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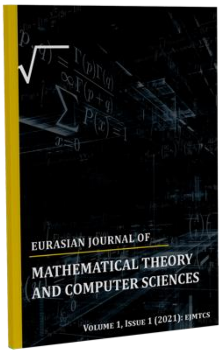

# CALCULATING THE VELOCITY OF GLOBAL BLOOD FLOW WITH COMSOLE MULTYPYSICS IN THE CARDIOVESSEL

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## ABSTRACT

*This abstract discusses the process of solving a differential equation of parabolic type by the finite difference method. The method is based on discretization of space and time, approximation of derivatives and subsequent calculation of function values on a grid. The solution of a system of equations is performed using an explicit or implicit scheme. In an explicit scheme, the function values in the new time layer are calculated based on the function values in the previous layer. In the implicit scheme, the function values in the new layer are found as a solution to a system of equations. For the implicit scheme, iterative methods are used.*

Scientists and engineers in various countries contributed to the development and refinement of Doppler ultrasound for clinical and research use. It's important to recognize that the study of global blood flow velocity is a collaborative effort involving experts from various fields, including physiology, cardiology, physics, and engineering. This ongoing research continues to advance our understanding of the complex hemodynamics of the cardiovascular system, with contributions from many researchers around the world. Playing a role in regulating global blood flow velocity within the cardiovascular system involves the coordinated efforts of various physiological and regulatory mechanisms. The cardiovascular system is a complex network of organs, blood vessels, and tissues responsible for pumping, transporting, and distributing blood throughout the body. Here are the key elements that contribute to regulating global blood flow velocity. The heart serves as the central pump of the cardiovascular system. It contracts rhythmically to pump blood into the circulatory system. The rate and strength of heart contractions (heart rate and stroke volume) influence cardiac output, which is the volume of blood ejected by the heart per minute. Cardiac output is a major determinant of global blood flow velocity. Blood vessels, particularly arterioles, play a crucial role in regulating blood flow velocity. Arterioles can constrict or dilate, adjusting their diameter to control the resistance to blood flow. Increased resistance leads to reduced blood flow velocity, while decreased resistance allows for increased blood flow velocity. The total volume of blood in the body affects global blood flow velocity. An increase in blood volume, as can occur with hydration or certain medical conditions, can increase blood flow velocity. The viscosity or thickness of blood affects flow velocity. Higher viscosity can reduce blood flow velocity, while lower viscosity can increase it. Blood viscosity is influenced by factors like hematocrit (the proportion of red blood cells in blood) and the concentration of proteins in plasma. The autonomic nervous system (sympathetic and parasympathetic branches) and hormonal factors (such as epinephrine and norepinephrine) influence heart rate, cardiac contractility, and blood vessel tone. These regulatory systems respond to physiological demands and stress, helping to maintain blood flow velocity within an appropriate range. Tissues and organs can locally regulate blood flow velocity based on their metabolic needs. When tissues require more oxygen and nutrients, local vasodilation occurs to increase blood flow to that area. Baroreceptors, located in the walls of certain blood vessels (e.g., carotid sinus and aortic arch), monitor blood pressure. When blood pressure deviates from the set point, the baroreceptor reflex adjusts heart rate and blood vessel tone to maintain blood pressure and blood flow. Blood flow velocity is adjusted in response to temperature changes. Blood vessels in the skin can constrict to conserve heat or dilate to dissipate heat. Various medical conditions, such as hypertension, atherosclerosis, and heart disease, can disrupt the normal regulation of blood flow velocity, potentially leading to pathological states. During exercise, the body increases its demand for oxygen and nutrients. To meet this demand, the cardiovascular system responds by increasing cardiac output and redistributing blood flow to active muscles.

The differential equation used to create a mathematical model of blood vessels is usually of the parabolic type.

Modeling blood vessels using parabolic differential equations allows one to study the dynamics of blood flow, the distribution of nutrients and oxygen in organs and tissues, and also predict the effects of various factors on the circulatory system.

The use of differential equations of parabolic type in modeling blood vessels allows one to study phenomena such as blood transport inside vessels, diffusion of nutrients through capillary walls, gas exchange between blood and tissues, etc.

