^2+\frac{M_1^4}{(\gamma^2+a)\,4^2.2^2}x^4+\cdots\ldots\right]$$

$$-\left[\frac{1}{4}\frac{M_1^2}{(\gamma^2+a)}x^2+\frac{3}{256}\frac{M_1^4}{(\gamma^2+a)}x^2\ldots\ldots\ldots\right] \quad (28)$$

To fulfill the boundary criterion in Eq. 9, we need $B=0$. Therefore, using Eq. 28

$$U_c(x)=A\sum_{n=0}^{\infty}A_n x^n \quad (29)$$

that solve the homogenous differential Eq. 17.

Assuming, the specific solution to the non-homogeneous term Eq. 18 is

$$U_c(x)=\sum_{n=0}^{\infty}\bar{A}_n x^{n+l} \quad (30)$$

where, $\bar{A}_0$, $\bar{A}_1$. constants.

Eq. 30, when twice differentiated, yields

$$\frac{\partial U_c}{\partial x}=\sum_{n=0}^{\infty}(n+l)\,\bar{A}_n\, x^{n+l-1} \quad (31)$$

$$\frac{\partial^2 U_c}{\partial x^2}=\sum_{n=0}^{\infty}(n+l)(n+l-1)\,\bar{A}_n\, x^{n+l-2} \quad (32)$$

Now substituting the relations from Eqs. 30-32 in Eq. 16, we get

$$(\gamma^2+a)\sum_{n=0}^{\infty}(n+l)^2\ \bar{A}_n\, x^{n+l-1} - k\sum_{n=3}^{\infty}(n+l)(n+l-3)\ \bar{A}_{n-3}\, x^{n+l-1} - M_1^2\sum_{n=0}^{\infty}\bar{A}_{n-2}\, x^{n+l-1} = x\frac{R_0^2}{\mu_0}\frac{\partial p}{\partial z} \quad (33)$$

The coefficients of each of the remaining terms on the LHS of Eq. 33 must vanish, and the leading term in Eq. 33 must have the least power of *x* By taking *l = 2*, these prerequisites are fulfilled.

We obtain the whole solution of Eq. 33 by comparing the coefficient of higher powers,

$$U_c(x) = A\sum_{n=0}^{\infty}A_n x^n + \frac{R_0^2}{4(\gamma^2+a)\mu_0}\frac{\partial p}{\partial z}\sum_{n=0}^{\infty}\bar{A}_n x^{n+l} \quad (34)$$

Applying the aforementioned transformations yields the complete solution for U_p as well,

$$U_p(x) = \frac{R_0^2}{4\,\mu_0}\frac{dp}{dz}\frac{1}{\sum_{n=0}^{\infty}F_n\left(\frac{R_1}{R_0}\right)^n + h\sum_{n=0}^{\infty}nF_n\left(\frac{R}{R_0}\right)^{n-1}}\left[\sum_{n=0}^{\infty}\bar{F}_n x^{n+2}\ \sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n - \sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+2}\sum_{n=0}^{\infty}F_n x^n + \right.$$

+hn=0∞n FnRR0n−1n=0∞ Fnxn+2−hn=0∞ FnRR0n+1n=0∞Fnxn (35)

Eqs. 33 and 34 with the boundary condition from Eq. 12 will result in

$$A = \frac{R_0^2}{4\,\mu_0}\frac{\partial p}{\partial z}\frac{1}{\left[a-k\left(\frac{R_1}{R_0}\right)^3\right]\sum_{n=0}^{\infty}n\,A_n\left(\frac{R_1}{R_0}\right)^{n-1}\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n}\times$$
$$\left[\begin{matrix}\sum_{m=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n\sum_{n=0}^{\infty}(n+2)\bar{F}_n\left(\frac{R_1}{R_0}\right)^{n+1} - \sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+2}\sum_{n=0}^{\infty}nF_n\left(\frac{R_1}{R_0}\right)^{n-1} - \\ -\frac{1}{(\gamma^2+a)}\left\{a-k\left(\frac{R_1}{R_0}\right)^3\right\}\sum_{n=0}^{\infty}(n+2)\bar{A}_n\left(\frac{R_1}{R_0}\right)^{n+1}\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n\end{matrix}\right] \quad (36)$$

