Analysis of Two-Phase Human Cerebral Blood Flow in Arterioles during Bacterial Meningitis by Mathematical Modeling

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Abstract: The present paper represents a Mathematical Model for Two-Phase Blood Flow through Arterioles in Human Cerebral Circulatory System. The Herschel Bulkily non-Newtonian Model transformed into Biofluid mechanical setup has been adopted for Mathematical formulation. Upadhyay V. and Pandey P. N. have already considered the blood as Two Phased namely Plasma Phase and that of RBC. The formulation is in Tensorial form. Using appropriate boundary conditions, a numerical expression for Blood Flow Flux and thereby Blood Pressure Drop have been successfully measured. The role of Haematocrit is explicit in Two Phased Cerebral Blood Flow during Bacterial Meningitis. The graphical presentation of Blood Pressure Drop versus Haematocrit explores the possibility for better Treatment in the serious case of Bacterial Meningitis.

***Keyword*: Herschel Bulkily non-Newtonian Model, Bacterial Meningitis, Hematocrit, Cerebral Arterioles.**

I. NTRODUCTION

Brain blood flow is the movement of blood through the network of cerebral arteries and veins supplying the brain. Large arteries that have thick walls or within the microcirculation within which flow is non-Newtonian. The rate of cerebral blood flow within the adult is usually 750 milliliters per minute, representing 15-20% of the flow rate. This equates to an average of 50 to 54 milliliters of blood per a hundred grams of brain tissue per minute. CBF is tightly regulated to fulfill the brain's metabolic demands. The arteries deliver oxygenated blood, glucose, and alternative nutrients to the brain, and also the veins carry deoxygenated blood back to the heart, removing carbon dioxide, lactic compound, and different metabolic products. Since the brain is incredibly at risk of compromises in its blood supply, the cerebral vascular system has several safeguards as well as the biological process of the blood vessels and also the failure of this safeguard may end up intend and another disease like bacterial meningitis. The number of blood that the cerebral circulation carries is known as cerebral blood flow (CBF).

1.1 Blood flow distribution in cerebral arterioles

Arterioles are the very smallest vessels of the arterial system with a diameter of and length of. In general, arterioles are defining as 40% of the total vascular resistance. Thus regulation of their diameter is a determinant process for appropriate perfusion of brain tissue and neurovascular coupling. Arterioles were monitored through the microscopic connected to a closed-circuit video system. Images of arterioles ware digitized using a video frame grabber. The arteriolar diameter was measured from the digitized images by the use of image analysis software.

The muscle fibers in arterioles are normally slightly contacted, causing arterioles to maintain a consistent muscle tone in this case referred to as vascular tone in a similar manner to the muscular tone of skeletal muscle. In reality, all blood vessels exhibit vascular tone due to partial contraction of smooth muscle. The importance of the arterioles is that they will be the primer site of both resistance and regulation of blood pressure. The precise diameter of the lumen of arterioles at any given moment is determined by the primary mechanism for the distribution of blood flow.

Therefore, the main identifying feature is not size, but the fact that their wall consists of only one or two layers of smooth muscle. Consequently, they are vital to the regulation of hemodynamics, contributing to the control of blood pressure and the regional distribution of blood.

1.2 Constitution of blood

Human blood is composed of blood cells consists in blood plasma. Plasma, that constitutes 55% of blood fluid, is mostly water 92% by volume and contains dissipated proteins, glucose, mineral ions, hormones and blood cells themselves. The blood cell is especially red blood cells (also referred to as RBCs or erythrocytes) and white blood cells, including leukocytes and platelets. The average volume of an erythrocyte represents approximately 40 to 45% and more than 99% of all blood cells. The volume percentage (vol%) of red blood cells (RBC) in the blood is called Hematocrit. The hematocrit of men average about 42, while that of women averages about 38. The red blood cells are semisolid particles, increase the velocity of blood and can have an effect on the behavior of a fluid. The viscosity of normal blood is about three times as great as the viscosity of water. It has been pointed out that plasma behaves Newtonian fluid wearer's whole blood show non-Newtonian character.

