JOURNAL OF BASIC SCIENCE AND ENGINEERING

NUMERICAL DISPLAYING OF BLOOD STREAM THROUGH A TIGHTENED COVERING STENOSED CORRIDOR WITH VARIABLE CONSISTENCY

[1]Dr.M.V.Suresh, [2]Dr.N. Srinivasan, [3]R.Sangeetha
[1]Assistant Professor, Department of Mathematics, SRM Institute of Science & Technology, Vadapalani, Chennai-600026
[2]Professor, Department of Mathematics, St.Peter's Institute of Higher Education and Research, Avadi, Chennai-600054.
[3]Research Scholar, Department of Biochemistry, Vallliammal College for Women, Anna Nagar, Chennai – 600 102
[1]dr.m.v.suresh1708@gmail.com, [2]nsri24455@gmail.com, [3]ssameerasangeetha@gmail.com,

1. Abstract

The research work presents a hypothetical investigation of blood course through a tightened and covering stenosed supply route under the activity of a remotely applied attractive field. The liquid (blood) medium is thought to be permeable in nature. The variable consistency of blood contingent upon hematocrit (rate volume of erythrocytes) is considered to further develop similarity to the genuine circumstance. The overseeing condition for laminar, incompressible and Newtonian liquid subject to the limit conditions is tackled by utilizing a notable Frobenius technique. The logical articulations for speed part, volumetric stream rate, wall shear pressure and strain angle are acquired. The mathematical qualities are removed from these scientific articulations and are introduced graphically. It is seen that the impact of hematocrit, attractive field and the state of corridor critically affect the speed profile, pressure inclination and wall shear pressure. In addition, the impact of essential stenosis on the optional one has been fundamentally noticed.

Keywords: Covering stenoses, tightened corridor, MHD stream, permeable vessel, hematocrit, Frobenius technique

2. Introduction

Numerous cardiovascular sicknesses, for example, because of the blood vessel impediment is one of the main source of death around the world. The fractional impediment of the corridors because of stenotic obstacle confine the ordinary blood stream as well as portrays the solidifying and thickening of the blood vessel wall. Nonetheless, the primary driver of the arrangement of stenosis is as yet unclear yet it is deeply grounded that the liquid dynamical variables assume a significant part as to additional advancement of stenosis. Consequently, during the beyond scarcely any rot a few investigations were led by to comprehend the impacts of stenosis on blood course through supply routes. Tu and Deville [4] researched pulsatile stream of blood in stenosed arteries. Since blood has a complex rheological qualities, it acts like different liquid model under various natural and primary circumstances. In this association commented that vessels of span more prominent than 0.025 cm, blood might be considered as a homogeneous Newtonian liquid and then again saw that typical blood vessel blood stream at high shear-rates blood acts like a Newtonian liquid. The refer put sent a numerical examination for the temperamental progression of blood through conduits having stenosis, in which blood was treated as a Newtonian thick incompressible liquid. A few trial investigations of demonstrated that at low shear-rates blood may acts as non-Newtonian liquid, even in enormous corridors. Likewise it is notable that, blood being a suspension of red platelets in plasma, acts like a non-Newtonian liquid at low shear rates as revealed. Besides, the concentrated on in two distinct circumstances on the blood course through blood vessel stenosis by regarding blood as a non-

Newtonian (Herschel-Bulkley) liquid model no matter what considering slip impact. Additionally, the concentrated on the pulsatile non-Newtonian stream past a stenosed course with atherosclerosis. An explored the non-Newtonian impacts of blood stream on haemodynamics in distal vascular join anastomoses.

The hemodynamics related with a solitary stenotic sore are essentially impacted by the presence of a subsequent injury. As a rule there are confirmations of the event of the numerous or covering stenosis like the patients of angiogram. The directed a hypothetical report for the impacts of numerous stenosis. An exploratory investigation of blood move through a blood vessel portion having different stenoses were made. The impacts of covering stenosis through a blood vessel stenosis have been effectively done logically as well as mathematically by separately. Nonetheless, this multitude of studies are confined in the thought of both the remotely applied attractive field as well as the permeable medium. Consequently, our inspiration is to consider these two impacts notwithstanding the variable thickness of blood contingent upon hematocrit. Since blood is electrically leading liquid, its stream qualities is affected by the utilization of attractive field. On the off chance that an attractive field is applied to a moving and electrically directing liquid, it will incite electric as well as attractive fields. The connection of these fields creates a body force for every unit volume known as Lorentz force, which essentially affects the stream qualities of blood. Such an examination might be helpful for the decrease of blood stream during a medical procedure and Attractive Reverberation Imaging (X-ray). The impact of attractive field on blood stream has been examined hypothetically and tentatively by numerous specialists under various circumstances. She and his co-examiners investigated assortment of stream conduct of blood in veins by treating Newtonian/non-Newtonian model within the sight of a uniform attractive field. As of late, the investigations of blood move through permeable medium has acquired extensive regard for the clinical experts/clinicians on account of its tremendous changes in the stream qualities. The hairlike endothelium is, thus, covered by a slight layer lining the alveoli, which has been treated as a permeable medium. The considered the Brinkman condition to show the blood stream when there is an aggregation of greasy plaques in the lumen of a blood vessel portion and supply route obstructing happens by blood clumps. They thought about the obstructed district as a permeable medium. The concentrated on the vehicle of drug species in laminar, homogeneous, incompressible, magneto-hydrodynamic, throbbing move through twodimensional channel with permeable walls containing non-Darcian permeable materials. An introduced a numerical model as well as mathematical model for concentrating on blood course through a permeable vessel under the activity of attractive field, in which the consistency fluctuates in the outspread heading. Hematocrit is the main determinant of entire blood consistency. In this manner, blood consistency and vascular opposition (because of the presence of stenosis) influence absolute fringe protection from blood stream, which is unusually high in the essential phase of hypertension. Again hematocrit is a blood test that actions the level of red platelets present in the entire blood of the body. The level of red platelets in grown-up human body is roughly 40-45%. Red platelets might influence the thickness of entire blood and accordingly the speed circulation relies upon the hematocrit. So blood can not be considered as homogeneous liquid. Because of the great shear rate close to the blood vessel wall, the consistency of blood is low and the convergence of red platelets is high in the focal center area. In this manner, blood might be treated as Newtonian liquid with variable consistency especially on account of enormous veins. The current review is persuaded towards a hypothetical examination of blood move through a tightened and covering stenosed conduit within the sight of attractive field. The review relates to a circumstance wherein the variable thickness of blood contingent on hematocrit is thought about. The current model is planned so that it very well may be material to both merging/veering vein contingent upon the decision of tightening point α. In this manner, the review will addresses the subject of component of additional affidavit of plaque under different angles.

