Cardiac magnetic resonance imaging: the new reference method for infarct characterization and prognostication after myocardial infarction?

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Online publish-ahead-of-print 14 November 2013

Introduction

Nuclear cardiology laboratories provide diagnostic services as part of standard care in many hospitals worldwide. In 2008, a world-wide survey of nuclear cardiology procedures was reported by the Working Group on Nuclear Cardiology for the International Atomic Energy Agency.1 High nuclear cardiology utilization (>1000 procedures/100 000 population) was reported in the USA, Canada, and Israel, and moderate-high utilization (250–999 procedures/100 000) was reported in most Western European countries, Australia, and Japan. Lower utilization rates were reported in other countries in all continents globally (Figure 1).1

Historically, in many hospitals, radionuclide testing has been the reference diagnostic method for the assessment of infarct size, myocardial viability, and ischaemia after acute myocardial infarction (MI).1–3 In contrast to North American guideline recommendations (see Supplementary data online, Table S1),2,3 recent European guidelines for the management of patients with ST elevation myocardial infarction (STEMI) accord radionuclide testing a more restricted indication and alternative diagnostic modalities have greater prominence.4 The evidence-base for imaging infarct size with Tc99m-Sestamibi-SPECT2,3,5 and late gadolinium enhancement cardiac magnetic resonance (CMR)4,6 are well established. However, the comparative diagnostic accuracy and prognostic significance of infarct size measured by SPECT and CMR are uncertain.

Our commentary is stimulated by the publication by Hadamitzky et al.6 who retrospectively analysed 281 acute STEMI patients treated by primary angioplasty who had undergone both Tc99m-Sestamibi-SPECT and CMR on a 1.5 T scanner at a median 5.0 (IQR 4.1–5.9) days post-MI. In multivariable analyses, the strongest predictor for the primary outcome was microvascular obstruction (P < 0.0001), followed by infarct size by CMR (P = 0.0043) and infarct size by SPECT (P = 0.012) (all P-values corrected for clinical risk). However, in a multivariate model including clinical and peri-procedural parameters, microvascular obstruction was the only significant predictor in addition to clinical risk as measured by the GRACE score. In addition to the authors three main conclusions,7 we would add a fourth. Given the prognostic importance of microvascular obstruction revealed by CMR, over-and-above infarct size, CMR has superior diagnostic utility over SPECT for prognostication post-MI.

Infarct size varied according to the method of analysis. Compared with SPECT, infarct size with CMR was greater when a × 4 SD threshold was used to discriminate infarct tissue from non-infarct tissue, whereas the amount of infarct size was smaller vs. SPECT when × 5 SD, × 6 SD, or ‘full-width half maximum’ methods were used. Clearly, technical factors underlie these differences. On the one hand, smaller MIs may be missed with SPECT due to limited spatial resolution. On the other hand, with CMR, viable oedematous tissue may be included in the infarct area when a less restrictive approach to CMR image analysis (e.g. × 2 SD) is used. In fact, the size of infarction as revealed by late gadolinium enhancement within the first week post-MI may over-estimate actual infarct size compared with when infarct size is re-assessed 6 months later.8 Therefore, the timing of the scan post-MI and the approach to infarct size measurement should be standardized.

Hadamitzky et al.6 also observed that infarct size by CMR using the 6 SD threshold had a stronger relationship with clinical outcomes compared with infarct size by other CMR methods or SPECT. The superior correlation between late enhancement at higher thresholds and health outcomes may be explained by the fact that the restrictive approach provides a more accurate assessment of actual (final) infarct size. This study’s results support the adoption of ×5 to ×6 SD difference in infarct zone signal intensity vs. mean signal intensity of the remote zone.