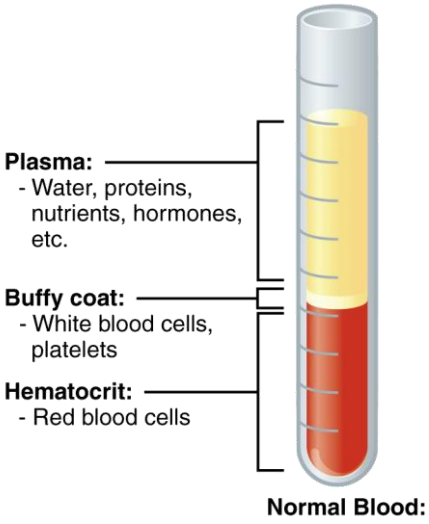

Figure1.Constitution of blood

Platelets are a vital component of the blood clotting mechanism. The entire volume concentration of leukocytes and platelets only concerned with 1% (N. Bessonve et al., 2016). Then we have considered only two phases of blood. Which is one of the red blood cells and another phase is plasma.

1.3 Description of bacterial meningitis

Meningitis is an inflammation of the meninges, the covering of the brain and spinal cord. It is most often caused by infection (bacterial, viral or fungal), but can also be produced by chemical irritation, subarachnoid hemorrhage, cancer and other condition [8]. Bacterial meningitis is common in children and people over 65. Additionally, people with a weak immune system are more at risk for bacterial meningitis. This disease mostly spreads in communities/societies that living in crowded areas close quarters (e.g. police staff, police cells, college students, military staff and prisons). The symptom associated with bacterial meningitis can be fever, headache, body aches, fatigue & sleepiness. Later symptoms that may occur are nausea, vomiting, confusion, stiff neck, and sensitivity of light. In babies, the symptoms include fever, fussiness, refusal to eat, difficulty waking up, and swelling of the soft spot on the baby's head. Infection from bacterial meningitis can cause permanent disabilities such as brain damage, hearing loss, and learning disabilities. The primary test for meningitis is a lumbar puncture. Bacterial meningitis need shut observation within the hospital and treatment with medicine. Additionally, ventilator assistant, kidney dialysis or different supportive treatment could also be required.

II. REAL MODEL

Choice of frame of reference

We have selected a frame of reference for mathematical modeling of stage of moving blood keeping in view the difficulty of generality of the problem of blood flow. We generalized three-dimensional orthogonal curvilinear co-ordinate system, briefly prescribed as E^3 called as 3-dim Euclidean space. We interpreted the quantities related to blood flow in Tensorial form which comparatively more realistic. The biophysical lows thus expressed fully hold good in any co-ordinate system, which is compulsion for the truthfulness of the low now, let the co-ordinate axes be OX^I where O is origin and superscript $i = 1,2,3$ let X^i is the co-ordinate of any point P in space. The mathematical description of the state if a moving blood is effected by mean of function which give the distribution of the blood velocity $V^k = V^k(X^I, t), k = 1,2,3$ and of pertaining of the blood any two thermodynamic quantities.

Choice of parameters

Because the blood is non-Newtonian fluids, then we using this constitutive equation for fluids.

$$\tau = \eta e^n$$

If $n = 1$ then the nature of fluid is Newtonian other is that of fluid is non-Newtonian. Where, τ is denoted by stress, e is denotad by strain rate and n is denoted by the parameter, these equation use as a equation of motion. In this study there are five parameters are used but three parameter components of velocity are frequently used namely velocity, pressure p and density ρ (Upadhyay, 2000).

Choice of constitutive equation

We have using in phase blood flow through arterioles and whose constitutive equation is as follows-

$$T' = \eta_m e^n + T_p\left(T' \geq T_p\right)$$ where, T_p is the yield stress.

When strain rate $e = (T' < T_p)$ a core region is formed which flows just like a plug (Upadhyay, 2000).

Constitution of two phase blood volume

They are already considered two-phase in blood (srivastva manoj et al, 2012). The flow is effects by the presence of blood cells. This effect is directly proportional to the volume of occupied by blood cells.

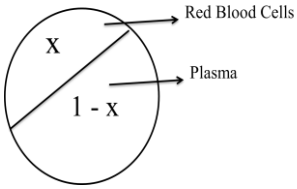

Figure2. One unit volume

Let the volume portion covered by blood cells in unit volume be X, $X$is replased by $Ht/100$, where H is the hematocrit the volume percentage of blood cells. Then the volume portion covered by plasma will be$(1 - X)$. If mass ratio of cells to plasma is r then clearly:

$$r = \frac{X_{\rho_c}}{(1-X)\rho_p}.$$

Where ρ_c and ρ_p are densities of blood cells and plasma respectively. Usually this mass ratio is not a constant; even then this may be supposed to constant in present context.

