CHAPTER 2

LITERATURE SURVEY
CHAPTER 2

LITERATURE SURVEY

Many researchers have studied the blood flow in stenotic region under different conditions. [Young [8], Talukdar [9], Shukla et al.,[10] Padmanabhan and Devanathan [11]]. Most of these studies have considered blood as a Newtonian fluid, but when it moves in small tubes and having low shear rates it acts as a non-Newtonian fluid. In this view, some investigators have considered the blood to be non-Newtonian. [Shukla et al.,[12, 13], Williams and Javadpour [14]]. Shukla et al., [12] investigated the properties of power law fluid in case of mild stenosis. They [Shukla et al., [13]] also considered the effect of peripheral layer of blood in a tube with stenosis by taking into account the clustering of cells in the central zone. The flow of magnetic fluid past a mild stenosis was analyzed by Wagh and Kashiv [15]. They used Rosensweig model and derived expressions for velocity, flux and pressure drop across the stenosis.

Liu and Yamaguchi [17] and Delplano et al., [18] have investigated unsteady flow in the presence of stenosis. The impact of elastic characteristics at the wall on flow properties in constricted arteries were discussed by Moayeri and Zendehbudi [19]. Mandal [20] observed that, the flow of blood in a tapered constricted artery by taking Power-law fluid into account. Non-Newtonian effects of blood flow on hemodynamics in distal vascular graft anastomoses were investigated by Chen et al., [21]. Sankar and Hemalatha [22] investigated the pulsatile flow of H-B fluid in catherized artery. Misra et al., [23] observed the blood flow in an artery with multiple stenoses, by considering blood as Casson fluid. The effect of the magnetic field on the flow characteristics of non-Newtonian unsteady blood flow through a constricted tube was studied by Ikbal et al., [24]. Siddique et al., [25] analyzed the effects of non-Newtonian behavior and pulsatility in a stenosed tube. Jain et al., [26] developed model for studying the oscillatory flow of fluid (blood) in constricted tube through porous medium. Misra et al., [27] presented a model to analyze the acceleration of blood with consideration of slip velocity and taking a Newtonian fluid into account. Rekha Bali and Usha Awasthi [28] observed the external
magnetic field effect on blood flow through a multi stenosed artery. The flow of fluid in a blood vessel by taking slip condition at the wall was studied by Basu Malik et al., [29]. Lokendra Pramar et al., [30] investigated the magnetic field effects on flow of blood with the core region in a constricted artery with overlapping condition. The characteristics of unsteady flow of blood through a tube with time-dependent stenosis were examined by Ranadhir Roy et al., [31]. Somachai Sriyab [32] analyzed the blood flow in a constricted tube by considering bell shaped mild stenosis. Ponalagusamy and Tamil Selvi [33] studied the two-phase fluid model for oscillatory blood flow through a tube under the influence of heat transfer and magnetic field.

These models studied the effects of single stenosis or multiple stenoses, but in practicality, the stenosis shapes are different, sometimes they are overlapping. Time-dependent overlapping stenosis in a tube was studied by Mandal and Chakravarthy [34]. Layek et al., [35] discussed the flow of unsteady blood in a vascular tube with overlapping stenosis. The effects of an overlapping stenosis on blood flow properties in a narrow tube were observed by Srivastava and Sailesh Mishra [36]. Daniel N. Riahi and Randhir Roy [37] analyzed the unsteady blood flow in a constricted artery with overlapping condition. The properties of blood flow in an artery with an unsteady overlapping stenosis were investigated by Randhir Roy and Daniel N. Riahi [38].

In physiological systems, most of the ducts are making an inclination to the axis. Devajyoti Biswas and Moumita Paul [39] presented a mathematical model of a Newtonian fluid, flowing through a non-uniform tapered artery with an inclination to the axis. The flow of fluid in a blood vessel with an inclination and tube having an axially non symmetric stenosis was analyzed by Uday Shankar Chakraborty et al., [40]. Peristaltic motion of a fractional second grade fluid through an inclined cylindrical tube was studied by Rathod and Anita Tuljappa [41].