Eq. 34, obtained by substituting the value of A from Eq. 37

$$U_c(x) = \frac{R_0^2}{4\,\mu_0}\frac{\partial p}{\partial z}\frac{1}{\left[a-k\left(\frac{R_1}{R_0}\right)^3\right]\sum_{n=0}^{\infty}n\,A_n\left(\frac{R_1}{R_0}\right)^{n-1}\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n}\times$$
$$\left[\left\{\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n\sum_{n=0}^{\infty}(n+2)\bar{F}_n\left(\frac{R_1}{R_0}\right)^{n+1} - \sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+2}\sum_{n=0}^{\infty}nF_n\left(\frac{R_1}{R_0}\right)^{n-1} - \frac{1}{(\gamma^2+a)}\left\{a-k\left(\frac{R_1}{R_0}\right)^3\right\}\sum_{n=0}^{\infty}(n+\right.\right.$$

2AnR1R0n+1n=0∞FnRR0nn=0∞ Anxn+1(γ2+a)a−kR1R03n=0∞FnRR0n n=0∞n AnR1R0n−1−n=0∞Anxn+2

(37)

The overall flow rate Q is determined by $Q = Q_c + Q_p$

$$Q = 2\pi R_0^2\left[\int_{R_1/R_0}^{R/R_0}xU_c\,dx + \int_{R_1/R_0}^{R/R_0}xU_p\,dx\right] =$$

$$\frac{\pi R_0^4}{2\,\mu_0}\frac{\partial p}{\partial z}\left[\frac{1}{\left[a-k\left(\frac{R_1}{R_0}\right)^3\right]\sum_{n=0}^{\infty}n\,A_n\left(\frac{R_1}{R_0}\right)^{n-1}\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n}\left[\sum_{n=0}^{\infty}\frac{A_n}{n+2}\left(\frac{R_1}{R_0}\right)^{n+2}\left\{\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n\sum_{n=0}^{\infty}(n+\right.\right.\right.$$
$$2)\bar{F}_n\left(\frac{R_1}{R_0}\right)^{n+1} - \sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+2}\sum_{n=0}^{\infty}nF_n\left(\frac{R_1}{R_0}\right)^{n-1} -$$
$$\frac{1}{(\gamma^2+a)}\left\{a-k\left(\frac{R_1}{R_0}\right)^3\right\}\sum_{n=0}^{\infty}(n+2)\bar{A}_n\left(\frac{R_1}{R_0}\right)^{n+1}\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n\bigg\}\frac{1}{(\gamma^2+a)}\bigg[a-$$
$$\left.\left.-k\left(\frac{R_1}{R_0}\right)^3\right]\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n\sum_{n=0}^{\infty}n\,A_n\left(\frac{R_1}{R_0}\right)^{n-1}\sum_{n=0}^{\infty}\frac{\bar{A}_n}{n+4}\left(\frac{R_1}{R_0}\right)^{n+4}\right]\right] +$$

$$+\left[\frac{1}{\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n + h\sum_{n=0}^{\infty}nF_n\left(\frac{R}{R_0}\right)^{n-1}}\left\{\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^n\sum_{n=0}^{\infty}\frac{\bar{F}_n}{n+4}\left[\left(\frac{R}{R_0}\right)^{n+4} - \left(\frac{R_1}{R_0}\right)^{n+4}\right] - \right.\right.$$
$$\sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+2}\sum_{n=0}^{\infty}\frac{\bar{F}_n}{n+4}\left[\left(\frac{R}{R_0}\right)^{n+4} - \left(\frac{R_1}{R_0}\right)^{n+4}\right] + h\sum_{n=0}^{\infty}F_n\left(\frac{R}{R_0}\right)^{n-1}\sum_{n=0}^{\infty}\frac{\bar{F}_n}{n+4}\left[\left(\frac{R}{R_0}\right)^{n+4} - \left(\frac{R_1}{R_0}\right)^{n+4}\right] -$$
$$\left.\left.-h\sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+1}.(n+2)\sum_{n=0}^{\infty}\frac{F_n}{n+2}\left[\left(\frac{R}{R_0}\right)^{n+2} - \left(\frac{R_1}{R_0}\right)^{n+2}\right]\right\}\right] \quad (38)$$