Hadamitzky’s study has several important and obvious limitations, but these limitations do not outweigh the originality of the data and importance of the paper. Instead, the reader should understand the limitations of the paper and interpret its results accordingly. The limitations are the retrospective nature of the analysis, the selection of...
patients from clinical trials (which may explain the small median infarct size and low event rates), the slight discordance in time from admission for each test modality (CMR was performed 0.4 days later than SPECT), the exclusion of potentially higher-risk patients with contra-indications to CMR (e.g. renal dysfunction, creatinine clearance <50 mL/min), and incomplete enrolment since only 281 STEMI patients of 1294 STEMI admissions in the two participating hospitals were included in the final analysis. The strengths of the data set are firstly, it uniquely involves SPECT and CMR in a reasonably large cohort of STEMI patients, and such data are unlikely to ever be obtained again in the future. The only other study that describes SPECT and CMR modalities in STEMI patients involved 16 patients.9 Also, the imaging physicians were blinded to the adverse events for the primary outcome, implying ascertainment bias was minimized. Finally, the cardiovascular events in the primary outcome were ‘spontaneous’ and the composite outcome did not include either revascularization or unstable angina, both of which are susceptible to bias.

Staff and patient exposure to ionizing radiation has public health importance, which should influence and where appropriate, constrain the provision of medical imaging procedures. The European Union Radioprotection Directive (97/43) states in Article 3 that ‘existing types of practices involving medical exposure (to ionising radiation) may be reviewed whenever new, important evidence about their efficacy or consequences is acquired’.10

In line with this directive, we believe that diagnostic tests should not involve ionizing radiation where an appropriate alternative exists. In the post-MI setting, clinical guidelines place emphasis on echocardiography as the standard care test for left ventricular function,3,4 whereas CMR is the only method which can delineate a broad range of prognostically important infarct characteristics, including infarct size, oedema, microvascular obstruction, and myocardial haemorrhage.11 For myocardial viability and ischaemia, compared with SPECT, both stress echocardiography and stress CMR are alternatives that do not involve ionizing radiation exposure.

In conclusion, healthcare providers that undertake radionuclide testing for the measurement of infarct size post-MI and prognostication should reconsider this practice in light of the new information reported by Hadamitzky et al.7 We conclude that CMR now represents the reference method for post-MI prognostication. Whether or not CMR can be used for this purpose in routine clinical practice depends on a range of factors, including cost and feasibility.

Supplementary data

Supplementary data are available at European Journal of Echocardiography online.

Conflict of interest: none declared.

Funding

This research was supported by a grant from the Chief Scientist Office, Scottish Health Department. C.B. was supported by a Senior Fellowship from the Scottish Funding Council, and holds project grants from Medical Research Scotland and the British Heart Foundation Project Grant (PG/11/2/28474).

References

The missing aortic prosthesis: an unusual case of pseudo-aortic regurgitation

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A 33-year-old woman with a history of multiple aortic valve replacements for infective endocarditis was referred to our institution for presumed vegetations of her aortic prosthesis and aortic root abscess. Transthoracic echocardiography performed shortly after her arrival showed a large pseudo-aneurysm and a mobile echodensity (arrow) at the aortic annulus with regurgitant flow filling the entire left ventricular outflow tract (LVOT) in diastole (Panels A and B, Supplementary data online, Movies S1 and S2). The continuous wave Doppler signal at the LVOT showed a short pressure half-time of 125 ms (Panel C). These findings mimicked a destroyed aortic prosthesis with severe regurgitation. However, the low peak velocity (2.2 m/s) of the regurgitant jet and normal mitral valve opening demonstrated by M-mode imaging (Panel D) argued against severe aortic regurgitation. The colour jet was in fact regurgitation from the pseudo-aneurysm into the aortic root (Panels E and F, Supplementary data online, Movie S3), while the aortic prosthesis was not visualized. Subsequent trans-oesophageal echocardiography revealed a normally functioning mechanical aortic prosthesis 3 cm above the aortic annulus with only trivial aortic regurgitation (Panels G and H, Supplementary data online, Movie S4). This unique case demonstrates the unusual supra-annular position of a mechanical aortic prostheses and pseudo-aortic regurgitation due to communication between a pseudo-aneurysm and the aortic root. It also highlights the importance of integrating 3D, Doppler, and M-mode findings for a correct echocardiographic diagnosis, as well as the value of utilizing multimodality imaging in delineating complex cardiac anatomy. Ao, aorta; PsA, pseudo-aneurysm; LA, left atrium; LV, left ventricle; PHT, pressure half-time.

Supplementary data are available at European Heart Journal – Cardiovascular Imaging online.