Partial narrowing of arteries is called post stenotic dilatation. Post stenotic dilatation is formed when the blood is moving back in low pressure region in the cardiac cycle. Atherosclerotic plaques of the renal, carotid and fermal arteries can cause post
stenotic dilatation, as the arteries become narrow by the abnormal anatomy in the bones, muscle or ligaments. Aneurysms associated with post stenotic dilatation may be seen in human regions distal to the coarctation of the aorta, abdominal aorta and pulmonary arteries. The effects of post stenotic dilatation on blood flow through coronary artery were analysed by Pincombe and Mazumdar [42]. Pincombe et al., [43] discussed the Casson fluid flow through small arteries with multiple stenoses and stenotic dilatation. The Binghan fluid flow in an artery with post stenotic dilatation has been studied by Sanjeev Kumar and Chandra Shekhar Dewakar [44]. Priyadharshini and Ponalagusamy [45] discussed the influence of stenosis and dilatation by considering Herschel-Bulkley fluid through a tapered artery. The effects of post stenotic dilatation and multiple stenosis through an artery by treating blood as Bingham plastic fluid were analyzed by A.K. Singh and D.P. Singh [46].

Magnetic therapy is one of the most widely used techniques, for curing various diseases like poor circulation, headaches, muscle sprains, joint pains, etc. Kolin [47] was the first person, who introduced electromagnetic fields in medical research. Later, Korchevskii et al., [48] observed the effect of magnetic field on blood flow in human system. Halder [49] studied magnetic field effect through an indented artery. Further, Tzirtzilakis [50] discussed the flow of Newtonian fluid in the presence of an applied magnetic field. Two dimensional MHD flow of upper convicted Maxwell fluid through a porous medium, by considering shear stress at the wall is a major factor in vicinity of atherosclerosis was studied by Abbas et al., [51]. The flow of an electrically conducting fluid in an artery with multiple constrictions of irregular shapes was studied by Mustapha et al., [52]. Jain et al., [53] studied the oscillatory flow of blood in a stenosed artery in a porous medium under the influence of magnetic field. Kumari and Prasad [54] discussed a fully developed free convection flow of third grade fluid in a vertical channel with the effect of magnetic field. Varun Kumar et al., [55] analyzed the influence of porous medium on flow of blood in a tube with an effect of transverse magnetic field. Hazarika and Barnali Sharma [56] investigated the flow of blood in constricted tube through porous medium with the influence of an applied magnetic field.
Hence a detailed knowledge of the effects of overlapping stenosis, post stenotic dilatation and magnetic field effect on blood flow in arteries helps in the prevention of diseases related to the arteries.