3. Numerical displaying of the issue

We consider the laminar, incompressible and Newtonian progression of blood through axisymmetric twodimensional tightened and covering stenosed course. Any material point in the liquid is addressing by the barrel shaped polar direction (r, θ, z), where z estimates along the pivot of the corridor and that of r and θ measure along the outspread and circumferential headings separately. The numerical articulation that compares to the calculation of the current issue is given by

$$R(z) = R_0\left[1.0 - \frac{11.0}{32.0} l^3 (z-d) + \frac{47.0}{48.0} l^2 (z-d)^2 - (z-d)^3 + \left(\frac{1.0}{3.0}\right)(z-d)^4\right] a(z)$$

$$\text{Where } d \le z \le d + \frac{3l}{2}$$

$$= R_0 a(z) \text{ else where} \tag{1}$$

where the beginning of the stenosis is situated a good ways off d from the channel, 3l/2 the length of the covering stenosis and l addressing the distance between two basic level of the stenoses. The articulation for a(z) is answerable for the supply route to merge or veering contingent upon tightening point α has the structure

$$a(z) = 1 + z\tan(\alpha) \tag{2}$$

We accepted that blood is incompressible, suspension of erythrocytes in plasma and has uniform thick all through yet the consistency μ(r) changes in the outspread bearing. As indicated by Einstein's recipe for the variable consistency of blood taken to be

$$\mu(r) = \mu_0\left[1 + \beta h(r)\right] \tag{3}$$

where μ0 is the coefficient of thickness of plasma, β is a consistent (whose incentive for blood is equivalent to 2.5) and h(r) represents the hematocrit. The examination will be completed by involving the accompanying experimental equation for hematocrit given by in

$$h(r) = H\left[1 - \left(\frac{r}{R_0}\right)^m\right] \tag{4}$$

in which R_0 addresses the sweep of an ordinary blood vessel portion, H is the greatest hematocrit at the focal point of the supply route and m(≥ 2) a boundary that decides the specific state of the speed profile for blood. The state of the profile given by Condition (4) is legitimate just for extremely weaken suspensions of erythrocytes, which are viewed as of circular shape. We expected to be that the blood stream happens in the hub heading just with the goal that all the stream amounts are autonomous of z and there by dR(z)/dz becomes irrelevantly little.

As per our contemplations, the condition that oversees the progression of blood under the activity of an outer attractive field through permeable medium might be put as

$$\frac{\partial p}{\partial z} - \frac{1}{r}\frac{\partial\left(r\mu(r)\frac{\partial u}{\partial r}\right)}{\partial r} + \sigma B_0^2 u + \frac{\mu(r)}{k} u = 0 \tag{5}$$

where u indicates the (hub) speed part of blood, p the circulatory strain, σ the electrical conductivity, ¯k the porousness of the permeable medium and B_0 is the applied attractive field strength. In Condition (5), the initial term demonstrates the pivotal tension slope, second term is the thick power, third term addresses the attractive body force per unit volume and last term becomes possibly the most important factor because of permeable medium. To tackle our concern, we utilize no-slip limit condition at the blood vessel wall, or at least,

$$u = 0 \text{ at } r = R(z) \tag{6}$$

Further we consider axi-symmetric limit condition of hub speed at the mid line of the course as

$$\frac{\partial u}{\partial r} = 0 \quad \text{at } r = 0 \tag{7}$$

4. Analytical solution

To improve on our concern, let us present the following change

$$\lambda = \frac{r}{R_0} \tag{8}$$

With the utilization of the change characterized in (8) and the Conditions (3) and (4), the overseeing Condition (5) lessens to

$$\frac{1}{\lambda}\frac{\partial}{\partial\lambda}\left[\lambda\left(a_1 - a_2\lambda^m\right)\frac{\partial u}{\partial\lambda}\right] - M^2 u - \frac{1}{k}\left(a_1 - a_2\lambda^m\right)u = \frac{R_0^2}{\mu_0}\frac{\partial p}{\partial z} \tag{9}$$

with $a_1 = 1 + a_2$, $a_2 = \beta H$, $k = \frac{1}{R_0^2}$ and $M^2 = \frac{\sigma\left(B_0 R_0\right)^2}{\mu_0}$

Comparatively the limit conditions changed into

$$u = 0 \text{ at } \lambda = \frac{R(z)}{R_0} \tag{10}$$

$$\text{and } \frac{\partial u}{\partial \lambda} = 0 \text{ at } \lambda = 0 \tag{11}$$

The Condition (9) can be tackled exposed to the limit conditions (10) and (11) utilizing the Frobenius strategy. For this, obviously, u must be limited at λ = 0. Then just allowable series arrangement of the Condition (9) will exists and can place in the structure

$$u = K\sum_{i=0}^{\infty} A_i\lambda^i + \frac{R_0^2\frac{dp}{dz}}{4a_1\mu_0}\sum_{i=0}^{\infty} B_i\lambda^{i+2} \tag{12}$$

Where K, A_i and B_i are arbitrary constants.

