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SHORT COMMUNICATION

MRI and cardiac pacing devices — beware the rules are changing

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We have been following the development of MRI-compatible cardiac permanent pacemakers (PPM) with great interest. Recently, we have been asked to perform clinical MRI studies in patients with a MRI-compatible PPM. We would like to share our experience in performing one such study and highlight important safety measures that radiologists should undertake prior to imaging.

Conventional PPM has always been regarded as an absolute contraindication for MRI. This has prevented a large number of patients from undergoing clinically important MRI studies. MRI-compatible PPM is now available for clinical use following a prospective randomised controlled unblinded multicenter study, involving 464 patients [1, 2]. Our first patient had an Advisa DR MRI SureScan (Medtronic, Minneapolis, MN) system, which is one of the most widely used MRI-compatible systems. These devices have been designed to minimise thermal damage and limit induced voltages preventing unintended stimulation of the heart.

Performing an MRI study in these patients requires robust preparation and liaison between physicist, radiographer, electrophysiology technicians, consultant radiologist and referring clinician. Informed consent should be obtained from the patient after discussing the benefits of the MRI study and potential complications. The following radiology specific pre-requisites should be fulfilled and adhered to and these may change depending on the manufacturer of the device:

- Cylindrical bore, clinical MR systems with a static magnetic field of 1.5 T.
- Gradient systems with maximum gradient slew rate performance per axis of $\leq$200 T m^{-1}per second.
- Whole body averaged specific absorption rate (SAR) must be $\leq$2 W kg^{-1} and for head $<$3.2 W kg^{-1}.
- Implant must consist of an MRI-compatible device as well as the lead. Any other leads or broken leads remain a contraindication.
- The pacing system should be implanted in either the right or left pectoral region and should have been in place for more than 6 weeks.
- The patient should not be positioned on his or her side within the scanner.
- Local transmit/receive coils should not be placed over the pacing system.

Prior to taking the patient into the scanner the PPM is programmed to MRI safe mode by electrophysiologists outside the MR safety zone. Once in the scanner, continuous monitoring using electrocardiography (ECG), pulse oximetry and blood pressure is essential. External defibrillator must be readily available and the procedure should be abandoned if patient's haemodynamic function is compromised. After completing the scan, the PPM is turned back on to normal mode and the correct pacing capture threshold is ensured prior to discharging the patient.

Our patient was a young man who underwent a cardiac MRI study for cardiomyopathy. He was involved in discussions regarding the safety of the procedure and consented prior to the study. He was extremely anxious when he went into the scanner, but relaxed as the procedure went on. He did not experience any untoward sensations or arrhythmia during the 40 min study. Standard TrueFISP (true fast imaging with steady state precession) images were degraded owing to artefacts from the leads; this was rectified by switching over to FLASH (fast low angle shot) cine images (Figure 1). Overall the image quality was good.

We foresee that more patients will undergo MRI scanning with compatible cardiac pacing systems. Currently there is limited evidence regarding its safety and long-term effects. We, therefore, profess extreme prudence and a multidisciplinary approach prior to scanning a patient with an MRI-compatible pacemaker.

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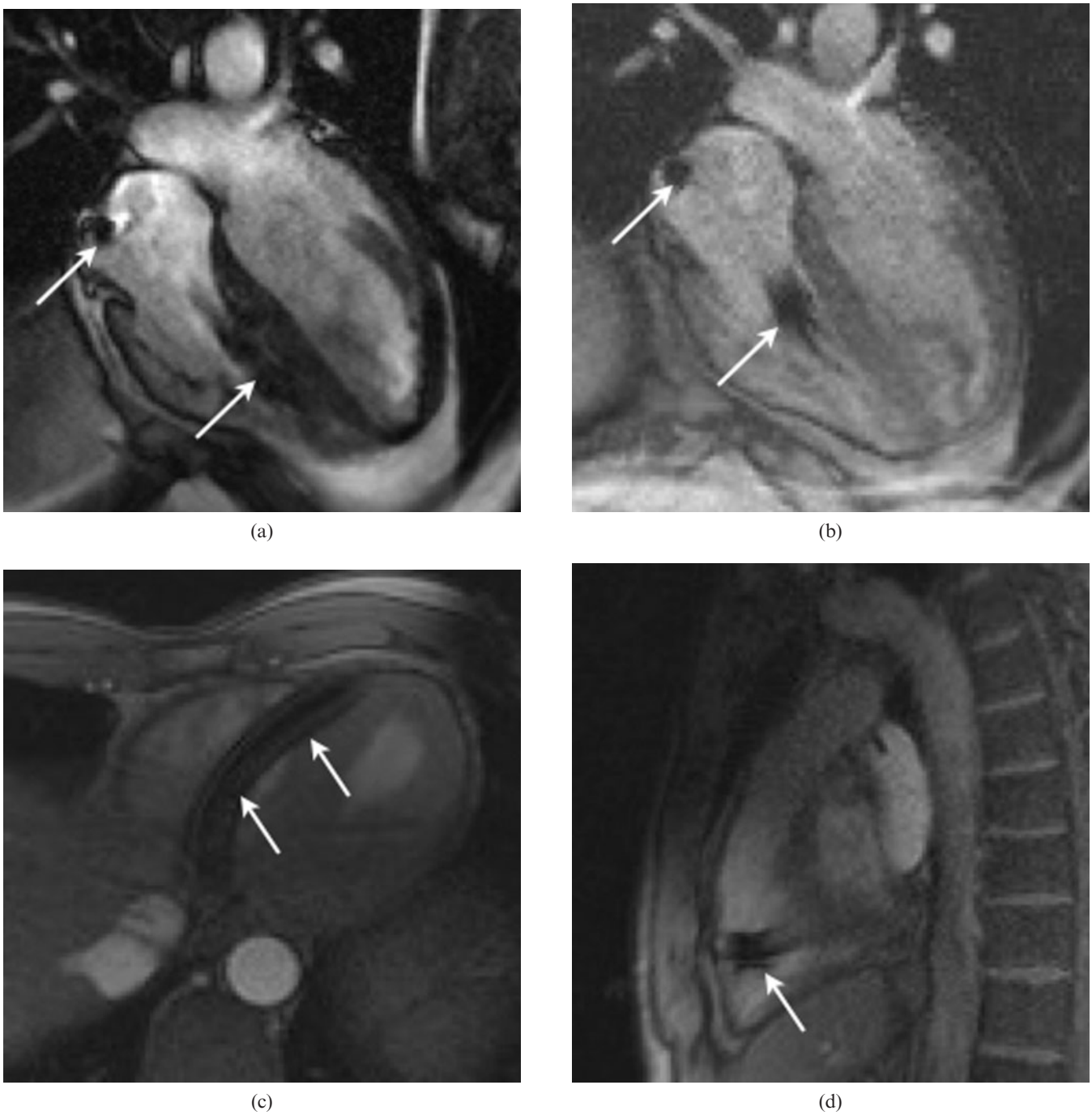

Figure 1. Cardiac MRI in standard planes in (a) TrueFISP (true fast imaging with steady state precession) and (b–d) FLASH (fast low angle shot) sequences. Note the clear delineation of the pacing leads (arrow) on the latter sequence with no significant artefacts compared with image (a).

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