Study shows disturbed blood flow can damage the vessel wall in cases of aortic dilation

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Petter Dyverfeldt, professor, and Filip Hammaréus, Ph.D. student, at Linköping University. The research was performed at the Center for Medical Image Science and Visualization in Linköping, Sweden. Credit: Magnus Johansson/Linköping University

Abnormal blood flow in the aorta is linked to inflammation and breakdown of the vessel wall in conditions where the aorta is dilated. This is shown in a study led by researchers at Linköping University. The findings can contribute to better diagnosis and open up new ways to assess the risk of serious and usually fatal complications, such as rupture of the aorta.

All blood in the body passes through the heart about once a minute. With every heartbeat, blood from the heart is pumped up into the aorta.

Dilation can occur in all parts of the aorta. It is unclear exactly how this happens, but one explanation may be weakening of the connective tissue in the vessel wall. Factors such as elevated blood pressure, age and various hereditary conditions increase the risk.

A person affected by aortic dilation usually does not notice anything. But more and more people with aortic dilation are being discovered by health care—often by chance.

"In health care, we're doing more and more imaging where we look at, for example, the heart or lungs, and then we can find that the patient's aorta is a little larger than normal in some parts. There's a need for more tools to guide doctors on how to handle these patients. In a minority of them, the aorta will unfortunately dilate more, and, in the worst case, the aorta will rupture, which is usually fatal," says Filip Hammaréus, Ph.D. student at the Department of Health, Medicine and Caring Sciences at Linköping University and intern physician at Ryhov County Hospital in Jönköping.

Most people with aortic dilation are offered regular surveillance of the aortic diameter—the larger the diameter, the higher the risk. Sometimes the aorta is operated on preventively to avoid acute complications, but it can rupture before dilation has become so pronounced that surgery is

considered appropriate.

At the same time, many examinations are made of people whose aortic diameter does not change. New methods for early identification of patients at elevated risk of growth could contribute to more individualized and cost-effective care.

Filip Hammaréus, Ph.D. student, and Petter Dyverfeldt, professor, at Linköping University. The research was performed at the Center for Medical Image Science and Visualization in Linköping, Sweden. Credit: Magnus Johansson/Linköping University

Therefore, the researchers behind the study, published in the journal

European Heart Journal—Cardiovascular Imaging, are investigating new methods for understanding both the risk and the condition itself. The paper is titled "Wall shear stress measured with 4D flow CMR correlates with biomarkers of inflammation and collagen synthesis in mild-to-moderate ascending aortic dilation and tricuspid aortic valves."

"We can be onto something new, which can say something more about the severity of the disease than what the aortic diameter shows," says Petter Dyverfeldt, professor at Linköping University and affiliated to the Center for Medical Image Science and Visualization, who led the study.

When blood is pushed out of the heart into the aorta, a frictional force occurs between the flowing blood and the vessel wall. This is important for a type of cell that is located in the vessel wall and can sense blood flow. When the frictional force is normal, the cells tend to be healthy. However, if the friction significantly changes direction, or becomes very low or abnormal in other ways, there seems to be a signaling into the vessel wall that can eventually lead to a weakening.

Blood flow through the body's large vessels and in the heart can be measured and visualized with magnetic resonance imaging, using an advanced technology called 4D flow MRI that is available in a small number of hospitals. This gives the researchers a picture of how blood flow affects the vessel wall.

In the current study, the researchers have carried out such measurements and also measured various proteins in the blood. It turned out that there existed interesting relationships between the effect of blood flow on the aortic wall and various proteins that relate to inflammation and the build-up and degradation of connective tissue.

"We see that in patients with dilated aorta, abnormal blood flow dynamics are associated with increased inflammation and turnover of

connective tissue—something we believe can reflect processes in the vessel wall. This seems reasonable based on the mechanisms that have been shown in previous research, but it's completely new to show the connections in the way we do now using a combination of magnetic resonance imaging and blood samples," says Hammaréus.

The findings strengthen previous research, but also bring new insights.

"What's interesting about the findings in our study is that the measures of how blood flow affects the aortic wall were not linked to the diameter of the aorta. So, the traditional measure that's often used in health care was not part of the relationship we see in the study between abnormal blood flow, inflammation and breakdown of the vessel wall," says Dyverfeldt.

The study was conducted on 47 men and women who participated in the Swedish CArdioPulmonary bioImage study (SCAPIS) and whose aortic diameter was over 40 mm. They were compared with 50 control subjects who were matched by sex and age.

SCAPIS (Swedish CArdioPulmonary bioImage Study) is a Swedish population study that recruits and examines the heart and lung status of 30,000 randomly invited women and men aged 50 to 64. The purpose is to identify individuals' risk of heart diseases and to prevent them before they arise. The study is a collaboration between six university hospitals in Sweden.

More information: Filip Hammaréus et al, Wall shear stress measured with 4D flow CMR correlates with biomarkers of inflammation and collagen synthesis in mild-to-moderate ascending aortic dilation and tricuspid aortic valves, *European Heart Journal - Cardiovascular Imaging*

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