To find the arbitrary constant K, we use the no-slip bounday condition (10) and obtained as

$$K = -\frac{R_0^2\frac{dp}{dz}\sum_{i=0}^{\infty} B_i\left(\frac{R}{R_0}\right)^{i+2}}{4a_1\mu_0\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^{i}} \tag{13}$$

Substituting the value of *u* from Equation (12) into Equation (9) and we get

$$K[\sum_{i=0}^{\infty} i(i-1)\left(a_1 - a_2\lambda^m\right)A_i\lambda^{i-2} + \sum_{i=0}^{\infty} i\left(a_1 - (m-1)a_2\lambda^m\right)A_i\lambda^{i-2}$$

$$-\left(M^2 + \frac{a_1}{k}\right)\sum_{i=0}^{\infty} A_i\lambda^i + \sum_{i=0}^{\infty}\frac{a_2}{k}A_i\lambda^{i+m}\ ] + \frac{R_0^2\frac{dp}{dz}}{4a_1\mu_0}$$

$$[\sum_{i=0}^{\infty}(i+1)(i+2)(a_1-a_2\lambda^m)B_i\lambda^i+\sum_{i=0}^{\infty}(i+2)(a_1-(m-1)a_2\lambda^m)B_i\lambda^i$$

$$-\left(M^2+\frac{a_1}{k}\right)\sum_{i=0}^{\infty}B_i\lambda^{i+2}+\sum_{i=0}^{\infty}\frac{a_2}{k}B_i\lambda^{i+m+2}]=\frac{R_0^2\frac{dp}{dz}}{4a_1\mu_0} \tag{14}$$

Equating the coefficients of K and other part in Equation(14) we have,

$$K\sum_{i=0}^{\infty}i(i-1)(a_1-a_2\lambda^m)A_i\lambda^{i-2}+\sum_{i=0}^{\infty}i(a_1-(m-1)a_2\lambda^m)A_i\lambda^{i-2}$$

$$-\left(M^2+\frac{a_1}{k}\right)\sum_{i=0}^{\infty}A_i\lambda^i+\sum_{i=0}^{\infty}\frac{a_2}{k}A_i\lambda^{i+m}=0 \tag{15}$$

and

$$\sum_{i=0}^{\infty}(i+1)(i+2)(a_1-a_2\lambda^m)B_i\lambda^i+\sum_{i=0}^{\infty}(i+2)(a_1-(m-1)a_2\lambda^m)B_i\lambda^i$$

$$-\left(M^2+\frac{a_1}{k}\right)\sum_{i=0}^{\infty}B_i\lambda^{i+2}+\sum_{i=0}^{\infty}\frac{a_2}{k}B_i\lambda^{i+m+2}=1$$

(16)

Now, the expressions for A^{i+1} and B^{i+1} are obtained by equating the coefficients of λ^{i-1} and λ^{i+1} from both side of Eqs. (15) and (16) respectively and can be put in the form

$$A_{i+1}=\frac{a_2(1+i)^2A_{i+1-m}-m(i+1)a_2A_{i+1-m}+(M^2+\frac{a_1}{k})A_{i-1}-\frac{a_2}{k}A_{i-1-m}}{a_1(1+i)^2} \tag{17}$$

$$B_{i+1}=\frac{a_2(3+i)^2-m(i+3)a_2B_{i+1-m}+(M^2+\frac{a_1}{k})B_{i-1}-\frac{a_2}{k}B_{i-1-m}}{a_1(3+i)^2} \tag{18}$$

With

$$A_0=B_0=1 \tag{19}$$

Finally the coefficients A_i and B_i are obtained using the boundary condition (11) and the recurrence relations (17) and (18). Substituting the expression for K in the Equation (12), we have

$$u=-\frac{R_0^2\frac{dp}{dz}\left[\sum_{i=0}^{\infty}B_i\left(\frac{R}{R_0}\right)^{i+2}\sum_{i=0}^{\infty}A_i\lambda^i-\sum_{i=0}^{\infty}B_i\lambda^{i+2}\sum_{i=0}^{\infty}A_i\left(\frac{R}{R_0}\right)^i\right]}{4a_1\mu_0\sum_{i=0}^{\infty}A_i\left(\frac{R}{R_0}\right)^i} \tag{20}$$

The average velocity u_0 has the form

$$u_0=\frac{R_0^2}{8\mu_0}\left(\frac{dp}{dz}\right)_0 \tag{21}$$

where $(dp/dz)_0$ is the tension angle of the stream field in the ordinary course without even a trace of attractive field.The non-layered articulation for u is given by

$$\bar{u} = \frac{u}{u_0} = \frac{2}{a_1}\frac{\frac{dp}{dz}}{\left(\frac{dp}{dz}\right)_0}\frac{\left[\sum_{i=0}^{\infty} B_i\left(\frac{R}{R_0}\right)^{i+2}\sum_{i=0}^{\infty} A_i\lambda^i - \sum_{i=0}^{\infty} B_i\lambda^{i+2}\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^i\right]}{\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^i} \tag{22}$$

The volumetric flow rate across the arterial segment is given by

$$Q = \int_0^{\frac{R}{R_0}} 2\pi R_0 \lambda u(\lambda) d\lambda \tag{23}$$

Substituting u from Equation (20) into Equation (23) and then integrating with respect to λ, we obtain

$$Q_R = -\frac{\pi R_0^3 \frac{dp}{dz}\left[\sum_{i=0}^{\infty} B_i\left(\frac{R}{R_0}\right)^{i+2}\sum_{i=0}^{\infty}\frac{A_i\left(\frac{R}{R_0}\right)^{i+2}}{(i+2)} - \sum_{i=0}^{\infty}\frac{B_i\left(\frac{R}{R_0}\right)^{i+4}}{(i+4)}\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^i\right]}{2a_1\mu_0\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^i} \tag{24}$$