III. MATHEMATICAL MODELING/FORMULATION

We have recommended that blood flow in vessels is a peristaltic transport system because they thought blood is having two layers of fluid while in the peripheral reasons of vessels blood flow is a Newtonian phenomenon. Blood is in the liquid form and it is non-Newtonian. Through blood is non-Newtonian fluid, even to develop the equation of motion. (singh and pandey, 1986), we start with a model of ideal fluid. The second important principal of fluid dynamics is that of conservation of momentum. The equation of motion is based on the principle. According this principle the total momentum of any fluid system is conserved in absence of external force.

$$\frac{dp}{dt} + P - F_{v(viscosity)} = 0(external\ force)$$

The blood can considered as homogenous mixture of two phases. We derive the fundamental equation of continuity, which is a mathematical expression of principle of conservation of matter.

Equation of continuity

If mass ratio of cells to plasma is r then clearly:

$$r = \frac{X_{\rho_c}}{(1-X)\rho_p}. \tag{1}$$

Where ρ_c and ρ_p are densities of blood cells and plasma respectively. Usually this mass ratio is not a constant; even then this may be supposed to constant in present context.

The both phase of blood cells and plasma i.e. blood cells plasma move with common velocity, Campbell and pitcher have presented a model for this situation. Give in to this model, we consider the two phase of blood separately. The principles of conservation of mass in cerebral circulatory system, equation of continuity for two phases are following as

$$\frac{\partial X_{\rho_c}}{\partial t} + \left(X_{\rho_c} V^i\right)_{,i} = 0 \tag{2}$$

$$\frac{\partial (1-X)\rho_p}{\partial t} + (1-X)X_{\rho_c} V^i)_{,j} = 0 \tag{3}$$

Where V is the common velocity of two phase blood cells and plasma. If we define the uniform density of blood ρ_m as follows.

$$\frac{1+r}{\rho_m} = \frac{r}{\rho_c} + \frac{1}{\rho_p} \tag{4}$$

$$\frac{\partial \rho_m}{\partial t} + (\rho_m V^i)_{,j} = 0 \tag{5}$$

Equation of motion for blood flow

The hydro dynamical pressure P between the two phase of blood can be supposed to be uniform because the both phases i.e. blood cells and plasma cells is always in equilibrium state in blood. Taking viscosity coefficient of blood cells to be η_c and applying the principle of conservation of momentum in cerebral circulatory system, we get the equation of motion for the two phases of blood cells is as follows.

$$\partial X_{\rho_c} \frac{\partial V^i}{\partial t} + \left(X_{\rho_c} V^i\right) V^i, j = -X_p, j g^{ij} + X_{\eta_c}(\mathrm{g}^{ij} V^i, k), j \tag{6}$$

Similarly, taking the viscosity coefficient plasma to be a equation of motion for plasma will be as follows-

$$(1-X)_{\rho_c} \frac{\partial V^i}{\partial t} + \left\{(1-X)_{\rho_c} V^j\right\} V^i, j = -(1-X)_p, j g^{ij} + (1-X)_{\eta_c}(\mathrm{g}^{jk} V^i, k), j \tag{7}$$

Now adding equation (6) and (7) and using relation (4), the equation of motion for blood flow with the both phase will be as follows-

$$\eta_m \frac{\partial V^i}{\partial t} + (\rho_m V^i)V^i,j = -P,j + \eta_m(g^{jk}V^i,k),j \quad (8)$$

Where $\eta_m = X_{\rho_c} + (1-X)\rho_p$, are the viscosity coefficients of blood as amixture of two phases. In this situation, the blood cell line up on the axix to build up rolex. Hence a yield stress is produced. Though this yield stress is very small, even then the viscosity of blood is increased nearly ten times.

