Morphological and hemodynamic characterization of post endovascular AAA repair: comparison between two different commercial devices

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1. Introduction

Abdominal aortic aneurysm (AAA) is a vascular disease characterized by a localized expansion of the abdominal aorta. In the last years the minimally invasive endovascular aortic repair (EVAR) approach for AAA treatment has been widely applied as alternative to classical open-chest surgery. EVAR results in (1) redirection of blood through the deployed endograft, and in (2) iliac bifurcation reshaping, thus altering local hemodynamics [1]. In this study the impact that two different commercial endovascular graft (EG) devices, have on vascular geometry and hemodynamics is investigated. In detail, geometric features are pre- and post-operatively evaluated. Computational Fluid Dynamics (CFD) is applied to explore if the vascular territory post interventional reshaping supports the re-establishment of physiological hemodynamics.

2. Methods

Subjects suffering from AAA were treated with two EG systems, N=5 with the Endurant® (Medtronic, CA, USA), N=5 with the Excluder® (Gore Medical, AZ, USA) (fig. 1). Also N=5 healthy subjects underwent CT angiography. CT scans were obtained before and one month after EVAR [1]. 3D models were reconstructed from CT images[1].

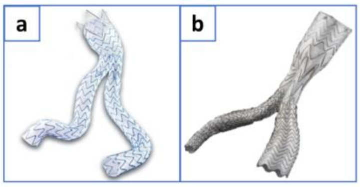

Figure 1: (a) Endurant device, (b) Excluder device.

Centerline-based geometry analysis was carried out on reconstructed models, in terms of curvature, torsion, normalized cross-sectional area and cross-sectional area variation rate [2]. The reconstructed 3D geometries were meshed with tetrahedral elements [1]. The governing equations of blood flow were solved by using the finite volume method. Boundary conditions at inflow and outflow sections were based on flow and pressure measurements [1]. Near-wall hemodynamics and intravascular flow structures were described in terms of time-average wall shear stress (TAWSS), and in terms of helical flow, blood recirculation volume (RV), respectively.

3. Results

Geometric features are similar between treated groups but present higher and more scattered values than healthy subjects, as an average. In terms of hemodynamics, subjects treated with the Excluder present lower percentages of surface area exposed to low WSS and lower RV (fig. 2).

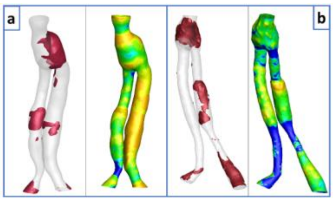

Figure 2: Explanary RV and TAWSS maps: (a) Endurant; (b) Excluder. In TAWSS maps low values are colored with red.

Overall, the Excluder group presents the highest TAWSS and helicity intensity values.

4. Discussion

From the geometrical point of view there are no-marked differences between the two devices. From the hemodynamic point of Excluder models present a higher mean value of TAWSS and helicity that could confirm that the helical flow plays a beneficial role in suppressing low velocity/stagnation regions that could lead to thrombus formation.

References

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