If Q_0 be the volumetric flow rate in the normal portion of the artery, in the absence of magnetic field and porosity effect, then

$$u_0 = \frac{\pi R_0^3}{8\mu_0}\left(\frac{dp}{dz}\right)_0 \tag{25}$$

Therefore, the non-dimensional volumetric flow rate has the following form

$$\bar{Q} = \frac{Q}{Q_0} = \frac{4\frac{dp}{dz}}{a_1\left(\frac{dp}{dz}\right)_0}\frac{\left[\sum_{i=0}^{\infty} B_i\left(\frac{R}{R_0}\right)^{i+2}\sum_{i=0}^{\infty} A_i\lambda^i - \sum_{i=0}^{\infty} B_i\lambda^{i+2}\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^i\right]}{\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^i} \tag{26}$$

Assuming the stream is consistent and no outward/internal stream takes place through the blood vessel section, then, at that point, the mass motion is consistent and consequently $\bar{Q} = 1$. The articulation for pressure angle from (26) can be put as

$$\left(\overline{\frac{dp}{dz}}\right) = \frac{\frac{dp}{dz}}{\left(\frac{dp}{dz}\right)_0} = \frac{a_1}{4}\frac{\left[\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^i\right]}{\left[\sum_{i=0}^{\infty} B_i\left(\frac{R}{R_0}\right)^{i+2}\sum_{i=0}^{\infty}\frac{A_i\left(\frac{R}{R_0}\right)^{i+2}}{(i+2)} - \sum_{i=0}^{\infty}\frac{B_i\left(\frac{R}{R_0}\right)^{i+4}}{(i+4)}\sum_{i=0}^{\infty} A_i\left(\frac{R}{R_0}\right)^i\right]} \tag{27}$$

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

The wall shear weight on the endothelial surface is given by

$$\tau_R = \left[-\mu(r)\frac{du}{dr} \right]_{r=R(z)} \tag{28}$$

Substituting *u* from Equation (20) into Equation (28), we obtain

$$\tau_R = \frac{\frac{dp}{dz} R_0 \left[1 + \beta H \left(1 - \left(\frac{R}{R_o} \right)^m \right) \right] \left[\sum_{i=0}^{\infty} B_i \left(\frac{R}{R_0} \right)^{i+2} \sum_{i=0}^{\infty} i A_i \left(\frac{R}{R_0} \right)^{i-1} - \sum_{i=0}^{\infty} (i+2) B_i \left(\frac{R}{R_0} \right)^{i+1} \sum_{i=0}^{\infty} A_i \left(\frac{R}{R_0} \right)^{i} \right]}{\sum_{i=0}^{\infty} A_i \left(\frac{R}{R_0} \right)^{i}} \tag{29}$$

On the off chance that $\tau_N = -\frac{R_0}{2}\left(\frac{dp}{dz}_0 \right)$ be the shear pressure at the ordinary part of the blood vessel wall, without attractive field, the non-layered type of the wall shear pressure is given by

$$\bar{\tau} = \frac{\tau_R}{\tau_N} = \frac{1}{2a_1}\left(\overline{\frac{dp}{dz}} \right) \left[1 + \beta H \left(1 - \left(\frac{R}{R_o} \right)^m \right) \right] \frac{1}{\sum_{i=0}^{\infty} A_i \left(\frac{R}{R_0} \right)^{i}} \left[\sum_{i=0}^{\infty} B_i \left(\frac{R}{R_0} \right)^{i+2} \sum_{i=0}^{\infty} i A_i \left(\frac{R}{R_0} \right)^{i-1} - \sum_{i=0}^{\infty} (i+2) B_i \left(\frac{R}{R_0} \right)^{i+1} \sum_{i=0}^{\infty} A_i \left(\frac{R}{R_0} \right)^{i} \right] \tag{30}$$

5. Results and discussion

In the past area we have acquired scientific articulations for various stream attributes of blood through permeable medium under the activity of an outer attractive field. In this part we are to talk about the stream attributes graphically with the utilization of following legitimate mathematical information which is relevant to blood. The following mathematical qualities to the boundaries include in the current issue are considered as accessible in the logical literary works.

$l = 2.0$, $d = 0.5$, $\alpha = 0.09$, $H = 0.2$, $m = 2$
$k = 0.25$, $\beta = 2.5$, $L = 5$, $M = 2.5$

Figure 2 shows the various areas of the stenosis in the pivotal heading. In Fig. 2, z = 0.5 and z = 3.5 compare to the beginning and start of the stenosis and z = 1 and z = 3 address the throat of the essential stenosis and auxiliary stenosis individually. It is intriguing to note from this figure that z = 2 is where further affidavit happens and thus it is known as covering stenosis.

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

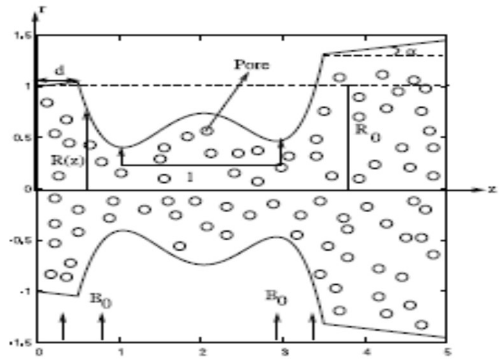


Figure.1, Schematic diagram of the model geometry.

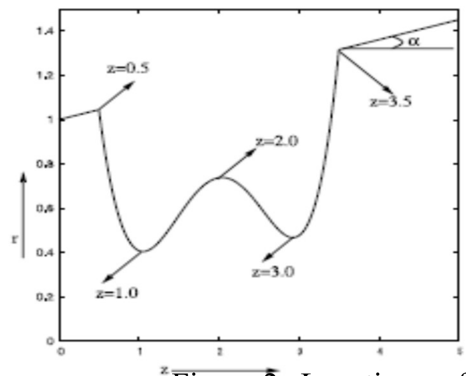


Figure.2, Locations of the points z=0.5, 1.0, 2.0, 3.0, 3.5

The variety of hub speed at various pivotal situation along the outspread bearing are displayed in Fig. 3.

