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Non-invasive assessment of fractional flow reserve using reduced-order models

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Fractional flow reserve (FFR) is the current gold standard of care for diagnosis of coronary heart disease. The invasive clinical procedure requires a pressure sensitive catheter to be inserted via the femoral artery, which is then guided to the coronary arteries. The pressure is simultaneously measured proximal and distal to a stenosis (vessel narrowing); the fractional flow reserve is defined as the pressure distal divided by the pressure proximal.

Recently, attempts have been made to use a combination of non-invasive imaging techniques and computational techniques to determine the FFR value; and hence estimate the severity of a stenosis non-invasively. In this paper a methodology is presented which uses clinically measured FFR values and CT scans (provided by Derriford Hospital), and reduced-order (1d-0d) modelling to calculate FFR. The model is built upon previous work from [1] and uses the numerical method from [2].

Preliminary results (13 patients) have been promising with a model performance of 92.5% absolute percentage accuracy; although the diagnostic accuracy is 85%. The model tends to perform well for stenosis of low to medium severity. The model struggles for more severe stenosis, particularly when there are large amounts of calcification within the arteries. However, for cases with large amounts of calcification, the model's poor performance can be attributed to difficulties in segmentation of these calcified arteries.

During the project up to 75 patient CT scans and FFR values will be compared with the model. The project's anticipated finish is the end of March 2018. This project is funded by the Life Sciences Bridging Fund (LSBF/R6-002).

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