CHIEF SCIENTIST OFFICE

Combined magnetic resonance coronary angiography and positron emission tomography in patients with coronary artery disease

AIMS

This research aimed to develop a protocol to use a combined PET-MRI (positron emission tomography and magnetic resonance imaging) scanner to visualise the blood vessels around the heart (the coronary arteries). For this we used a new type of iron based MRI contrast agent (ultrasmall superparamagnetic particles of iron oxide, USPIO) and a PET radiotracer (18F-sodium fluoride) which identifies ongoing calcification within coronary artery plaques.

KEY FINDINGS

- We have successfully developed a protocol to visualise the coronary arteries using a PET-MRI scanner in healthy patients and patients with coronary artery disease.
- We have investigated how to optimise the PET-MRI image reconstruction in order to visualise coronary artery disease using combined USPIO and 18F-sodium fluoride.
- USPIO PET-MRI can identify coronary artery disease with good accuracy compared to other imaging techniques
- 18F-sodium fluoride PET-MRI can identify areas of the coronary arteries which are associated with recent heart attacks
- The protocol we have developed could be used in future to assess the effects of new treatments for coronary heart disease

WHAT DID THE STUDY INVOLVE?

This study used a combined PET-MRI scanner at the Edinburgh Imaging facility. Healthy volunteers and patients with coronary artery disease of varying severities were invited to undergo this non-invasive imaging which took between 1 and 2 hours to perform. The scanner obtained both structural MRI images of the heart and coronary arteries using USPIO contrast and functional PET images showing the activity of calcification in the heart blood vessels using 18-F sodium fluoride. We assessed the optimal timing of the USPIO contrast and optimal reconstructions for PET imaging. We then used this protocol to identify differences in the coronary arteries between patients with and without coronary artery disease and recent heart attacks.

WHAT WERE THE RESULTS AND WHAT DO THEY MEAN?

Firstly we optimised the MRI images of the coronary arteries using USPIO contrast. We now know how much contrast to use and after what time to perform the MRI scan. Secondly we optimised the reconstruction of the 18-sodium fluoride PET-MRI images. A variety of parameters can be adjusted to produce multiple images from one PET scan (software type, image size, etc). On these images we measured the amount of PET signal in order to determine which was the best combination of reconstruction parameters.

Using our optimised PET-MRI protocol we compared the coronary arteries of patients with and without coronary artery disease. We found that that PET-MRI could find coronary artery disease with good accuracy compared to other imaging tests. We also compared the coronary arteries in patients with and without recent heart attacks. We found that our protocol could identify differences in the blood vessels between patients with and without recent heart attacks.

This figure shows a narrowed coronary artery on both computed tomography and using our USPIO MRI protocol. The arrows show areas of coronary artery disease with narrowings of the coronary arteries which can be seen well with our new protocol
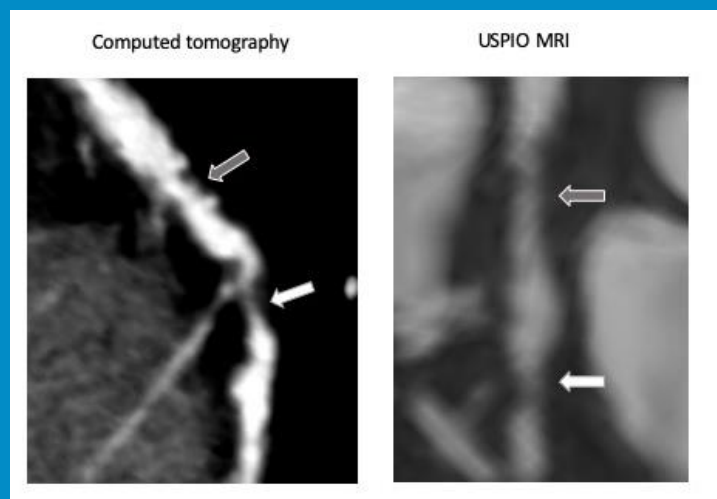
WHAT IMPACT COULD THE FINDINGS HAVE?

- This USPIO and 18-F sodium fluoride PET-MRI protocol can now be used to assess patients with coronary artery disease with a low radiation dose compared to other imaging techniques
- This test will be useful to assess new treatments for coronary artery disease in research studies which require multiple imaging tests to assess treatment response

HOW WILL THE OUTCOMES BE DISSEMINATED?

We have presented this research as a poster at the British Society of Cardiovascular Imaging meeting in Cambridge and at the European Society of Cardiovascular Radiology in Antwerp.

These abstracts have been published in Heart (Heart 2019;105:A1) and in the International Journal of Cardiovascular Imaging (Int J Cardiovasc Imaging 2019:1573-0743).

We plan to submit our research to a peer reviewed journal for publication.

CONCLUSION

We have successfully developed a protocol to assess the coronary arteries using combined USPIO and 18-F sodium fluoride PET-MRI. This protocol could now be used to assess patients with coronary artery disease in research studies assessing new treatments which require multiple imaging assessments.

RESEARCH TEAM & CONTACT

Dr Michelle Williams

University of Edinburgh

Chancellors Building

Michelle.williams@ed.ac.uk

01312426515

Additional Information
Funding received £20000.