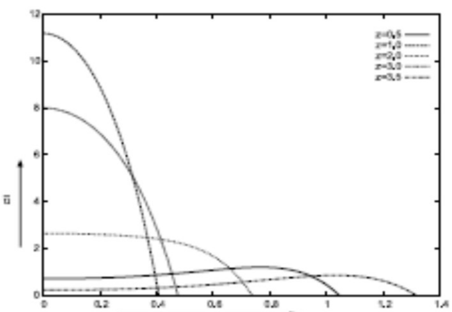


Figure.3, Velocity distribution in the radial direction at different axial position z, when H=0.2, M=2.5, β=2.5, α=0.09 and k=0.25.

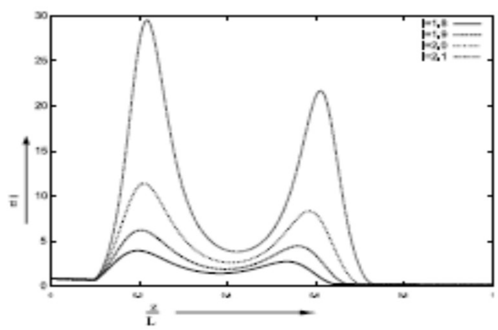
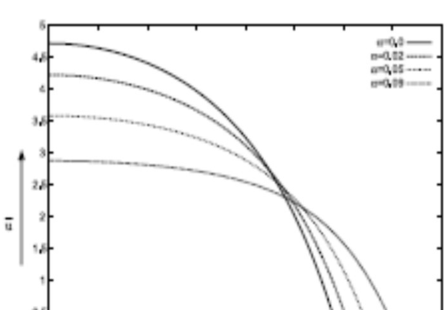


Figure.4, Variation of axial velocity along axial direction for different values of l, when H=0.2, M=2.5, α=0.09 and k=0.25.

We see from this figure that the speed ismaximumat the focal line of the vessel for all place of z.Among this multitude of positions, the speed is high at the throat of the essential stenosis and lowat the beginning of the covering stenosis. Nonetheless, the focal line speed at the throat of optional stenosis is around 30% not exactly the essential stenosis. Yet, the focal line speed at z = 2 (between the throat of two stenosis) abruptly falls about 55% than that of optional one. This perception may prompts the stream dissemination zone and may creates additional affidavit of plaque. Figure 4 portrays the variety of pivotal speed for various length between the throat of two stenoses. It has been seen that the speed at the throat of the stenoses fundamentally increments with the increment of l. Consequently, the impact of the state of stenosis plays significant part on the stream qualities. Comparative is the perception from Fig. 5 that the pivotal speed diminishes as the tightening point α increments. Figure 6 represents the variety of hub speed at the throat of the auxiliary stenosis for various upsides of the Hartmann Number M.



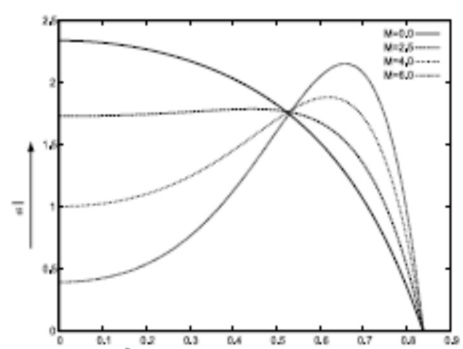


Figure.5, Variation of axial velocity at z=2.0 for different values
different values of α, when H=0.2, M=2.5, β=2.5 0.25.
and k=0.25..

Figure.6, Velocity distribution at z =2.0 for of M, when H=0.2, β=2.5, α = 0.09 and k =

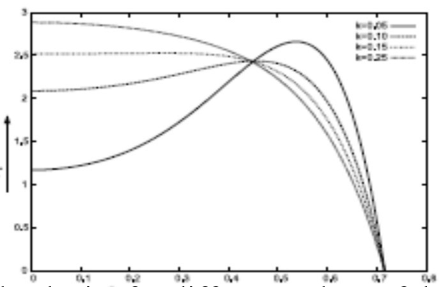
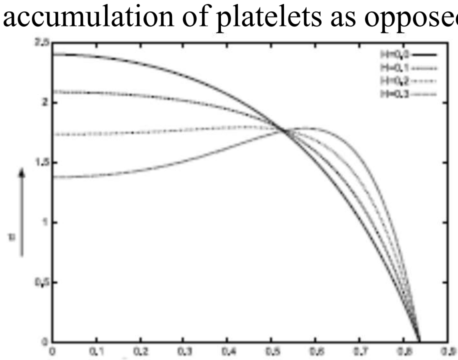


Figure.7, Variation of axial velocity for different values of the permeability parameter k at z = 2.0, when H=0.2, M=2.5, β=2.5 and α=0.09.

We see that the pivotal speed fundamentally diminishes at the focal line of the course with the increment of the attractive field strength. While the speed nearby the blood vessel wall increments with the rising upsides of M to keep up with consistent volumetric stream rate. It is likewise notable that when an attractive field is applied in an electrically directing liquid (subsequently for blood) there emerges Lorentz force, which tends to dial back the movement of the liquid. It has been seen from Fig. 7 that the pivotal speed close to the focal line of the channel increments with the increment of the penetrability boundary k, while the pattern is switched nearby the blood vessel wall. This peculiarities is seen due to the porousness boundary k is depend as the complementary of the penetrability of the permeable medium. Figure 8 gives the conveyance of hub speed for various upsides of the hematocrit H. We note from Fig. 8 that the hub speed diminishes at the center locale of the supply route with the increment of hematocrit levelH, where as the contrary pattern is seen in the fringe area.
This reality exists in the hematocrit as the blood thickness is high in the center locale because of the accumulation of platelets as opposed to low consistency in the plasma close to the blood vessel wall.



