All CIEDs are MRI safe - antagonist

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Disclosures: speakers fees for Abbott, BSC, Biosense, Medtronic
All CIEDs are MRI safe

“All” - used to refer to the whole quantity or extent of a particular group or thing
An area of expertise

Permanent pacemaker implantation technique: part I
Kim Rajappan

Permanent pacemaker implantation technique: part II
Kim Rajappan
An area of expertise

Assessment of left ventricular mass regression after aortic valve replacement – cardiovascular magnetic resonance versus M-mode echocardiography

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Measurement of Ventricular Volumes and Function: A Comparison of Gated PET and Cardiovascular Magnetic Resonance

Kim Rajappan, MBBS; Lefteris Livieratos, MSc; Paolo G. Camici, MD; and Dudley J. Pennell, MD

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Comparison of Techniques for the Measurement of Left Ventricular Function Following Cardiac Transplantation

Nicholas G. Bellenger, Neil J. Marcus, Kim Rajappan, Magdi Yacoub, Nicholas R. Banner, and Dudley J. Pennell

Is it an issue?

- **Pacemaker**
  - 0.32% of traditional pacemaker patients get an MRI annually vs. 15% of non-pacemaker patients
  - Patient cohorts were matched so both represent a group of patients with the same factors: 1) Gender, 2) Age, 3) Major comorbidities

- **ICD**
  - 0.57% of traditional ICD patients get an MRI annually vs. 12% of non-ICD patients
  - Patient cohorts were matched so both represent a group of patients with the same factors: 1) Gender, 2) Age, 3) Major comorbidities

- **CRT-D**
  - 0.43% of traditional CRT-D patients get an MRI annually vs. 16% of non-CRT patients
  - Data from 2012 were used to project MRI utilization in the CRT patient cohort over 1 year; whereas the actual MRI utilization rate over 1 year was measured in the non-CRT cohort.
What are the risks?

- Device malfunction (change in programming, damage to hardware permanently disabling or changing normal function, lead dislodgement)
- Heating (RF energy via lead at device tissue interface, tissue injury, perforation, sensing/threshold issues)
- Noise (creation of EMI that will affect CIED function while it is present)
<table>
<thead>
<tr>
<th>Problem</th>
<th>Problem Description</th>
<th>Suggested Measures to Prevent Problem</th>
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<tbody>
<tr>
<td>A</td>
<td>Movement of pulse generator or dislodgment of leads</td>
<td>Perform examination at least 6 weeks after device implantation</td>
</tr>
<tr>
<td>B</td>
<td>Damage to heart tissue caused by lead tip heating</td>
<td>Theoretical problem – does not exist in clinical practice</td>
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| C       | Changes in device function or programming during the examination | 1. Device checking before the examination and performance of adequate programming  
          |                                                 | 2. Use of an MRI-conditional device                                                                  |
| D       | Detection of false electric signals by the device  | 1. Adequate programming of the device before the examination  
          |                                                 | 2. Use of an MRI-conditional device                                                                  
          |                                                 | 3. Continuous monitoring during the examination                                                      |
| A–D     |                                                | Perform the examination only if deemed necessary and it provides information that cannot be obtained by other means |

CIED indicates cardiac implantable electronic device.
Does the MRI exam provide information crucial to patient management that can not be obtained by another imaging modality?

- **No**
  - Do not perform an MRI exam. May proceed with a different imaging modality.

- **Yes**
  - Have at least six weeks elapsed since device implantation?
    - **No**
      - Do not perform an MRI exam. Can wait until six weeks have elapsed or use a different imaging modality.
    - **Yes**
      - Before the exam - device checked by trained personnel to ensure its proper function and to allow proper programming that minimizes potential interferences during the exam.

- During the exam:
  - both personnel and equipment for cardiac resuscitation should be readily available.
  - continuous monitoring (ECG, pulse oximeter, blood pressure, verbal communication).
  - the exam should be stopped immediately if:
    - the patient has any complaints that might be referred to the device.
    - an abnormal cardiac rhythm is detected.

