Exploring age probability distribution indices to predict thrombosis in atrial fibrillation conditions

Jorge Dueñas-Pamplona¹*, José Sierra-Pallares², Javier García García¹, Francisco Castro² and Jorge Muñoz Paniagua¹

¹Departamento de Ingeniería Energética.
Escuela Técnica Superior de Ingenieros Industriales.
Universidad Politécnica de Madrid (Spain)
e-mail: jorge.duenas.pamplona@upm.es

²Departamento de Ingeniería Energética y Fluidomecánica.
Escuela de Ingenierías Industriales
Universidad de Valladolid (Spain)

Key Words: atrial fibrilation, computational fluid dynamics, left atrial appendage, thrombus formation

ABSTRACT

During the recent years, advances in medical imaging, segmentation techniques and high-performance computing have boosted the use of patient-specific Computational Fluid Dynamics (CFD) simulations. This has provided important insights to understand the mechanism of diseases such as atrial fibrillation (AF), which usually leads to a process of thrombus formation within the left atrial appendage (LAA). Moreover, it has opened the door to the development of clinic tools able to facilitate the diagnose and even provide assistance during surgical procedures[1].

However, it does not exist yet a unified criterion to quantify the risk of thrombus formation within the LAA. So far, there have been two main approaches: indices based on blood age distribution and indices based on wall-shear distribution. While the first ones provide useful information about where the blood stasis is high, the latter ones also contain information about zones with changing velocities which can contribute to damage the endothelium near the ostium. Hence, both families of indices are complementary.

Nevertheless, quantifying the thrombosis risk through the blood age distribution shows a problem. As the calculated age value depends on the number of simulated cycles, many cycles should be simulated to have meaningful results. In this work, we propose a new index based on the fourth moment of the age probability distribution[2]. This index is related to the tail of the age distribution in each computational cell, and it can filter the zones with older fluid easier and earlier during the simulation, avoiding some computational effort. This new index could overcome some of the problems that usually shows the mean age. This will mean to lessen the computational cost and timing of patient-specific thrombosis risk estimations, providing at the same time a more unambiguous indication of the thrombogenic regions within the LAA.

REFERENCES
