Standard care pathway to perform MRI in patients implanted with Pacemaker or ICD

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Disclosure

None

- The rate of cardiac electronic implantable device (CEID) implantation is increasing every year

- MRI has become the reference imaging for the management of a large number of pathology.

Bradshaw Trends in the incidence and prevalence of cardiac pacemaker insertions in an ageing population. Open Heart 2014
OECD (2019), Magnetic resonance imaging (MRI) exams (indicator).

MR-nonconditional devices	MR-conditional devices under specific conditions
• Magnetic induced force and torque (generator) • Gradient Magnetic field induced electrical current → oversensing, myocardial rapid capture, arrhythmias • Transmission of RF field: tissue heating and damage, arrhythmias, change in capture or sensing thresholds • Oversensing→ pacing inhibition/inappropriate ICD therapy • Reset mode and emergency mode (usually VVI with risk of pacing inhibition by pulsed MR fields) • Reed switch → asynchronous pacing/inhibition of tachycardia detection • Battery depletion • Ventricular arrhythmia induced by asynchronous pacing mode (DOO/VOO) • Acute bradycardia in ODO/OOO mode • Inactivation of ICD therapy: absence of VT/VF treatment	• Oversensing → pacing inhibition/inappropriate ICD therapy • Ventricular arrhythmia induced by asynchronous pacing mode (DOO, VOO) • Acute bradycardia in ODO/OOO mode • Inactivation of ICD therapy: absence of VT/VF treatment

For a long time, the presence of a CEID has been considered an absolute contra-indication for MRI

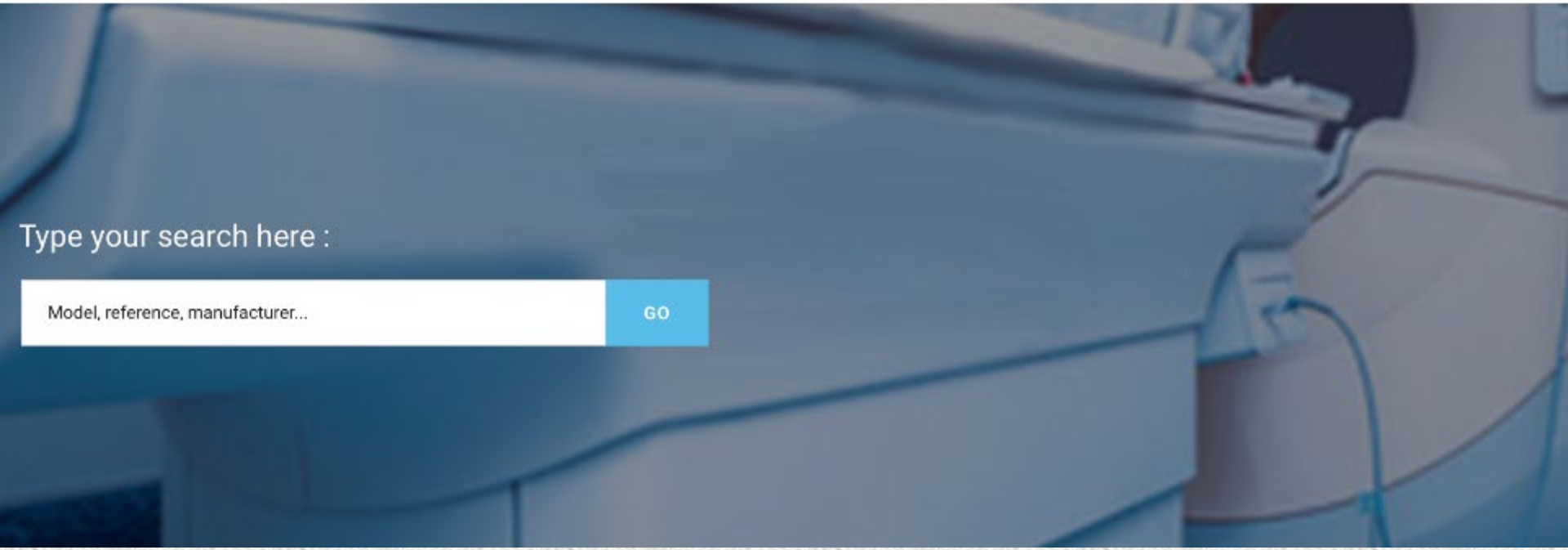
2 major evolutions have changed this paradigm

MRI-conditional systems

- MR conditional system refers to both CIED generator and leads approved by the manufacturer

- The updated list of “MR-conditional” CEID is provided at the website www.irm-compatibilite.com

created with the support of the Working Group of Pacing and Electrophysiology of the French Society of Cardiology