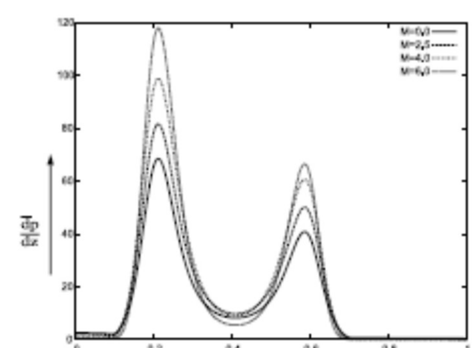
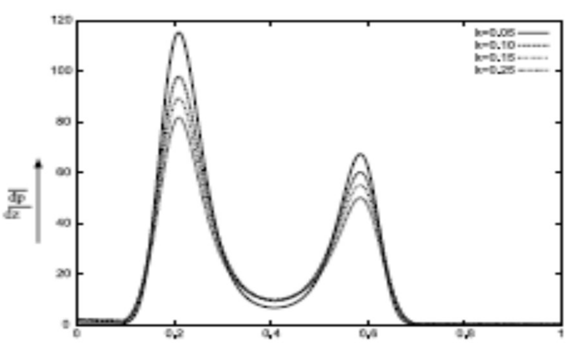
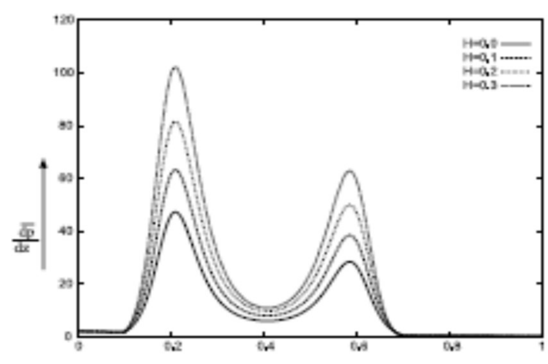


Fig. 8. Variation of axial velocity in the radial direction for different Fig. 9. Variation of pressure gradient $\left(\frac{dp}{dz}\right)$ for different values

values of H at $z = 2.0$, when $M = 2.5$, $\beta = 2.5$, $\alpha = 0.09$ and $k = 0.25$ of M when $H = 0.2$, $\beta = 2.5$, $\alpha = 0.09$ and $k = 0.25$.

Figures 9-12 show the variety of strain slope $\left(\frac{dp}{dz}\right)$ along the length of the stenosis for various upsides of the actual boundaries of interest. Figure 9 shows that the pivotal tension slope increments with the increment of attractive field strength.We have previously seen that the Lorentz force has decreasing impact of blood speed, so as more tension is expected to pass a similar measure of liquid under the activity of an outside attractive field. In any case, the contrary pattern is seen on account of permeable porousness boundary k as displayed in Fig. 10. It has been seen from Fig. 11 that the strain slope increments with the increment of the hematocrit H. It shows from this figure that when the accumulation of platelets increment at the center locale that is hematocrit H is high, more strain angle is expected to pass a similar measure of liquid through the stenotic locale. These outcomes are reasonable with those revealed in [35], wherein they referenced that the more noteworthy blood thickness prompted by higher hematocrit and the resulting expanded protection from blood stream seem the most sensible causes basic the relationship among hematocrit and pulse. It is fascinating to note from these three figures that the size of the tension angle is sufficiently high at the throat of the essential stenosis than that of the auxiliary one. Be that as it may, from Fig. 12, we saw that at the throat of optional stenosis, the tension slope is high in contrast with the throat of the essential stenosis. This occurs because of the expanding of the tightening point α. In this manner, on account of veering corridor more tension is required as the stream progresses in the downstream heading.
Figures 13 and 14 give the dissemination of the wall shear pressure for various upsides of the hematocritH and tightening point α.We see from Fig. 13 that the wall shear pressure increments as the hematocrit H increments. One can note from this figure that thewall shear pressure is low at the throat of the auxiliary stenosis as well as at the downstream of the course. It is for the most part notable that at the low shear pressure district mass transportation happens and subsequently happens further testimony. Nonetheless, it is intriguing to note from Fig. 14 that the wall shear pressure diminishes fundamentally with the rising upsides of the tightening point α. Also, the greatness of the wall shear pressure is same at boththe throat of the stenosis without even a trace of tightening point α.

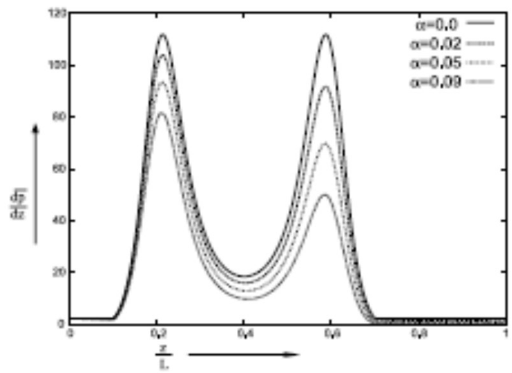




Vol. 21, No. 1, (2024)
ISSN: 1005-0930

Fig. 10. Variation of pressure gradient $\left(\frac{\overline{dp}}{dz}\right)$ with z for different values Fig. 11. Variation of pressure gradient $\left(\frac{\overline{dp}}{dz}\right)$ for different values

of k when $H = 0.2$, $M = 2.5$, $\beta = 2.5$, when $\alpha = 0.09$. of H when $M = 2.5$, $\beta = 2.5$, $\alpha = 0.09$ and $k = 0.25$.



