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HELICAL FLOW AS POSSIBLE MECHANISM OF MIGRATION RISK REDUCTION IN EVAR-TREATED PATIENTS

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Introduction

Endovascular aneurysm repair (EVAR) for the treatment of the abdominal aortic aneurysm (AAA), has become alternative to open surgery in the last decades, thanks to its low invasiveness and morbidity rate. In face of these advantages, EVAR treatment still present some post-surgical complications, in particular endoleaks, thrombosis and migration. Migration of the stent graft is still a major complication that markedly increases AAA risk of rupture. In this study, we analyze the in-stent hemodynamics in a cohort of image-based computational fluid dynamics models of post-EVAR patients treated with commercial endograft devices[1,2], exploring the existence of possible association of distinguishable hemodynamic features *vs.* displacement forces (**DF**s). The base idea is to identify, if any, a hemodynamic quantity as potential target of endografts design optimization strategies, aimed to minimize EVAR risk of failure. Stimulated by a recent study [2], reporting the beneficial role of helical flow plays in reducing the in-stent graft risk of thrombosis, here we focus the attention on in-stent helical flow features.

Material & Methods

Twenty subjects treated with two different commercial stent grafts were considered: 10 treated with Endurant® (Medtronic, CA, USA), and 10 with Excluder® (Gore Medical, AZ, USA) [1,2]. Starting from 1-month post-implantation CT scans, 3D geometries (as in Fig. 1) were reconstructed and computational fluid dynamics analysis was performed as described elsewhere [2]. Cycle-averaged **DF**s resultant forces (**TADF**) were evaluated as given by the action exerted on the inner surface of the device by blood pressure and fluid shear stress. In-stent helical flow patterns were visualized in terms of local normalized helicity (LNH, the normalized value local velocity and vorticity vectors). Helical flow was quantified in terms of cycle-averaged helicity intensity (h_2).

Results & Discussion

From the analysis it emerged that, on average, **TADF** magnitude in Endurant (2.52±1.61 N) patients is higher than in the Excluder group (1.58±0.65 N). The observation of paucity of helical structures in correspondence of the highest value of displacement force (as in the explanatory cases reported in Fig. 1, representing the Endurant models with the highest and the lowest peak **DF** magnitude values, respectively) encouraged us to further investigate on the existence of a relationship between helical flow and **DF**s strength.

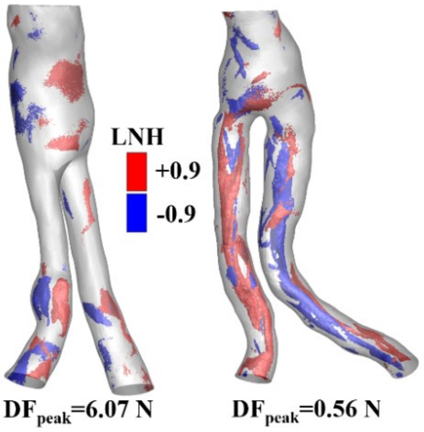

Fig.1: LNH isosurfaces for two representative cases and the respective **DF**$_{peak}$ *value (red and blue colors indicate right- and left-handed rotating helical fluid structures)*

Interestingly, it was observed that h_2 is negatively associated to **TADF** (Fig.2), i.e., the higher is the helicity intensity in the stent graft, the lower the displacement forces.

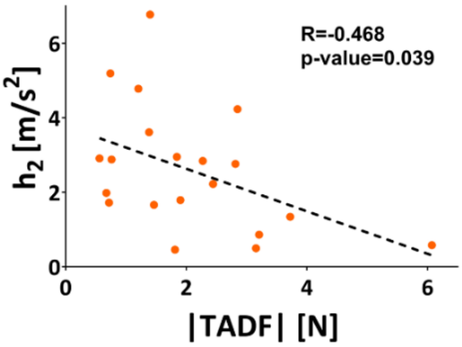

Fig.2: Scatter plot of **|TADF|** *vs.* h_2 *values.*

Based on the emerged inverse relationship of helical flow intensity with **DF**s, and on its recently suggested beneficial role in reducing the risk of thrombosis in implanted endografts, we are proposing h_2 as potential target of endografts design optimization strategies aimed at minimizing EVAR failure risk.

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