Imaging aortic valve bioprosthesis degeneration with 18F-sodium fluoride positron emission tomography

Aortic stenosis is the most common valvular heart disease, and the number of patients is set to double in the next 20 years. The only possible treatment of aortic stenosis is aortic valve replacement, typically with a bioprosthetic valve. However, as the time passes by, bioprosthetic valves, which are made of bovine or porcine pericardial tissue, start to degenerate. Unfortunately, valve degeneration is usually diagnosed at a very late stage, when the only possible treatment is a reintervention. As emergency repeat surgical aortic valve replacement is associated with a mortality of over 20% compared to 1.4% for planned repeat surgery, it exposes patients to substantial risk. Therefore, a better understanding of the processes underlying valve degeneration, which would enable early identification of patients at-risk, is desirable.

In current guidelines, a systematic echocardiography assessment of bioprosthetic valves is recommended. However, the number of artefacts, lack of reproducibility, and the inability to detect the early stages of valve degeneration are the main limitations of this easily available method. Recently, there is growing evidence that computed tomography can identify patients with bioprosthetic valve abnormalities. Unfortunately, its value in the prediction of bioprosthetic valve failure is limited.

As the process of bioprosthetic valve degeneration, especially its early stages, is very poorly understood, currently available diagnostic methods are also limited. However, as we already know, small calcifications within aortic bioprostheses are a hallmark of degeneration. Unfortunately, they are not detected neither by echocardiography nor computed tomography. Importantly, a radioactive substance, called ^{18}F- sodium fluoride (NaF) detects small calcifications and can be visualised on positron emission tomography (PET) imaging. ^{18}F-NaF has previously shown its value in the detection of small calcification in aortic bioprostheses, predicting bioprosthetic valve failure, and outperforming other clinically used methods. Nevertheless, due to high costs and limited availability of PET scanners, ^{18}F-NaF-PET scanning was not applied in daily practice as the number of patients at risk exceeds the capacity. Moreover, the acquisition protocol of ^{18}F-NaF-PET is not optimised for bioprosthetic valves.

Therefore, as a first step we aim to perform ^{18}F-NaF-PET in a population selected based on echocardiography and computed tomography which will help to define an optimal target population that could derive the greatest benefit from the ^{18}F-NaF-PET scan. Secondly, we aim to optimise ^{18}F-NaF-PET protocol for bioprosthetic valves.

We believe that results of this study will enable to establish an optimal ^{18}F-NaF-PET scanning protocol for bioprosthetic valves and will help to define a subpopulation of patients who should undergo ^{18}F-NaF-PET scan.