False lumen thrombosis in aortic dissection and its impact on blood conductivity variations – an application for impedance cardiography

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ABSTRACT

Aortic dissection (AD) is a hazardous disease with high mortality rate. It is initiated by the occurrence of a tear in the aortic wall. Then, the pulsating blood flow penetrates through the tear between the layers of the aortic wall and causes a new passageway of blood, the so-called false lumen. As a result of haemodynamic conditions in the false lumen, the blood might clot, which causes false lumen thrombosis. The level of thrombosis in the false lumen affects the patients’ prognosis and chances of survival, in which a complete thrombosis is usually beneficial [1,2]. Applying non-invasive methods for diagnosis and monitoring purposes could be beneficial in decision making and, therefore, medical management of AD by clinicians. Previously, impedance cardiography (ICG) was proposed for diagnostics, which allows to identify and quantify aortic changes by measuring the impedance on the thorax during a cardiac cycle [3]. To investigate the feasibility of ICG in monitoring thrombosis in the false lumen, the influence of false lumen thrombosis on the thorax impedance in AD patients has to be studied.

In the present work, the electrical conductivity of blood as a non-Newtonian fluid is investigated in a simplified geometry of a dissected aorta. Numerical simulations of the pulsating blood flow with thrombus formation in OpenFOAM apply a semi-analytical model for flowing suspensions with non-spherical particles for blood electrical conductivity. During thrombus formation, the partition of flowing blood between true and false lumen changes, reducing the false-lumen flow rate as the thrombus grows, with consequences for the blood conductivity. Moreover, the conductivity in the thrombus is much lower than in blood. These two effects together raise the conductivity of blood in the true lumen and reduce it in the false lumen. This phenomenon suggests the application of the ICG method for monitoring false lumen thrombosis in AD patients.

REFERENCES