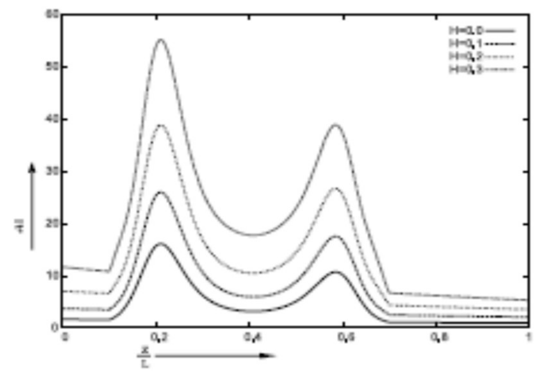


Fig. 12. Variation of pressure gradient $\left(\frac{\overline{dp}}{dz}\right)$ with z for different values Fig. 13. Distribution of wall shear stress $\bar{\tau}$ along with z for

of α when $H = 0.2$, $M = 2.5$, $\beta = 2.5$, and $k = 0.25$. different values of H when $k = 0.25$, $M = 2.5$, $\beta = 2.5$, and $\alpha = 0.09$.

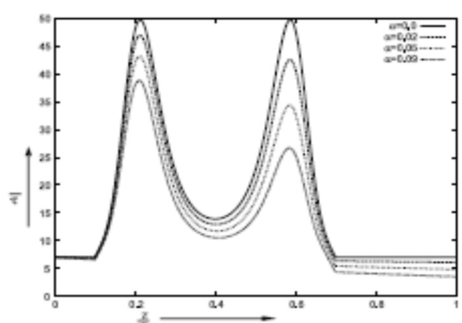


Fig. 14. Distribution of wall shear stress $\bar{\tau}$ along with z for different values of α when $H = 0.2$, $\beta = 2.5$, $M = 2.5$ and $k = 0.25$.

In this way, we might reason that there is an opportunity of additional testimony at the downstream of the wandering course.- contingent upon hematocrit and the blood has been treated as the permeable medium. The issue is addressed logically by utilizing the Frobenius strategy. The impacts of different key boundaries including the tightening point α, level of hematocrit H, the attractive field and penetrability boundary k are analyzed. The fundamental discoveries of the current review might be recorded as follows:

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

6. Conclusions

A hypothetical investigation of blood course through covering stenosis within the sight of attractive field has been completed. In this study the variable thickness of blood contingent upon hematocrit and the blood has been treated as the permeable medium. The issue is addressed scientifically by utilizing the Frobenius technique. The impacts of different key boundaries including the tightening point α, level of hematocritH, the attractive field and penetrability boundary k are analyzed. The fundamental discoveries of the current review might be recorded as follows:

The impact of essential stenosis on the auxiliary one is critical in the event of separating course (α >0).

(i) The stream speed at the focal district diminishes progressively with the increment of attractive field strength.

(ii) The porousness boundary k affects the stream qualities of blood.

(iii) At the center district, the hub speed diminishes with the increment of the level of hematocrit H.

(iv) The hematocrit and the circulatory strain has a direct relationship as revealed.

(v) The lower scope of hematocrit may prompts the further testimony of cholesterol at the endothelium of the vascular wall.

(vi) Hematocrit adds to the guideline of circulatory strain.

At long last we can presume that further likely improvement of the model are expected. Since the hematocrit emphatically influences pulse, further review ought to look at different factors, for example, diet, tobacco, smoking, overweight and so on according to a cardiovascular perspective. Additionally based on the current outcomes, it very well may be presumed that the flowof blood and strain can be constrained by the use of an outside attractive field.

Nomenclature

z - Hub distance,

l -Length between throat of two stenoses,

r - Outspread distance,

L - Length of blood vessel portion,

R(z) - Blood vessel wall,

B_0 - Attractive field strength,

d - Distance from bay of beginning of stenosis,

σ - Electrical conductivity,

u - Hub speed part,

k - Permeable porousness boundary,

$\bar{u}$ - Non-layered pivotal speed,

M - Hartmann number,

$\mu(r)$ - Coefficient of thickness of blood at a spiral distance r,

p - Pulse,

μ_0 - Consistency coefficient for plasma,

h(r) - Hematocrit a good ways off r,

H - Most extreme hematocrit at the focal point of the blood vessel fragment,

m(≥2) - Shape boundary of hematocrit,

R_0 - Sweep of the pericardial surface of the typical piece of the blood vessel section,

$\overline{\frac{dp}{dz}}$ - Non-layered hub pressure inclination,

Q- Volumetric stream rate,

$\overline{Q}$ - Wall Shear pressure,

τ_R - Non-layered volumetric stream rate,

τ - Non-layered wall shear pressure

References

[1] D.F. Young, Fluid mechanics of arterial stenoses, *ASME Journal of Biomechanical Engineering* **101** (1979), 157–175.

[2] D.F.Young and F.Y. Tsi, Flowcharacteristics in models of arterial stenoses-I, Steady flow, *Journal of Biomechanics* **6** (1973), 395–410.

[3] D.F. Young and F.Y. Tsi, Flow characteristics in models of arterial stenoses-II, Unsteady flow, *Journal of Biomechanics* **6** (1973), 465–475.

[4] C. Tu and M. Deville, Pulsatile flow of non-Newtonian fluid through arterial stenosis, *Journal of Biomechanics* **29** (1996), 899–908.

[5] D.A. MacDonald, On steady flow through modeled vascular stenoses, *Journal of Biomechanics* **12** (1979), 13–20.

[6] C.G. Caro, T.J. Pedley, R.C. Schroter and W.A. Seed, *The Mechanis of the Circulation*, Oxford University Press, Oxford, 1978.

[7] C.G. Caro, Vascular fluid dynamics and vascular biological and disease, *Mathematical Methods in the Applied Sciences* **24** (2001), 1311–1324.

[8] J.C. Misra and S. Chakravorty, Flow in arteries in the presence of stenosis, *Journal of Biomechanics* **19** (1986), 907–918.

[9] G.C. Shit and M. Roy, Hydromagnetic pulsating flow of blood in a constricted porous channel: A theoretical study, in: *Proceedings of the world congress on Engeering*, London, UK, vol.1, 2012, pp. 83–88.