- After the exam:
  - the device should be checked by trained personnel in order to verify its proper function and, in case any changes were made prior to the exam, to reprogram it to the original settings.
  - preferably - perform another check of the device several weeks following the exam to ensure its proper function.
Safety of Magnetic Resonance Imaging in Patients with Cardiac Devices

Saman Nazarian, M.D., Ph.D., Rozann Hansford, R.N., M.P.H.,
Amir A. Rahsepar, M.D., Valeria Weltin, M.S., Diana McVeigh, B.S.,
Esra Gucuk Ipek, M.D., Alan Kwan, M.D., Ronald D. Berger, M.D., Ph.D.,
Hugh Calkins, M.D., Albert C. Lardo, Ph.D., Michael A. Kraut, M.D., Ph.D.,
Ihab R. Kamel, M.D., Ph.D., Stefan L. Zimmerman, M.D.,
and Henry R. Halperin, M.D.
We performed a prospective, nonrandomized study to assess the safety of MRI at a magnetic field strength of 1.5 Tesla in 1509 patients who had a pacemaker (58%) or an implantable cardioverter–defibrillator (42%) that was not considered to be MRI-conditional (termed a “legacy” device). Overall, the patients underwent 2103 thoracic and nonthoracic MRI examinations that were deemed to be clinically necessary. The pacing mode was changed to asynchronous mode for pacing-dependent patients and to demand mode for other patients. Tachyarrhythmia functions were disabled. Outcome assessments included adverse events and changes in the variables that indicate lead and generator function and interaction with surrounding tissue (device parameters).
We evaluated the safety of MRI, performed with the use of a prespecified safety protocol, in 1509 patients who had a legacy pacemaker or a legacy implantable cardioverter-defibrillator system. No long-term clinically significant adverse events were reported. (Funded by Johns Hopkins University and the National Institutes of Health; ClinicalTrials.gov number, NCT01130896.)
No long-term clinically significant adverse events were reported. In nine MRI examinations (0.4%; 95% confidence interval, 0.2 to 0.7), the patient’s device reset to a backup mode. The reset was transient in eight of the nine examinations. In one case, a pacemaker with less than 1 month left of battery life reset to ventricular inhibited pacing and could not be reprogrammed; the device was subsequently replaced. The most common notable change in device parameters (>50% change from baseline) immediately after MRI was a decrease in P-wave amplitude, which occurred in 1% of the patients. At long-term follow-up (results of which were available for 63% of the patients), the most common notable changes from baseline were decreases in P-wave amplitude (in 4% of the patients), increases in atrial capture threshold (4%), increases in right ventricular capture threshold (4%), and increases in left ventricular capture threshold (3%). The observed changes in lead parameters were not clinically significant and did not require device revision or reprogramming.
No long-term clinically significant adverse events were reported. In nine MRI examinations (0.4%; 95% confidence interval, 0.2 to 0.7), the patient’s device reset to a backup mode. The reset was transient in eight of the nine examinations. In one case, a pacemaker with less than 1 month left of battery life reset to ventricular inhibited pacing and could not be reprogrammed; the device was subsequently replaced. The most common notable change in device parameters (>50% change from baseline) immediately after MRI was a decrease in P-wave amplitude, which occurred in 1% of the patients. At long-term follow-up (results of which were available for 63% of the patients), the most common notable changes from baseline were decreases in P-wave amplitude (in 4% of the patients), increases in atrial capture threshold (4%), increases in right ventricular capture threshold (4%), and increases in left ventricular capture threshold (3%). The observed changes in lead parameters were not clinically significant and did not require device revision or reprogramming.
10th August 2018

To: Whom it may concern

Re: MRI for patients with pacemakers and implantable cardioverter-defibrillators – MRI-conditional and legacy devices
The British Cardiovascular Society and the Clinical Imaging Board (the Society and College of Radiographers, the Institute of Physicians and Engineering in Medicine, and the Royal College of Radiologists) jointly believe that patients with cardiac devices should no longer be disadvantaged and have the same access to MRI scanning in the NHS as everyone else. Addressing this will require local champions, new working practices (clinical, financial), and partnerships – especially between cardiology and radiology and medical physics departments. But there are no fundamental barriers - we as a community are capable of making this happen. We encourage you to help make this a reality in the NHS.

Dr Nicola H Strickland BM BCh MA Hons (Oxon) FRCP FRCR
President, Royal College of Radiology
On behalf of the Clinical Imaging Board

Professor Simon Ray, BSc MD FRCP FACC FESC
President British Cardiovascular Society
The British Cardiovascular Society and the Clinical Imaging Board (the Society and College of Radiographers, the Institute of Physicians and Engineering in Medicine, and the Royal College of Radiologists) jointly believe that patients with cardiac devices should no longer be disadvantaged and have the same access to MRI scanning in the NHS as everyone else. Addressing this will require local champions, new working practices (clinical, financial), and partnerships – especially between cardiology and radiology and medical physics departments. But there are no fundamental barriers - we as a community are capable of making this happen. We encourage you to help make this a reality in the NHS.