The enclosed blood circulation system maintains a steady flow rate, thus we take $Q = \pi$ In light of this, the pressure gradient is provided by

$$\frac{\partial p}{\partial z} = \frac{2\mu_0}{R_0^4}\left[\left\{\left[a - k\left(\frac{R_1}{R_0}\right)^3\right]\sum_{n=0}^{\infty} n A_n \left(\frac{R_1}{R_0}\right)^{n-1} \sum_{n=0}^{\infty} F_n \left(\frac{R}{R_0}\right)^n\right\} \div \left\{\sum_{n=0}^{\infty} \frac{A_n}{n+2}\left(\frac{R_1}{R_0}\right)^{n+2}\left\{\sum_{n=0}^{\infty} F_n\left(\frac{R}{R_0}\right)^n \sum_{n=0}^{\infty}(n+2)\bar{F}_n\left(\frac{R_1}{R_0}\right)^{n+1} - \sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+2}\sum_{n=0}^{\infty} nF_n\left(\frac{R_1}{R_0}\right)^{n-1} - \frac{1}{(\gamma^2+a)}\left\{a - k\left(\frac{R_1}{R_0}\right)^3\right\}\sum_{n=0}^{\infty}\frac{(n+2)\bar{A}_n\left(\frac{R_1}{R_0}\right)^{n+1}}{\sum_{n=0}^{\infty} F_n\left(\frac{R}{R_0}\right)^n}\right\}\frac{1}{(\gamma^2+a)}\left[a - k\left(\frac{R_1}{R_0}\right)^3\right]\sum_{n=0}^{\infty} F_n\left(\frac{R}{R_0}\right)^n \sum_{n=0}^{\infty} n A_n\left(\frac{R_1}{R_0}\right)^{n-1}\sum_{n=0}^{\infty}\frac{A_n}{n+4}\left(\frac{R_1}{R_0}\right)^{n+4}\right\}\right] + \left[\left\{\sum_{n=0}^{\infty} F_n\left(\frac{R}{R_0}\right)^n + h\sum_{n=0}^{\infty} nF_n\left(\frac{R}{R_0}\right)^{n-1}\right\} \div \left\{\sum_{n=0}^{\infty} F_n\left(\frac{R}{R_0}\right)^n \sum_{n=0}^{\infty}\frac{F_n}{n+4}\left[\left(\frac{R}{R_0}\right)^{n+4} - \left(\frac{R_1}{R_0}\right)^{n+4}\right] - \sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+2}\sum_{n=0}^{\infty}\frac{F_n}{n+4}\left[\left(\frac{R}{R_0}\right)^{n+4} - \left(\frac{R_1}{R_0}\right)^{n+4}\right] + h\sum_{n=0}^{\infty} F_n\left(\frac{R}{R_0}\right)^{n-1}\sum_{n=0}^{\infty}\frac{F_n}{n+4}\left[\left(\frac{R}{R_0}\right)^{n+4} - \left(\frac{R_1}{R_0}\right)^{n+4}\right] - h\sum_{n=0}^{\infty}\bar{F}_n\left(\frac{R}{R_0}\right)^{n+1}.(n+2)\sum_{n=0}^{\infty}\frac{F_n}{n+2}\left[\left(\frac{R}{R_0}\right)^{n+2} - \left(\frac{R_1}{R_0}\right)^{n+2}\right]\right\}\right] \quad (39)$$

3. RESULTS AND DISCUSSION

Fig. 1 shows how the behavior of pressure gradient when the size of the stenosis increases for various Hartmann number values, $\boldsymbol{M_1}$ and $\boldsymbol{M_2}$ for the central and peripheral layers, respectively. It demonstrates that as stenosis size rises, the pressure gradient also increases. Additionally, it shows that the porosity effect, which causes a small rise in the variation of pressure with a rise in magnetic field, is what causes the gradient to gradually decrease with a rise in magnetic field, showing how applying a magnetic field to arteries with stenosis controls blood flow.

