

# Measurement of Migratory Forces Acting on Abdominal Aortic Endovascular Stent Grafts

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## EXTENDED ABSTRACT

Abdominal aortic aneurysms (AAA) are one of the leading causes of death in America, especially among men above the age of 60. One of the forms of treatment for AAA involves the insertion of an endovascular stent graft into the aneurysm, blocking the flow of blood. In patient follow up studies, it has been reported that the endovascular stent grafts have a tendency to migrate causing a rupture of the AAA and the complication due to the AAA migration may potentially result in death. In order to determine the forces acting on the endovascular stent grafts, results from theoretical models, computational modeling and analyses, and experimental measurements were compared.

The models that were used in testing the apparatus were designed using the ANSYS Design Modeler software. The abdominal aorta has a wide variety of geometries including branches such as renal, celiac, and mesenteric arteries and a bifurcation at the end of the aorta into the iliac arteries. These varieties appear in the angle between the iliac artery branches, the location of the aneurysm in relation to the bifurcation, and the neck angle of AAA. The geometric variations to be tested were determined by taking the average values from the range of conditions found in literature for the patients with abdominal aortic aneurysms. The computational hemodynamics modeling and simulation program (ANSYS CFX) was also used to determine the forces acting on the endovascular stent grafts. The maximum force that acts on the examined AAA model geometries was found to be approximately 9.5 N. These findings were supported by numerical analysis calculations performed using the Reynolds Transport Theorem (RTT), with a percentage error between the models of no more than 2.5% at the greatest. These forces were then used as evaluation parameters for the components of the experimental apparatus.

The experimental testing will be performed under biological conditions. The Reynold's number for the system at the inlet was calculated to be 5300 (range of 5000-6000). The pressure and flow rates will be monitored and adjusted to maintain a biologically accurate system (90-110 mm Hg pressure range at the inlet of the model and a flow rate range  $4.0-4.5 \times 10^{-4} \text{ m}^3/\text{s}$ ). This parameters will be tested at varying conditions to account for the differences between genders, health, and age among patients. The forces that are acting on the stentgrafts due to the fluid force will be measured according to the displacement of the model during steady state flow conditions. Sliding linear potentiometers will be used for measuring this displacement. The change in resistance is directly correlated with the displacement, and from the displacement values the force can be determined. The migratory forces will be measured for all the cases tested in CFD and with numerical analyses. Obtained results will be compared between all three data sets to determine the accuracy of the modeling and any issues with the experimental apparatus.