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Studying the effects of electro-osmotic and several parameters on blood flow in stenotic arteries using CAGHPM

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ABSTRACT

In this investigation, a new approach is proposed to study blood flow through a stenotic artery under the impact of electro-osmosis and several other main parameters. The new approach depends on the Chebyshev series, the Akbari-Ganji method, and the new homotopy perturbation method named the Chebyshev Akbari-Ganji homotopy perturbation method (CAGHPM). The validity of the proposed method was ensured by the good agreement of its results with the results obtained by other methods mentioned in previous studies. The influences of the electro-osmotic parameter and the Helmholtz-Smoluchowski velocity, as well as the inclination angle, magnetic field, porosity, and chemical reaction, are discussed in terms of the velocity, temperature, wall shear stress, and concentration of blood flow. The results obtained by using the CAGHPM are more accurate than those obtained by other methods used to solve the current problem. Furthermore, error tables, figures, and convergence analysis theoretically and computationally show the efficiency and effectiveness of the proposed new method.

1. Introduction

In recent years, the exploration of blood flow within stenotic arteries has garnered significant attention from the scientific community. This interest is attributed to the pivotal role that blood plays in regulating an individual's temperature and facilitating the transport of essential nutrients and oxygen to various body regions through the arteries and veins. Sometimes stenosis occurs in these arteries due to the accumulation of fatty materials on their inner walls. These stenoses disrupt blood perfusion, leading to a reduction in blood flow to the respective regions. The most prevalent blood circulation disruptions are found in vessels nourishing the heart and those supplying the brain. Arterial stenosis in these vessels results in diminished blood access to the heart, brain, and other vital organs, with repercussions ranging from cardiac episodes and cerebral strokes to mortality. Understanding and addressing these circulatory irregularities is crucial for advancing medical knowledge and improving patient outcomes. Consequently, numerous scientists have diligently examined the impact of these arterial stenoses through diverse methodologies[1–3].

The dynamics of blood flow and its interdependent factors have intrigued researchers, especially mathematicians, who have thoroughly examined their impact using various methodologies. Among these factors is the influence of the magnetic field on blood flow, coupled with the porosity of the medium, which is deemed a fundamental feature of arteries. Furthermore, the viscosity of the blood, considered a variable in the actual physiological system, fluctuates based on pressure, temperature, or hematocrit level in the artery. Additionally, studying chemical reactions is crucial because it aids in understanding the quantitative rate of flow. The effect of nanoparticles on blood flow is also an important study because of its significant contributions to medical treatments. For more detailed information, refer to[4-20].

In the realm of fluid mechanics, the domain of electro-kinetics has experienced noteworthy advancements, emerging as a preeminent branch thereof. In 1809, Reuss conducted significant investigations, elucidating an electro-kinetic phenomenon commonly referred to as electroosmotic flow (EOF). This phenomenon involves the study of fluid dynamics under the influence of an externally applied electric field. When a charged solid surface comes into contact with water or an aqueous solution, it results in the formation of a thin layer characterized by an unbalanced distribution of charges, commonly referred to as the electric double layer (EDL). This phenomenon results in the accumulation of negative charges on the solid surface, leading to the attraction of positive ions within the liquid toward the surface while simultaneously repelling negative ions. Furthermore, when an electric field aligns parallel to the solid surface, the electric double layer tends to migrate in the direction of the electric field, acquiring a positive charge. For more information about this topic and its interactions in various studies, refer

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