The Herschel Bulkley low holds good on the two phase blood flow through arterioles and whose constitutive equation is as follows-

$$T' = \eta_m e^n + T_p\left(T' \geq T_p\right) \text{ where, } T_p \text{ is the yield stress.}$$

When strain rate $e = (T' < T_p)$ a core region is formed which flows just like a plug. Let the radius of plug be r_p . the stress action on the surface of plug will we T_p'. Equating the force acting on the plug, we get

Whose generalized from will be as follows-

$$T^{ij} = -Pg^{ij} + T_e^{ij} \quad (9)$$

Where $T^{ij} = \eta_m(e^n)^n$ while $e^{ij} = \left(g^{jk}V^j_{,k} + g^{jk}V^j_{,k}\right)$

Where all the symbols have their usual meaning.

Now we consider the basic equation for Herschel Bulkley flow as follows.

Equation of continuity-

$$\frac{1}{\sqrt{g\sqrt{(gV^i)_{,i}}}} = 0 \quad (10)$$

Equation of motion-

$$\rho_m \frac{\partial v^i}{\partial t} + \rho_m v^i v_{,j}{}^i = -T_{e,j}{}^{ij}$$

Where all the symbols have their usual meaning.

Analysis

Since the blood vessels are cylindrical, the above governing equations have to be transformed into cylindrical co-ordinates. As we know earlier:

$$x^1 = r, \quad x^2 = \theta, \quad x^3 = z,$$

Matrix of metric tensor in cylindrical co-ordinates is as follows:

$$[g_{ij}] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & r^2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

While matrix of conjugate metric tensor is as follows:

$$[g^{ij}] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1/r^2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

Whereas the christoffel's symbols of 2nd kind are as follows:

$$\begin{Bmatrix} 1 \\ 2\ 2 \end{Bmatrix} = -r, \quad \begin{Bmatrix} 2 \\ 2\ 1 \end{Bmatrix} = \begin{Bmatrix} 2 \\ 1\ 2 \end{Bmatrix} = \frac{1}{r}, \text{ remaining other is zero.}$$

Relation between contravariant and physical components of velocity of blood flow will be as follows:

$$\sqrt{g_{11}\, v^1} = v_r \Rightarrow v_r = v^1$$

$$\sqrt{g_{22}\, v^2} = v_\theta \Rightarrow v_\theta = rv^2$$

$$\text{And } \sqrt{g_{33}\, v^3} = v_z \Rightarrow v_z = v^3$$

Again the physical components of $-p_{,j}g^{ij}$ are $-\sqrt{g_{ii}}\ p_{,j}g^{ij}$

Now, equation (9) and (10) are transformed into cylidriecal form so as to solve as power low to get

Equation of continuity:

$$\frac{\partial V}{\partial Z} = 0$$

The equation of motion:

r- component:

$$-\frac{\partial p}{\partial r} = 0$$

θ – *component:*

$$0=0$$

z- component:

$$0 = -\frac{\partial p}{\partial z} + \frac{\eta_m}{r}\left[r\left[\frac{\partial v_r}{\partial r}\right]^n\right]$$

Here this fact has been taken in view that the blood flow the axially symmetric in arteries concerned, i.e. $V_0 = 0$ and $V_r, V_z \; and \; p = p(z)$ and

$$0 = -\frac{\partial p}{\partial z} + \frac{\eta_m}{r}\left[r\left[\frac{\partial v_r}{\partial r}\right]^n\right] \tag{11}$$

Since pressure gradient $-\frac{\partial p}{\partial z} = P$

$r\left[\frac{dv}{dr}\right]^n = -\frac{p_{r^2}}{2\eta_m} + A$, we apply boundry condition at $r = 0, V = V_0$ then $A = 0$.

$$\Rightarrow -\frac{dv}{dr} = \left[\frac{p_r}{2\eta_m}\right]^{1/n} \text{ Replace from } r - r_p$$

$$-\frac{dv}{dr} = \left(\frac{\frac{1}{2}pr - \frac{1}{2}p_r}{\eta_m}\right)^{\frac{1}{n}} \Rightarrow \frac{dv}{dr} = -\left(\frac{p_r}{2\eta_m}\right)^{\frac{1}{n}}(r - r_p)^{\frac{1}{n}} \tag{12}$$

Integrating above equation (12) under the no slip boundary condition $V = 0$ at $r = R$ so we get:

$$v = \left(\frac{P}{2\eta_m}\right)^{\frac{1}{n}}\frac{n}{n+1}\left[(R - r_p)^{\frac{1}{n}+1}\right] - (r - r_p)^{\frac{1}{n}+1} \tag{13}$$

$$v_p = \frac{n}{n+1}\left(\frac{P}{2\eta_m}\right)^{\frac{1}{n}}(R - r_p)^{\frac{1}{n}+1} \tag{14}$$

Where the value r_p of is taken from (7)

IV. RESULT AND DISCUSSION

Observation- Hematocrit v/s blood pressure drop during bacterial meningitis in cerebral arterioles.
Patient- Mr. Suresh Patel (age 35 years old)
Diagnosis: Bacterial Meningitis (cerebral disease)

Table1. Clinical data: blood pressure and hemoglobin during bacterial meningitis in cerebral arterioles.