The nature of blood shown in detail through Herschel-Bulkley fluid model by Scott Blair and Spanner [57]. Iida [58] reported that Herschel-Bulkley fluid is suitable for blood flow through arterioles of small diameters of 0.065mm. Also, [Chaturani and Ponnalagar Samy [59]] reported that if the tube diameter is 0.095mm, blood is considered as Herschel-Bulkley fluid. Tu and Diville [2] used Galerkin method for solving the pulsatile blood flow of Herschel-Bulkley fluid in a constricted tube. The steady flow of Herschel-Bulkley fluids in a canonical three-dimensional expansion was analyzed by Alexandrou et al., [60]. Vajravelu et al., [61, 62] discussed the peristaltic motion of Herschel-Bulkley fluid through an inclined tube. The steady flows of Bingham, Casson and Herschel-Bulkley fluids in tubes of two different cross-sections were analyzed by Huilgol and You [63]. Misra and Shit [64] used Herschel-Bulkley fluid to study the blood flow in a constricted tube. The pulsatile flow of Herschel-Bulkley fluid in a constricted tube was studied by Shankar and Hemalatha [21]. The oscillatory pressure gradient of an irregular axi-symmetric artery of blood flow was investigated by Jain et al., [65] by assuming the stenosis was mild and considering blood as Herschel-Bulkley fluid. Siddiqui et al., [66] studied the pulsatile flow of blood in a constricted tube by treating blood as Herschel-Bulkley fluid. Vajravelu et al., [67] discussed the Herschel-Bulkley fluid flow through an elastic tube. Sapan Ratan Shah [68] investigated the effect of Herschel-Bulkley fluid in an artery with radially non symmetric multiple stenoses. The magnetic field effect on Herschel-Bulkley fluid through a multiple constricted artery was studied by Amit Bhatnagar and R.K. Shrivastav [69] by considering slip velocity. Arun Kumar Maiti [70] studied the behavior of Herschel-Bulkley in a non symmetric constricted artery. A two-fluid model of Herschel-Bulkley fluid flow through small diameter tube by considering slip velocity at the wall was investigated by Santhosh et al., [71].
Several authors have studied micropolar fluid flow in both mechanical and physiological points of view. The peristaltic pumping of micropolar fluid in a cylindrical tube with a sinusoidal wave of small amplitude travelling down its flexible wall for the case of low Reynolds number devoid of wall properties like tension and damping was investigated by Girija Devi and Devanathan [72]. Philip and Chandra [73] investigated the peristaltic motion of microfluid that relates to microrotation and micro stretching of elements present in a small volume. Ming and Chang [74] discussed the influence of wall conduction on laminar natural convection heat transfer of micropolar fluids through vertical flat plate. Thermo micropolar flow of a nematic liquid crystal in a flexible stenosed tube was studied by Narasimhan [75]. Srinivasacharya et al., [76] analyzed the unsteady flow of incompressible micropolar fluid between two parallel porous plates. In this paper they assumed periodic suction at the lower plate and injection at the upper plate. Pulsatile flow of micropolar fluids with stretch, whose micro elements can undergo expansions and contractions besides translations and rotations in straight circular tubes are analyzed by Narasimhan [77]. Bhargava et al., [78] investigated the effect of temperature dependent heat sources on the fully developed free convection electrically conducting micropolar fluid between two parallel porous vertical plates in a strong cross magnetic field. The asymmetric nature of the stenosis was investigated by Mekhemier and El Kot [79] by treating blood as micropolar fluid. The stagnant flow through a permeable vertical surface immersed in micropolar fluid was analyzed by Anuar Ishak et al., [80]. Muthu et al., [81] studied the oscillatory flow of micro polar fluid in an annular region with constriction. They observed the influence of micropolar fluid parameters on mean flow and pressure variables by assuming that the constriction varies over the cross-section of the annular region. Chaube et al., [82] studied the slip effect on peristaltic motion of micropolar fluid. They analyzed the effects of coupling number, slip parameter on pumping region, friction force and trapping. The influence of magnetic field on peristaltic motion of micropolar fluid in a porous channel was investigated by Pandey and Chaube [83]. Srinivasacharya and Srikanth [84] discussed the flow of micropolar fluid in a catheterized artery. The peristaltic transport of micropolar fluid through a tube having
an inclination with the effect of magnetic field was studied by Krishna Kumari et al., [85]. Ali and Ashraf [86] analyzed the heat transfer properties of a viscous incompressible micropolar fluid through a tube under the influence of magnetic field with a shrinking and stationary wall. Aziz [87] studied the influence of variable viscosity on mixed convection heat transfer along a vertical stretching surface. Gurju Awgichew and Radhakrishnamacharya [88] investigated the flow of micropolar fluid through a uniform channel with stenosis by considering slip velocity. The axi-symmetric micropolar fluid flow through a tapered artery with an overlapping constriction, by taking slip velocity into consideration was studied by Ramana Reddy and Srikanth [89].

Hayat et al., [91] investigated the peristaltic flow of Jeffrey fluid through a circular pipe. The influence of magnetic field on peristaltic flow of Jeffrey fluid was discussed by Kothandapani and Srinivas [92]. Krishna Kumari et al., [93] analyzed the peristaltic transport of Jeffrey fluid through an inclined tube with the influence of magnetic field. Rajani kanth et al., [94] analyzed the partial slip effects on the peristaltic flow of a Jeffrey fluid in an asymmetric channel.

Sreenadh et al., [95] investigated the unsteady flow of Jeffrey fluid in an elastic tube with constriction. In this, they studied different types of pressure radius relations. The peristaltic motion of a Jeffrey fluid of variable viscosity in a porous medium in an asymmetric tube was studied by Afsar Khan et al., [96]. Noreen Sher Akbar et al., [97] discussed the peristaltic mechanism of Jeffrey fluid in small intestine. A mathematical model to study the pulsatile flow of Jeffrey with an internal porous lining through a circular tube was developed by Lalitha Jyothi et al., [90]. Arshad Riaz et al., [98] studied the peristaltic flow of Jeffrey fluid through a three dimensional rectangular medium by considering slip at the boundaries. Vajravelu et al., [99] investigated the peristaltic transport of Jeffrey fluid in an asymmetric channel with inclination. The effects of porous medium on a two fluid model were studied by Santhosh et al., [100] with Jeffrey fluid in the core and a Newtonian fluid in the peripheral region.