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Model, reference, manufacturer... GO

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ADVISA MRI (A3DR01, A3SR01, A2DR01)

Field strength 1,5T full body
3T full body

Exclusion zone No exclusion zone

Specific conditions In combination with Medtronic/Vitatron MRI compatible leads

Last update Monday, 30 September 2019

Non MRI conditional systems

2009-2014 Magnasafe registry rapported safety on patient with system integrity, referred for

- **1,5 tesla extrathoracic** MRI
- **non stimulodependant**

1000 MRI scan on 818 PM => VOO/DOO
500 MRI scan in 418 ICD => Deactivation of therapy

=> 6 cases (five patients), partial generator electrical reset occurred

Magnasafe registry Russo RJ, et al. *N Engl J Med.* 2017

Non MRI conditional systems

- 2013 ESC guidelines on pacing and resynchronization therapy allow MRI in conventional MR-nonconditional CEID if appropriate precautions are taken : class IIb- B
- 2017 HRS expert consensus statement on magnetic resonance imaging and radiation exposure in patients with CIED issued a class IIa-B recommendations for this indication

Brignole M, et al. 2013 ESC guidelines on cardiac pacing and cardiac resynchronization therapy: the task force on cardiac pacing and resynchronization therapy of ESC in collaboration with EHRA. Europace 2013;15:1070–118.
Indik JH et al. 2017 HRS expert consensus statement on magnetic resonance imaging and radiation exposure in patients with cardiovascular implantable electronic devices. Heart Rhythm 2017;14:e97–153.

Workflow

MR-examination should be integrated into a **standardized workflow** specific to the center

Pre, per and post MR exam protocol has to be defined wether MRI-conditional or non-conditional system is referred

Protocol has to take in consideration

- Guidelines
- Manufacturer instructions
- Patient caracteristics

Before MRI

- Validate the clinical benefit of the MRI
- Exclude contra-indications:
  - epicardial, fractured and abandoned leads as well as adapters and lead extensions (chest X-ray if necessary)
  - high capture thresholds > 2V/0.4 ms
  - out of range impedance values < 200 ohms or > 1500 ohms .
  - Elective replacement indicator (ERI) or end of service (EOS)
- MR-conditional system?
- PM/ICD: Pacing-dependency?
- ICD: primary or secondary indication?
- Specific MR-pacing programmation:
  - MRI Non conditional CIED: ODO/OVO if <40/mn, VOO/ DOO if >40/mn
  - MRI conditional CIED: MRI mode
- Deactivate tachycardia detection (ICDs)

During MRI

- Monitoring (cardiac frequency by pulse oximetry + ECG monitoring + visual monitoring) by physician or qualified personal
- Presence of a defibrillator and emergency material on site
- Physicians with the skill to perform resuscitation available immediately
- Physicians with the skill of programming devices *present on site or available immediately* depending on the device and patient dependency

CPR support

I	B-NR	It is recommended that personnel with the skill to perform advanced cardiac life support, including expertise in the performance of CPR, arrhythmia recognition, defibrillation, and transcutaneous pacing, accompany the patient with an MR nonconditional CIED for the duration of time the patient's device is reprogrammed, until assessed and declared stable to return to unmonitored status.
I	B-R	It is recommended for patients with an MR conditional system that personnel with the skill to perform advanced cardiac life support, including expertise in the performance of CPR, arrhythmia recognition, defibrillation, and transcutaneous pacing, be in attendance with the patient for the duration of time the patient's device is reprogrammed, until assessed and declared stable to return to unmonitored status.

2017 HRS expert consensus statement on magnetic resonance imaging and radiation exposure in patients with CIED

After MRI

- Device control (battery, sensing, impedance, pacing threshold)
- Reprogramming of baseline settings, reactivation of tachycardia detection (ICDs)

IIa	C-LD	For patients with an MR nonconditional CIED, it is reasonable to perform repeat MRI when required, without restriction regarding the minimum interval between imaging studies or the maximum number of studies performed.

Risk of programmation for MRI (MRI conditional or not)

- While the CIED is being programmed for scanning, there is a potential for
  - Absence of bradycardia pacing (VVI mode)
  - Arythmia induced by pacing (VOO/DOO)
  - Untreated tachyarrhythmias
- Monitoring of the patient should be continued as long as the programmed mode is active and CPR should be available.

Conclusion

- MRI is not anymore a contra indication for patient implanted with CEID
- Workflow protocol has to be written in each center to optimize safety and efficiency

Thanks to Estelle Grandjbackh and Working Group of Pacing and Electrophysiology of the French Society of Cardiology