S. No.	Date DDMMYY	Hemoglobin(HB) gm/dl	Hematocrit(3×HB) kg/m^3	Blood pressure mm Hg	Arterioles Pressure Drop $\frac{\left(\frac{S+D}{3}+D\right)}{3} - \left(\frac{S+D}{2}\right)$ mm Hg
1.	201218	11.4	34.2	170/80	-70.56
2.	241218	11.2	33.6	120/80	-51.12
3.	271218	11.4	34.2	160/80	-66.67
4.	311218	11.8	35.4	130/70	-54.44
5.	050119	12.2	36.6	110/70	-46.67
6.	150119	12.4	37.2	120/80	-51.12
7.	300119	12.5	37.5	130/80	-55.00

Clinical data source: Sanjay Gandhi Medical and Hospital Rewa (M.P.)

The flow flux of two phase blood flow in arterioles is-

$$Q = \int_o^{r_p} 2\pi r v_p dr + \int_{r_p}^{R} 2\pi r v dr$$

$$= \int_0^{r_p} 2\pi r \frac{n}{n+1}\left(\frac{P}{2\eta_m}\right)^{\frac{1}{n}}(R - r_p)^{\frac{1}{n}+1} dr + \int_{r_p}^{R} 2\pi r \frac{n}{n+1}\left(\frac{P}{2\eta_m}\right)^{\frac{1}{n}}\left[(R - r_p)^{\frac{1}{n}+1} - (r - r_p)^{\frac{1}{n}+1}\right] dr$$

Using equation from (13) and (14), we get

$$= \frac{2\pi n}{(n+1)}\left(\frac{P}{2\eta_m}\right)^{\frac{1}{n}}(R-r_p)^{\frac{1}{n}+1}\left[\frac{r^2}{2}\right]_0^{r_p} + \frac{2\pi n}{(n+1)}\left(\frac{p}{2\eta_m}\right)^{\frac{1}{n}}\left[\frac{r^2}{2}(R-r_p)^{\frac{1}{n}+1} - \frac{r(r-r_p)^{\frac{1}{n}}}{\frac{1}{n}+2} + \frac{(r-r_p)^{\frac{1}{n}+3}}{\left(\frac{1}{n}+2\right)\left(\frac{1}{n}+3\right)}\right]_{r_p}^{R}$$

$$Q = \frac{2\pi n}{(n+1)}\left(\frac{P}{2\eta_m}\right)^{\frac{1}{n}} r_p^2(R-r_p)^{\frac{1}{n}+1} + R^2(R-r_p)^{\frac{1}{n}+1} - \frac{2R(R-r_p)^{\frac{1}{n}+2}}{\left(\frac{1}{n}+2\right)} + \frac{2R(R-r_p)^{\frac{1}{n}+3}}{\left(\frac{1}{n}+2\right)\left(\frac{1}{n}+3\right)} - r_p^2(R-r_p)^{\frac{1}{n}+1}$$

$$Q = \frac{\pi n}{(n+1)}\left(\frac{P}{2\eta_m}\right)^{\frac{1}{n}} R^{\frac{1}{n}+3}\left[\frac{r_p^2}{r^2}\left(1-\frac{r_p^2}{R}\right)^{\frac{1}{n}+1} + \left(1+\frac{r_p}{R}\right)\left(1-\frac{r_p}{R}\right)^{\frac{1}{n}+2} - \frac{2\left(1-\frac{r_p}{R}\right)^{\frac{1}{n}+2}}{\left(\frac{1}{n}+2\right)} + \frac{2\left(1-\frac{r_p}{R}\right)^{\frac{1}{n}+3}}{\left(\frac{1}{n}+2\right)\left(\frac{1}{n}+3\right)}\right] \quad (15)$$