These equations allow us to take into account various parameters, such as the size and shape of blood vessels, their elasticity, blood pressure, vascular resistance and other factors that affect the functioning of the circulatory system. Modeling blood vessels using differential equations of parabolic type helps to better understand and predict various processes occurring in the body, and can be useful for the development of new methods for diagnosing and treating diseases associated with blood circulation. One of the most common parabolic differential equations used in blood vessel modeling is called the diffusion equation or heat equation. This equation describes the distribution of the concentration of a substance or temperature in space and time. This equation allows one to model the distribution of nutrients, oxygen, or other substances within blood vessels and surrounding tissues. It takes into account the diffusion of a substance along vessels and through their walls, as well as the transfer of a substance under the influence of a concentration gradient.

In addition to the diffusion equation, other parabolic differential equations can be used in modeling blood vessels, including equations that describe the propagation of electrical or chemical signals in the nervous system or the propagation of heat in tissue during laser treatment, for example. The choice of a particular equation depends on the specific characteristics of the system and the physical processes that need to be modeled.

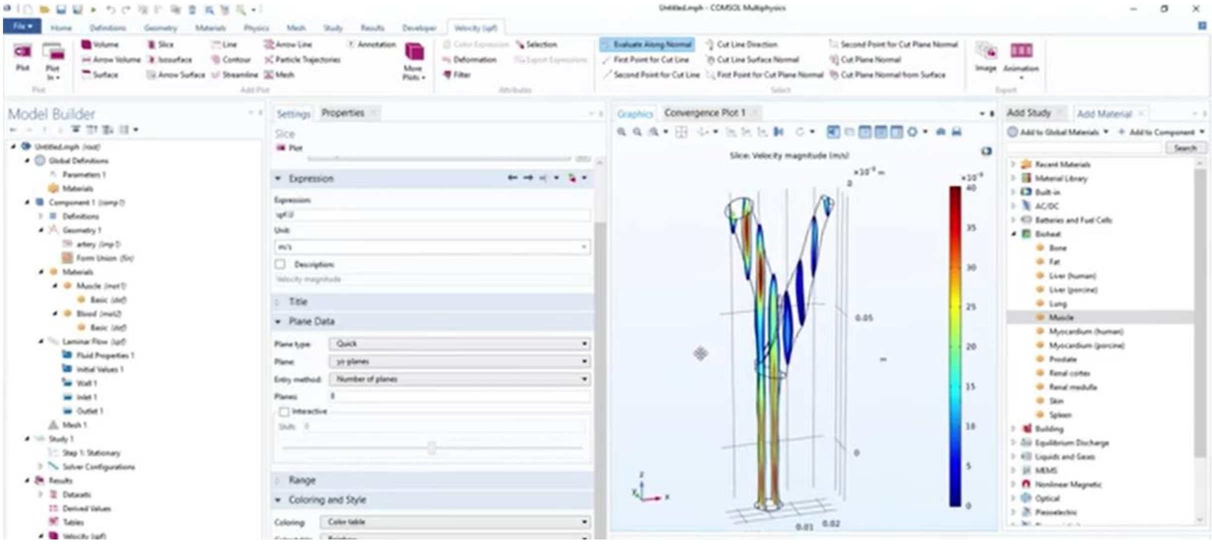

Fig 1. Model of arteries velocity blood flow with oriented place

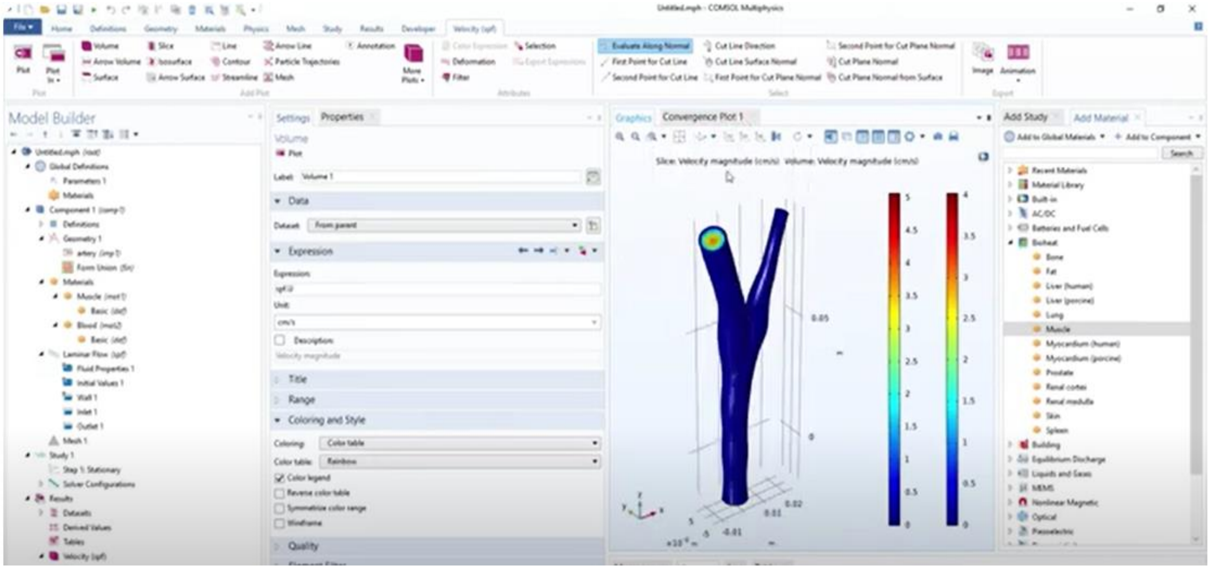

Fig 2. Model of arteries velocity blood flow with oriented place

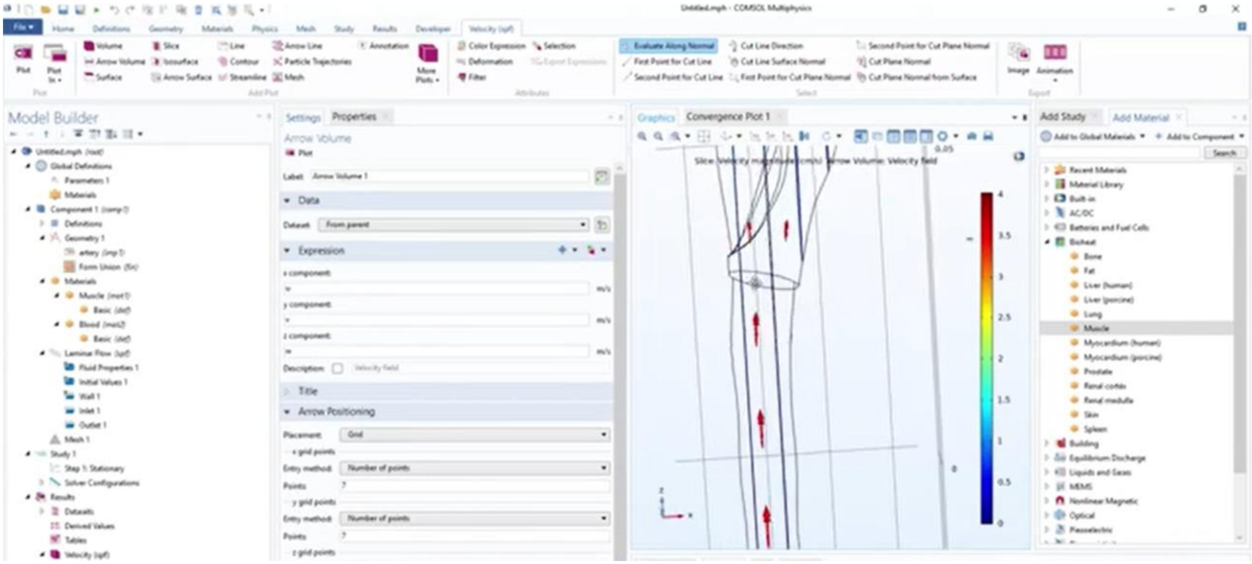

Fig 3. Model of arteries velocity blood flow with oriented place

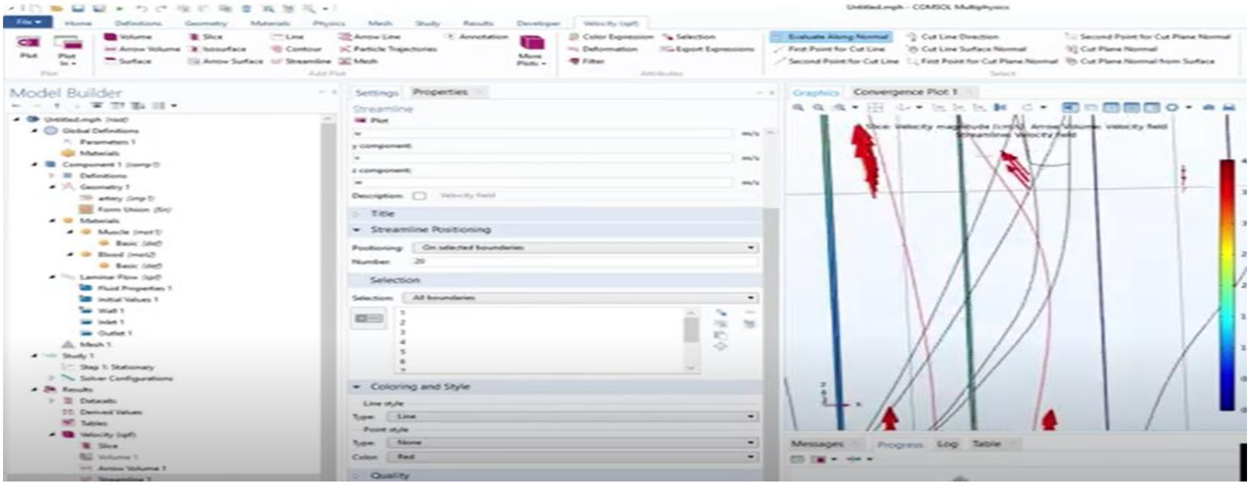

Fig 4. Model of arteries velocity blood flow with oriented place

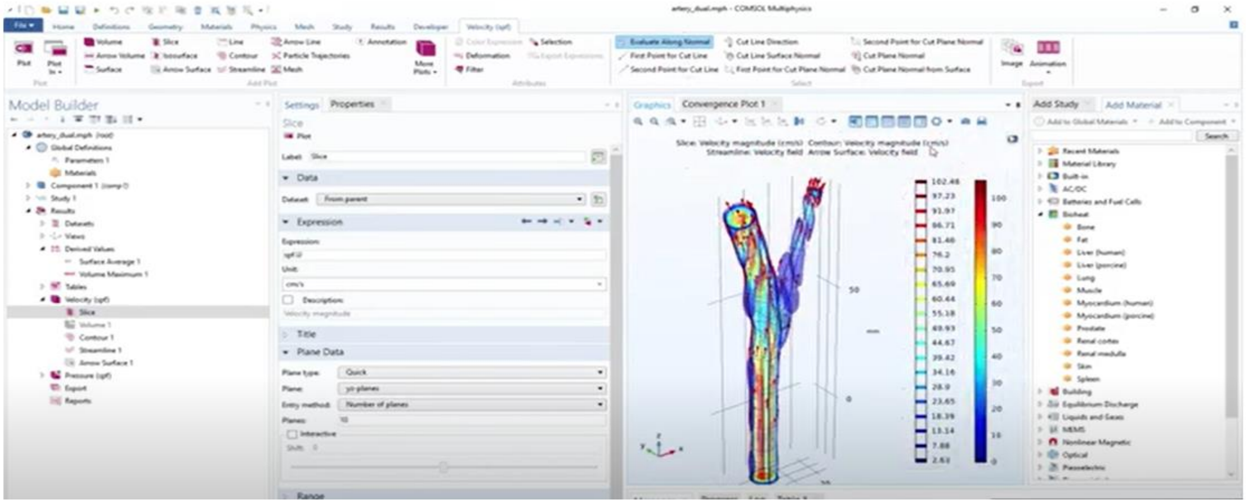

Fig 5. Model of arteries velocity blood flow with oriented place

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