Research Highlights

Highlights from the latest articles on cardiac nuclear imaging

Coronary artery inflammation imaging

Evaluation of: Cheng VY, Slomka PJ, Le Meunier L *et al.* Coronary arterial ^{18}F-FDG uptake by fusion of PET and coronary CT angiography at sites of percutaneous stenting for acute myocardial infarction and stable coronary artery disease. *J. Nucl. Med.* 53, 1–9 (2012).

Increased ^{18}F-FDG uptake due to inflammation in carotid artery lesions has been shown to predict vulnerable plaques. However, it is difficult to identify increased FDG uptake in coronary arteries due to the small size of coronary arteries, motion of the heart and the presence of high physiologic cardiac FDG uptake. Using recently placed metallic coronary artery stents as a landmark to ensure proper fusion of PET/CT and CT angiography images obtained on different devices, the authors assessed the presence of FDG uptake at the sites of culprit lesions in 27 patients post-percutaneous stenting. Twenty patients had acute myocardial infarction (AMI) and seven had stable coronary artery disease. Cardiac FDG activity suppression was attempted with a low carbohydrate meal the night before, fasting for more than 12 h and injection of heparin when possible. FDG PET/CT studies were gated. Maximum target-to-background ratio (max TBR) was calculated based on the FDG uptake in the culprit lesion at the site of the stent compared with the average uptake in four regions of interest within the left atrial cavity. Twelve out of 20 (60%) patients with AMI had a max TBR >2.0, compared with one out of seven (14%) in patients with stable coronary artery disease. Adequately suppressing physiologic cardiac FDG uptake was difficult to achieve with eight out of twenty AMI and three out of seven stable coronary artery disease patients showing high radiotracer activity in the heart. In the small number of patients included in this pilot study, the authors demonstrated the feasibility of reproducible cardiac fusion and of the evaluation of small coronary arteries despite coronary motion. However, eight out of twenty patients in the post-AMI group did not have a max TBR >2.0. They probably represent a relatively large group of patients who theoretically may have unidentified inflammatory high-risk lesions, a significant limitation of FDG PET/CT for coronary plaque evaluation. Further studies will also have to address the feasibility of methods to fuse images without the aid of the stent as a landmark in order to permit the evaluation of high-risk lesions prior to clinical events.

In vivo imaging of pathogenesis of aortic stenosis

Evaluation of: Dweck MR, Jones C, Joshi NV *et al.* Assessment of valvular calcification and inflammation by positron emission tomography in patients with aortic stenosis. *Circulation* 125, 76–86 (2012).

A number of PET radiotracers are available today for clinical and experimental indications. Using PET/CT, they offer the possibility of studying *in vivo* biological processes. ^{18}F-FDG accumulates in inflammatory processes while ^{18}F-sodium fluoride (NaF), primarily a bone-scanning agent, can be used to assess the presence

Gad Abikhzer*[1] & Ora Israel[1,2]

[1]*Department of Nuclear Medicine, Rambam Healthcare Campus, 6 Ha'Aliya Street, Haifa, 31096, Israel*
[2]*B&R Rappaport School of Medicine, Technion, Israel Institute of Technology, Haifa, Israel*
**Author for correspondence:*
Tel.: +972 4 8543009
gad101@hotmail.com

Financial & competing interests disclosure

G Abikhzer is a clinical and research fellow supported by the Azrieli foundation and the Dr Dov Front scholarship fund of the Rambam Fund for R&D. The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

No writing assistance was utilized in the production of this manuscript.

Future Medicine part of fsg

of calcifications in atherosclerotic plaques. The authors of this study used both agents in an attempt to understand the pathophysiology of aortic valve stenosis. A study population of 121 subjects including controls, patients with aortic sclerosis and with mild, moderate and severe aortic stenosis was recruited. PET/CT studies were processed using multiplanar reconstruction to view the aortic valve in its true axis. Tracer uptake, measured by mean and maximal standardized uptake value was used to derive TBR. Focal NaF uptake was observed in areas of CT-evident valvular calcifications, as well as in the absence of visible calcium deposits. On the other hand, areas of established calcifications did not always demonstrate NaF uptake. Patients with aortic sclerosis and stenosis had higher TBR for NaF than controls, with increasing ratios correlating with disease severity. Similar results were observed with FDG, although the proportion of patients with increased FDG activity in severe aortic stenosis (54%) was significantly lower than the 100% of cases in the same group with increased NaF uptake. Calcification appears to be the predominant pathological process in the development of aortic stenosis. NaF uptake on PET/CT can, therefore, potentially be used to identify disease pathogenesis, to define appropriate therapeutic strategies to inhibit valvular calcification and to monitor and assess the effectiveness of therapeutic interventions.

Downstream resource utilization following hybrid cadmium–zinc–telluride/CT angiography cardiac imaging

Evaluation of: Fiechter M, Ghadri J, Wolfrum M *et al.* Downstream resource utilization following hybrid cardiac imaging with an integrated cadmium–zinc–telluride/64-slice CT device. *Eur. J. Nucl. Med. Mol. Imaging* 39, 430–436 (2012).