[10] D.W. Liepsch, Flow in tubes and arteries - A comparison, *Biorheology* **23** (1986), 395–433.

[11] D.W. Liepsch, An introduction to biofluid mechanics – basic models and applications, *Journal of Biomechanics* **35** (2002), 415–435.

[12] J.R. Buchanan, C. Kleinstreuer and J.K. Corner, Rheological effects on pulsatile hemodynamics in a stenosed tube, *Computers & Fluids* **29** (2000), 695–724.

[13] R.L. Whitemore, *Rheology of the circulation*, Pergaman Press, London, UK, 1959, 84–102.

[14] J.C. Misra and G.C. Shit, Blood flow through arteries in a pathological state: A theoretical study, *International Journal of Engineering Science* **44** (2006), 662–671.

[15] J.C. Misra and G.C. Shit, Role of slip velocity in blood flow through stenosed arteries: A non-Newtonian model, *Journal of Mechanics in Medicine and Biology* **7** (2007), 337–353.

[16] F.B. Tian, L. Zhu, P.W. Fok and X.Y. Lu, Simulation of a pulsatile non-Newtonian flow past a stenosed 2D artery with atherosclerosis, *Computers in Biology and Medicine* **43** (2013), 1098–1113.

[17] J. Chen, X.Y. Lu and W. Wang, Non-Newtonian effects of blood flow on haemodynamics in distal vascular graft anastomoses, *Journal of Biomechanics* **39** (2006), 1983–1995.
[18] J.C. Misra, A. Sinha and G.C. Shit, Theoretical analysis of blood flow through an arterial segment having multiple stenosis, *Journal of Mechanics in Medicine and Biology* **8** (2008), 265–279.
[19] N. Talukder, P.E. Karayannacos, R.M. Narem and J.S. Vasco, An experimental study of fluid mechanics of arterial stenosis, *ASME Journal of Biomechanical Engineering* **99** (1977), 74–82.
[20] S. Chakravarty and P.K. Mondal, Mathematical modelling of blood flow through an overlapping stenosis, *Mathematical and Computer Modelling* **19** (1994), 59–70.
[21] G.C. Layek, S. Mukhopadhaya and R.S.R. Gorla, Unsteady viscous flow with variable viscosity in a vascular tube with a double constriction, *International Journal of Engineering Science* **47** (2009), 649–659.
[22] G. Varshney, V.K. Katiyar and S. Kumar, Effect of magnetic field on the blood flow in artery having multiple stenosis: A numerical study, *International Journal of Engineering Scienceand Technology* **2**(2) (2010), 67–82.
[23] Y. Haik, V. Pai and C.J. Chen, Apperent viscosity of human blood in a static magnetic field, *Journal of Magnetism and Magnetic Materials* **225** (2001), 180–186.
[24] D.W. Chakeras, A. Kargarlu, H. Boundoulas and D.C. Young, Effect of static magnetic field exposure of upto 8 Tesla on sequential human vital sign measurements, *Journal of Magnetic Resonance Imaging* **18** (2003), 346–352.
[25] Y. Kinouchi, H. Yamaguchi and T.S. Tenforde, Theoretical analysis of magnetic field interactions with aortic blood flow, *Bioelectromagnetics* **17** (1996), 21–32.
[26] G.C. Shit and M. Roy, Pulsatile flow and heat transfer of a magneto micropolar fluid through a stenosed artery under the influence of body acceleration, *Journal of Mechanics in Medicine and Biology* **11** (2011), 643–661.
[27] J. C. Misra, A. Sinha and G.C. Shit, Mathematical modelling of blood flow in a porous vessel having double stenoses in the presence of an external magnetic field, *International Journal of Biomathematics* **4**(2) (2011), 207–225.
[28] J.C. Misra, G.C. Shit, S. Chandra and P.K. Kundu, Hydromagnetic flow and heat transfer of a second grade viscoelastic fluid in a channel with oscillatory stretching walls: Application to the dynamics of blood flow, *Journal of Engineering Mathematics* **69** (2011), 91–100.
[29] J.C. Misra, G.C. Shit, Flow of a biomegnetic fluid in a channel with stretching walls, *ASME J Appl Mech*, **76** (2009), 061006 (9 pages).
[30] J.C. Misra, G.C. Shit and H.J. Rath, Flow and heat transfer of a MHD viscoelastic fluid in a channel with stretching walls: Some applications to hemodynamics, *Computers & Fluids* **37** (2008), 1–11.
[31] R.K. Dash, K.N. Mehta and G. Jayaraman, Casson fluid flowin a pipe filled with homogeneous porous medium, *International Journal of Engineering Science* **34** (1996), 1146–1156.
[32] R. Bhargava, S. Rawat, H.S. Takhar and O.A. Beg, Pulsatile magneto-biofluid flow and mass transfer in a non-Darcian porous medium channels, *Meccanica* **42** (2007), 247–262.
[33] J.C. Misra, A. Sinha and G.C. Shit, A numerical model for the magnetohydrodynamic flow of blood in a porous channel, *Journal of Mechanics in Medicine and Biology* **11** (2011), 547–562.
[34] S. Oka, *Cardiovascular hemorheology*, Cambridge University Press, London, 1981, 28.
[35] M. Cirillo, M. Lourenzi, M. Trevisan and J. Stamler, Hematocrit, Blood Pressure and Hypertension: The Gubbio population study, *Hypertension* **20** (1992), 319–326.
[36] M.M. Lih, *Transport phenomena in Medicine and Biology*, John Wiley & Sons, New York,

Vol. 21, No. 1, (2024)
ISSN: 1005-0930

1975.
[37] G.C. Shit, Computational modelling of blood flow development and its characteristics in magnetic environment, *Modeling and Simulation in Engineering* **2013** (2013), Article ID 758748, 12 pages.

Vol. 21, No. 1, (2024)
ISSN: 1005-0930