CONTRIBUTION TO OPTIMIZING THE IMPLANTABLE MEDICAL DEVICES (IMDS) FOR THE TREATMENT OF INTRACRANIAL ANEURYSM

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ABSTRACT: In order to contribute to the optimisation of the IMDs for the treatment of intracranial aneurysms, this study will evaluate the influence of geometrical parameters of arteries and flow-diverter devices on bloodstream and aneurysm thrombosis. Different mock-up/models have been used to evaluate the pressure drop due to the presence of flow-diverter devices. A numerical model will be determined to predict the pressure drop and the thrombosis phenomenon in in-vivo cases. The numerical model will be calibrated and tested comparing it to experimental results.

DESCRIPTION:
for \( i = 1 \) to 46 (In Vivo Cases):
- DICOM file ➔ DICOM
- 3D Geom ➔ Centreline evaluation ➔ Aneurysm characterizing

As a first step, a simple mock-up has been designed to test different types of flow-diverter devices and calibrate a CFD model to simulate the experiments. In this project the mock-up will be improved to be more similar to a real aneurysm/artery case with the aim to study the physical parameters that influence the thrombosis. In order to build a mock-up/model of the aneurysm and arteries, a software has been developed. The software is able to rebuild the 3D geometry of any in-vivo case starting from medical digital images (DICOM files) of a cranium angiography and to calculate the centerline fixing the proximal and the distal sections (start and end points). Once the geometry is built the user can select the proximal section of the neck aneurysm, the distal section and the neck surface normal; then all the other geometrical parameters researched are calculated by the software: aneurysm wide, neck surface, artery average curvature, artery average diameter and angle. The artery curvature has been calculated projecting the centerline in a plane tangent to the centreline and containing the direction of the aneurysm, fit for the purpose of studying the relationship between flow streamlines, neck surface normal and pressure drop considering that the mock-up/model realised will be symmetric plane. In the end, average values of the geometrical variables have been separated in six typical case-studies with the aim of building different mock-up/models.

OBTAINED RESULTS

The upstream/downstream drop pressure has been evaluated for four different types of flow-diverter devices varying the flow from 1.3 ml/s up to 2.1 ml/s. A glycerine solution has been used to reproduce the blood viscosity. The results have been compared to numerical CFD simulations to evaluate the pressure in a point centred along the device axis.

EXPECTED RESULTS

Six full-sized scale models will be used to study the influence of geometry on the pressure drop measured inside the aneurysm. Three pressure sensors will be connected to the model to measure the inlet/outlet pressures and the pressure inside the aneurysm. A viscometer will check the glycerine solution viscosity and an endoscope will investigate on device spirals shape.

EXPECTED RESULTS

First a FEM model will be calibrated basing on experimental results, then the results of CFD simulations will be used to study the physical phenomenon with more details tracing the liquid streamlines and the pressure/velocity diagrams. Moreover an empirical formula will be determined to evaluate the pressure drop in function of geometry parameters.