Diagnostic coronary angiography is an invasive and relatively costly procedure. Noninvasive cardiac imaging can serve as a gatekeeper for coronary angiography, optimizing selection of patients who need a therapeutic intervention. Coronary CT angiography (CTA) provides a noninvasive technique to anatomically assess coronary arteries, with high sensitivity to detect coronary artery stenosis. However, the hemodynamic significance of coronary lesions may be overestimated by CTA when plaques are calcified. Myocardial perfusion imaging (MPI) assesses the functional significance of coronary obstruction through the detection of ischemia. The novel hybrid cadmium–zinc–telluride SPECT/CTA device used in this study allows the acquisition of both modalities in a single imaging session. The authors evaluated whether results of the hybrid MPI/CTA would lead to a decrease in the number and type of invasive procedures and subsequent reduced downstream costs. Sixty two patients who underwent single session MPI-SPECT/CTA were included in the study. Hybrid imaging results were classified as matched findings when perfusion defects were at the site of a coronary artery stenosis territory. Patients with normal results or with findings on only one of the two modalities were grouped in the 'no match' category. There were 26 patients with reversible MPI findings, and three with normal CTA results. On the other hand, there were 17 patients with coronary stenosis of >50% on CTA with no evidence of ischemia on MPI. All 23 patients with matched findings proceeded to invasive coronary angiography, with 21 (91%) of these undergoing a revascularization procedure. Only five of the 39 patients within the no match group underwent invasive angiography, with only three (8%) undergoing a revascularization procedure. These results were statistically significant. This study demonstrates the importance of noninvasive hybrid cardiac imaging as a gatekeeper prior to invasive coronary angiography, increasing the yield of this procedure. Routine use of such algorithms is expected to lead to decreased morbidity and mortality related to invasive procedures and reduced overall healthcare costs. A major limitation of this study, which unfortunately was not addressed, is the specific fact that the authors did not perform a comparative analysis of the downstream resource utilization and cost-effectiveness had MPI and CTA been performed separately. SPECT/CTA has, however, the potential to become a gatekeeper for invasive coronary angiography representing the most cost–effective diagnostic procedure for patients with significant coronary artery disease.

Low-dose, rapid 201-thallium cardiac imaging

Evaluation of: Songy B, Guernou M, Lussato D *et al.* Low-dose thallium-201 protocol with a cadmium–zinc–telluride cardiac camera. *Nucl. Med. Commun.* 33, 464–469 (2012).

Cardiac SPECT imaging has undergone a facelift following the recent development of novel cadmium zinc telluride (CZT)-based cameras characterized by increased sensitivity, as well as spatial, temporal and contrast resolution. 201-thallium (^{201}Tl), a commonly used cardiac imaging radiotracer in the 1970s and 1980s, was mostly replaced by ^{99m}Tc-MIBI and tetrofosmin since the 1990s. Although ^{201}Tl has superior physiological properties as a cardiac imaging agent, the Tc-based tracers had better imaging characteristics and delivered lower radiation

dose. ^{201}Tl has stirred renewed interest following the generator-based isotope crisis that affected ^{99m}Tc. CZT cameras can theoretically overcome at least some of the limitations of ^{201}Tl imaging. The high sensitivity permits a reduction of the injected dose, and therefore of radiation exposure. One hundred and thirty seven patients who had previously undergone stress ^{201}Tl myocardial perfusion imaging (MPI) with conventional SPECT cameras (CC) were recruited in this study by Songy *et al.* The CC imaging protocol consisted of post-stress 111–148 MBq (3–4 mCi) ^{201}Tl injection followed by imaging in the prone position, with the use of supine imaging only when a breast attenuation artifact was suspected. When post-stress images were abnormal, redistribution images were obtained 4–6 h later following the reinjection of an additional 37 MBq (1 mCi). The CZT imaging protocol was similar, except that the injected dose was weight-based at 1.1 MBq (28 μCi/kg). This resulted in 30% lower injected activities for an average of 88 MBq (2.38 mCi) ^{201}Tl. Despite the lower administered radionuclide dose and a 54% decrease in camera acquisition time (13 vs 6 min for CC and CZT, respectively), myocardial counts increased twofold, image quality was better for CZT in 69% of the cases and the incidence of artifacts decreased (59 vs 29 artifacts for CC and CZT, respectively). The authors calculated a 97% diagnostic agreement between the cameras in 115 of the 137 patients who did not have any significant interval clinical or angiographic changes between the scans. The large interval of 22 months (range: 4–60 months) between the scans represents a significant limitation of this study, acknowledged by the authors, together with the absence of a gold standard to ensure proper diagnostic accuracy of the low-dose ^{201}Tl MPI results. In addition, prone-only imaging is not routinely used in MPI, although this and other centers report comparable results compared with supine-only imaging. However, in line with other studies showing the feasibility and comparable accuracy of low dose and reduced imaging time ^{99m}Tc-MIBI and tetrofosmin CZT protocols, this study shows that similar MPI protocols with ^{201}Tl can and should also be used. Together with other studies that have described rapid dual isotope (^{99m}Tc and ^{201}Tl) protocols, present results encourage a return to the use of ^{201}Tl MPI.