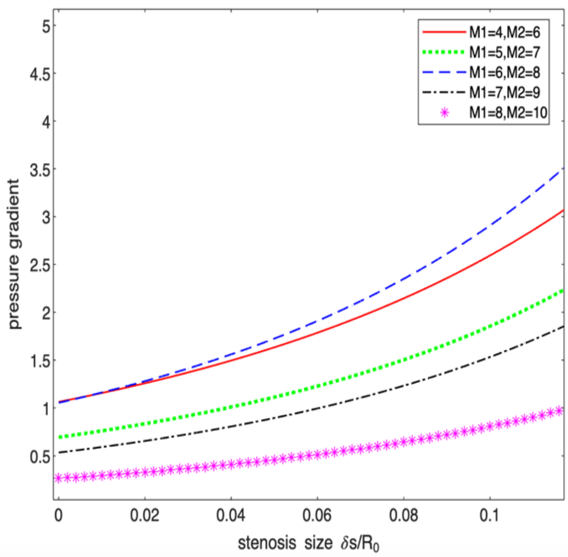

Figure 1. Variation of Pressure Gradient for Hartmann number values, $\boldsymbol{M_1}$ and $\boldsymbol{M_2}$

Fig. 2 depicts the pressure gradient fluctuations along the size of the stenosis increases for various values of permeability constant, $\boldsymbol{K}$ also increases. Therefore, this can be inferred that a diseased heart may be at risk from rising levels of hematocrit concentration.

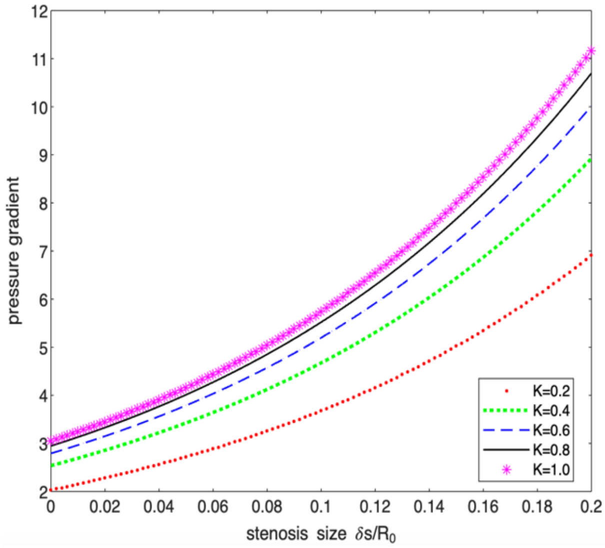

Figure 2. Variation of Pressure Gradient for Permeability constant, K values

4. CONCLUSIONS

The following conclusions are drawn from the present work.

- As a magnetic field is applied to a stenosed artery via a porous media, the existence of a peripheral layer reduces the flow properties of blood flow.
- The pressure gradient increases for a modest increase in magnetic field intensity and subsequently decreases for a further increase, demonstrating that the magnetic field could be utilized to regulate the flow of blood in sick persons with hypertension.

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IZVOD

UTICAJ MAGNETNOG POLJA NA PULSALNI PROTOK KRVI KROZ MULTISTENOZNU CEV

Protok krvi preko višestruko stenoziranog krvnog suda koji je modelovan kao da ima dva sloja i koji prolazi kroz porozni medij menja spoljašnje magnetno polje, kao što je navedeno u ovom radu. U našem trenutnom istraživanju, eksplicitna rešenja gradijenta pritiska i centralne i periferne brzine se procenjuju korišćenjem Frobeniusove tehnike. Slikovni prikazi podataka o gradijentu pritiska za različite parametre se proizvode korišćenjem MATLAB programiranja. Studija dokazuje da varijacije u debljini perifernog sloja utiču na gradijent pritiska. Ovi uvidi mogu pomoći u stvaranju snažnijih tretmana za poremećaje krvotoka.

Ključne reči: *Frobenijusova metoda, gradijent pritiska, periferni sloj, fluk profil, dvoslojni model.*

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