Dr Nicola H Sipe, BSc, MB BS, MA Hons, FRCP, FRCR
President, Royal College of Radiologists
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(Oxon) FRCP FRCR
President, Royal College of Radiology
On behalf of the Clinical Imaging Board

Professor Simon Ray, BSc MD FRCP FACC FESC
President British Cardiovascular Society
2017 HRS expert consensus statement on magnetic resonance imaging and radiation exposure in patients with cardiovascular implantable electronic devices
<table>
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<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendations</th>
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<tbody>
<tr>
<td>IIa</td>
<td>B-NR</td>
<td>It is reasonable for patients with an MR nonconditional CIED system to undergo MR imaging if there are no fractured, epicardial, or abandoned leads; the MRI is the best test for the condition; and there is an institutional protocol and a designated responsible MR physician and CIED physician.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It is reasonable to perform an MR scan immediately after implantation of a lead or generator of an MR nonconditional CIED system if clinically warranted.</td>
</tr>
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</table>

**CLASS IIa (MODERATE)**

Suggested phrases for writing recommendations:
- Is reasonable
- Can be useful/effective/beneficial
- Comparative-Effectiveness Phrases‡:
  - Treatment/strategy A is probably recommended/indicated in preference to treatment B
  - It is reasonable to choose treatment A over treatment B

**LEVEL B-NR**

- Moderate-quality evidence‡ from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies
- Meta-analyses of such studies
Review

Safe use of MRI in people with cardiac implantable electronic devices

Martin D Lowe¹, Christopher J Plummer², Charlotte H Manisty³, Nicholas J Linker⁴

Author affiliations +

Abstract

MR scanning in patients with cardiac implantable electronic devices (CIEDs) was formerly felt to be contraindicated, but an increasing number of patients have an implanted MR conditional device, allowing them to safely undergo MR scanning, provided the manufacturer's guidance is adhered to. In addition, some patients with non-MR conditional devices may undergo MR scanning if no other imaging modality is deemed suitable and there is a clear clinical indication for scanning which outweighs the potential risk. The following guidance has been formulated by the British Heart Rhythm Society and endorsed by the British Cardiovascular Society and others. It describes protocols that should be followed for patients with CIEDs undergoing MR scanning. The recommendations, principles and conclusions are supported by the Royal College of Radiologists.

http://dx.doi.org/10.1136/heartjnl-2015-308495
Safe use of MRI in people with cardiac implantable electronic devices

Introduction

In addition, some patients with non-MR-conditional devices may undergo MR scanning which outweighs the potential risks. The following guidance is deemed suitable by the British Heart Rhythm Society and endorsed by the British Cardiovascular Society for the use of MRI in patients with cardiac implantable electronic devices and provides a clear clinical indication for scanning which outweighs the potential risks. Some patients with non-MR-conditional devices may undergo MR scanning. The scanning may not be contraindicated, but an imaging modality should be considered for patients with CIEDs. The manufacturer's guidance is adhered to.
Dr Charlotte Manisty is a Senior Lecturer at University College London and a Consultant Cardiologist at the Barts Heart Centre and University College Hospitals, London. She specialises in heart failure and cardiac imaging, and has set up and leads the cardio-oncology service at Barts. She trained in cardiac device implantation and has current IBHRE Device accreditation, and leads the MRI imaging service for device patients at Barts and Chenies Mews Imaging Centre. She has co-written the national recommendations for MRI imaging in patients with implantable cardiac devices, and is currently performing research into optimizing scar localization in patients with ventricular arrhythmias.
How do I know if my device can undergo MRI?

At the time of implant, your team should tell you if you can have an MRI scan, based on your pacemaker design. Some pacemakers are easy to scan — they have been built for MRI. If this is the case, your device is “MRI conditional”. Older pacemaker or cardiac defibrillators may not have tested in an MRI environment (“legacy” devices), but they can still be scanned in the majority of cases with careful procedures, if the scan is necessary.

Dr Charlotte Manisty

Cardiologist at the Barts Heart Centre and University College Hospitals, London. She specialises in heart failure and cardiac imaging, and has set up and leads the cardio-oncology service at Barts. She trained in cardiac device implantation and has current IBHRE Device accreditation, and leads the MRI imaging service for device patients at Barts and Chenies Mews Imaging Centre. She has co-written the national recommendations for MRI imaging in patients with implantable cardiac devices, and is currently performing research into optimizing scar localization in patients with ventricular arrhythmias.
Vote against (but please don’t deny your CIED patients from a discussion about MRI)