Mathematicians devise new model to study response of endovascular aneurysm sealing

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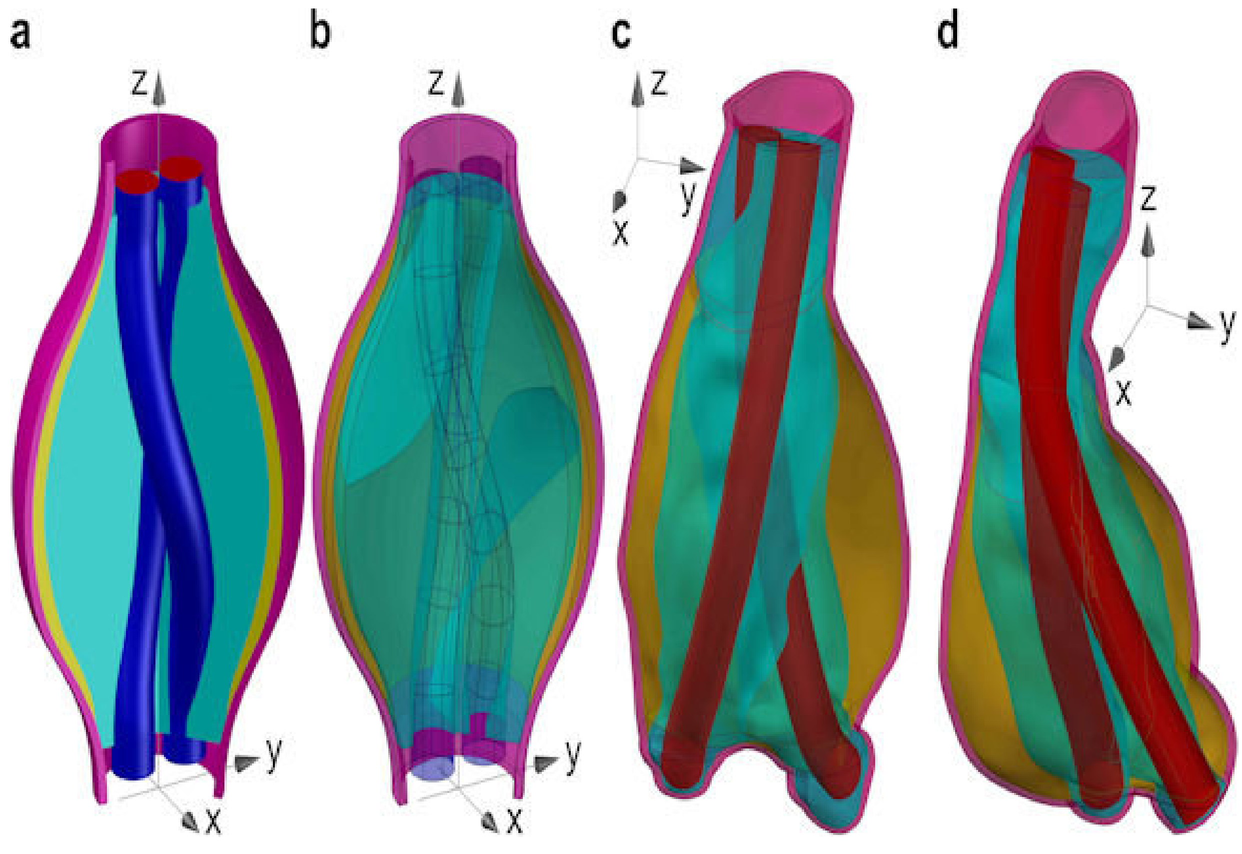

Mathematical model geometry of post-EVAS AAA. (a) Solid cut-view of the idealised geometry of a sealed AAA with helical-like shape stents. (b) Transparent view of the idealised geometry of a sealed AAA showing the surface separating the two polymer filled endobags. (c) Transparent view of the sealed AAA for Patient 1. (d) Transparent view of the sealed AAA for Patient 2. Credit: University of Liverpool

Researchers at the University of Liverpool have developed a mathematical model that has the potential to improve the performance of endovascular aneurysm sealing (EVAS), which is an innovative procedure to treat abdominal aortic aneurysms (AAA).

AAA is a swelling of part of the aorta inside the abdomen caused by a weakness in the aortic wall resulting in a balloon-like bulge in the artery. If untreated there is a risk of leakage or rupture, causing internal bleeding and death.

A commonly used procedure to treat AAA is known as endovascular aneurysm repair (EVAR). EVAS is an alternative minimally invasive procedure which involves the placement of stent-grafts supported by expandable, polymer filled endobags.

However, for a small number of patients some movement of the stent-grafts has been noted and if this causes blood to re-enter the aneurysm, then this may require further surgical intervention, something which clinicians want to avoid.

Researchers in Applied Mathematics at the University collaborated with vascular surgeons and a vascular radiologist at the Royal Liverpool and Broadgreen University Hospital to undertake a study to map and understand the various forces and actions that affect the EVAS system.

The results of their study are published in a research article in *Scientific Reports*. The Liverpool mathematicians were able to produce a three-dimensional mathematical model that explains both static forces, for example gravity, and dynamic forces, for example vibrations from everyday activities, on the sealed abdominal aortic aneurysms which can cause movement of the stent-grafts and disruption of the seal.

The model took into account the pressure of the blood and the subsequent stresses and deformations in the aortic wall. It also factored in the effects of friction on the interaction between the endobags of the EVAS system and the aorta.

Alexander Movchan, Professor of Applied Mathematics at the University, said: "We were able to apply our expertise in theoretical mathematical modelling on a very real healthcare challenge and through the research collaboration with the vascular team we produced a three-dimensional model of an AAA treated with EVAS, and its response to static and dynamic loads.

The research was supported through the Engineering and Physical Sciences Research Council (EPSRC) Centre for New Mathematical Sciences Capabilities for Healthcare Technologies, based in the University's Department of Mathematical Sciences.

The Centre undertakes multidisciplinary research to explore how mathematics and statistics can deliver a more refined and accurate set of predictive models and tools for personalised healthcare delivery.

The article, "Deformation and dynamic response of abdominal aortic aneurysm sealing," is published in *Nature Scientific Reports*.

More information: L. P. Argani et al. Deformation and dynamic response of abdominal aortic aneurysm sealing, *Scientific Reports* (2017). DOI: 10.1038/s41598-017-17759-3

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