$P =$ Pressure gradiant, v = viscosity of mixture(blood), n = parameter

Now, we have $Q = 670ml/min$, $Q = 0.011166\text{m}^3/\text{s}$ and $R = 1, r_p = \frac{1}{3}$

Hematocrit (Ht) = 35.4

$\eta_m = 0.0039\ Pa.s$[3,4]

$\eta_p = 0.00149\ Pa.s$[4]

We know that

$$\eta_m = \eta_c X + \eta_p(1-X), \text{ where X = Ht/100} \quad (16)$$

$$\Rightarrow \eta_c = \frac{\eta_p(1-X)-\eta_m}{X}$$

$$\eta_c = \frac{0.00149(1-0.354)-0.0039}{(0.354)} \Longrightarrow \eta_c = 0.00829791 Pa.s$$

Again using the relation and change in to the hematocrit

$$\eta_m = \eta_c X + \eta_p(1-X)$$

$$\eta_m = X(\eta_c - \eta_p) + \eta_p \Longrightarrow \boldsymbol{\eta_m} = 0.0000680791\boldsymbol{Ht} + 0.00149 \quad (17)$$

Length of cerebral arterioles $\Delta Z = 0.0000030m$[6]

Radius of cerebral arterioles $R = 0.00000625$

Pressure drop $\Delta P = \frac{\left(\frac{S+D}{3}+D\right)}{3} - \left(\frac{S+D}{2}\right) = 7247.70\ Pa.s$

Now substituting the values of r_p and R in equation (15)-

$$Q = \frac{\pi n}{(n+1)}\left(\frac{P}{2\eta_m}\right)^{\frac{1}{n}} R^{\frac{1}{n}+3}\left[\frac{r_p^2}{R^2}\left(1-\frac{r_p^2}{R}\right)^{\frac{1}{n}+1} + \left(1+\frac{r_p}{R}\right)\left(1-\frac{r_p}{R}\right)^{\frac{1}{n}+2} - \frac{2\left(1-\frac{r_p}{R}\right)^{\frac{1}{n}+2}}{\left(\frac{1}{n}+2\right)} + \frac{2\left(1-\frac{r_p}{R}\right)^{\frac{1}{n}+3}}{\left(\frac{1}{n}+2\right)\left(\frac{1}{n}+3\right)}\right]$$

And we get equation-

$$Q = \pi\left(\frac{2P}{6\eta_m}\right)^{\frac{1}{n}}\left(\frac{2}{27}\right)\left[\frac{26n^3+33n^2+9n}{6n^3+11n^2+6n+1}\right] \quad \text{Or,} \quad \frac{27\times Q}{2\pi} = \left(\frac{P}{3\eta_m}\right)^{\frac{1}{n}}\left[\frac{26n^3+33n^2+9n}{6n^3+11n^2+6n+1}\right]$$

Let $A = \left[\frac{26n^3+33n^2+9n}{6n^3+11n^2+6n+1}\right]$ $\Rightarrow \frac{P}{3\eta_m} = \left(\frac{27\times Q}{2\pi A}\right)^n$ $\Rightarrow P = \left(\frac{27\times Q}{2\pi A}\right)^n . 3\eta_m$

$$P = -\frac{dp}{dz}$$

$$-dp = Pdz$$

And limit from the pressure from Z_f to Z_i then-

$$\int_{P_f}^{P_i} dP = -\int_{Z_f}^{Z_i}\left(\frac{27\times Q}{2\pi A}\right)^n . 3\eta_m dz$$

Where $P_f - P_i$ = pressure drop and $Z_f - Z_i = cerebral\ arteroles\ lenght.$

$$P_f - P_i = \left(\frac{27\times Q}{2\pi A}\right)^n . 3\eta_m . (Z_f - Z_i) \tag{18}$$

After solving equation (15) and we have find out-

$$\frac{27\times Q}{2\pi A} = \left(\frac{P_f - P_i}{(Z_f - Z_i)\, 3\eta_m}\right)^{1/n}$$

$$\frac{27\times Q}{2\pi} = \left[\frac{26n^3+33n^2+9n}{6n^3+11n^2+6n+1}\right]\left(\frac{P_f - P_i}{(Z_f - Z_i)\, 3\eta_m}\right)^{1/n} \tag{19}$$

Again substituted above values $Q, \eta_m, (P_f - P_i)\ and\ (Z_f - Z_i)$ and solve by Numerical method (Trial and Error method).

$$\frac{27\times 0.011166}{6.28} = \left[\frac{26n^3+33n^2+9n}{6n^3+11n^2+6n+1}\right]\left(\frac{7247.70\ 608}{0.0000030\times 0.0117}\right)^{1/n}$$

$$0.047963 = \left[\frac{26n^3+33n^2+9n}{6n^3+11n^2+6n+1}\right](9.22E+9)^{1/n}$$

$$n = -3.9364 \tag{20}$$

Now putting in this value equation (18) again and we get ΔP

$$P_f - P_i = \left(\frac{27\times Q}{2\pi A}\right)^n . 3\eta_m . (Z_f - Z_i)$$

$$\Delta P = (29594827) \times (0.0000030) \times 3\eta_m$$

$$\Delta P = 266.353443(\ 0.0000680791\boldsymbol{Ht} + 0.00149)$$

$$\Delta P = 0.018133103Ht + 0.39686663 \tag{21}$$

ΔP is calculated in Equation (21) with the help of Ht of table2. Mathematically calculated value multiplied by 100 for better graphical representation purpose, which is sown in the table2 BPD terms.

Table2. Hematocrit (Ht) v/s Mathematically Modulated Blood Pressure Drop (BPD)

Date	201218	241218	271218	311218	050119	150119	150119
Ht (kg/m^3)	34.2	33.6	34.2	35.4	36.6	37.2	37.5
BPD (Pa.s)	101.701	100.613	101.701	103.877	106.053	107.141	107.685

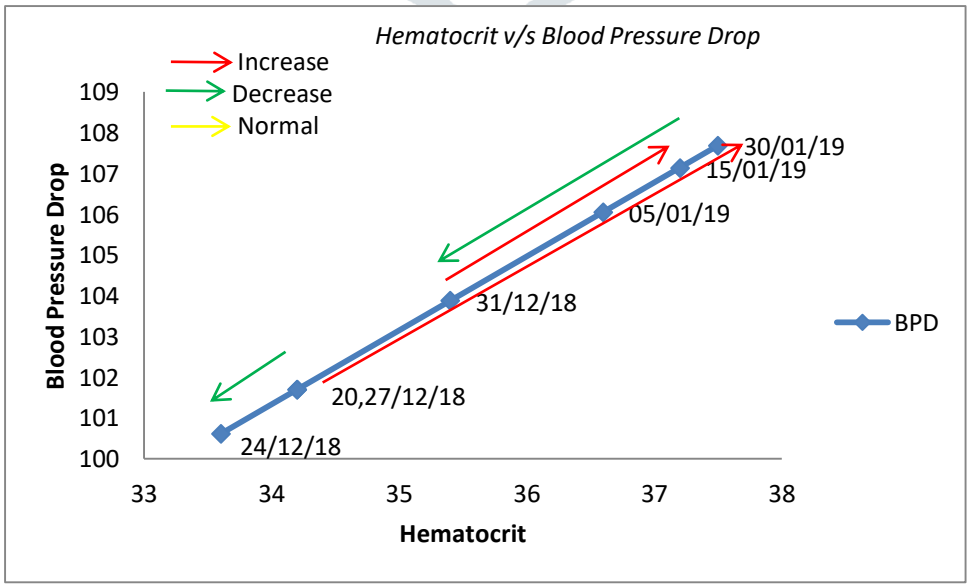

Figure3. *Bio-physical interpretation of clinical data (Hematocrit v/s Blood Pressure Drop) in case of bacterial meningitis in cerebral Arterioles.*

V. CONCLUSION

Figure3 (Table1, 2) Shows from 20/12/118 to 24/12/18 & 30/01/19 to 31/01/19 blood pressure drop straightly decreases and another time blood pressure drop is increases.

According to this study we have concluded that designate the function of hematocrit with respect to blood pressure drop. When graph shows increasing sence then we cannot suggest for serious dose and when graph shows decreasing sence then we suggest for serious dose but according to steepness of slops (trend line) at different conditions (increase, decrease and normal). We have suggested for successful operation but subject to the condition that the clinical data is collected in the duration of declared operation.

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