

ORAL PRESENTATION

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Safety of CMR in patients with cardiac implanted electronic devices

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Background

CMR has been reported to be safe in patients with cardiac implantable electronic device (CIED), provided a specific protocol is followed. The goal of this study is to examine whether this is true for patients excluded from published protocols, e.g. CIED patients with abandoned leads or pacemaker dependency.

Methods

The protocol followed at our institution for MR imaging of CIED patients is as follows: 1) Necessity and absence of an alternative imaging modality; 2) Device-related relative contraindications, including the presence of abandoned leads, pacemaker dependency, and time to lead implant < 6 weeks, with the possibility of the ordering physician to overrule these exclusions. 3) A provider with CIED management expertise assesses the baseline device information, where the device was programmed according to the patient's needs with tachyarrhythmia detection and therapy disabled during the scan. 4) Device reinterrogation and reprogramming after completion of the scan, as well as at 1 week and 3 months after imaging.

Results

A total of 162 MR scans were obtained in 142 consecutive patients with CIED's (106 patients had defibrillators and 36 had pacemakers, as shown in Figure 1). 29 patients were pacemaker dependent and 11 patients had abandoned leads. Cardiac MR scans were performed in 94 patients (late gadolinium enhancement (LGE) was used to determine myocardial scar prior to ablation) and spinal/brain scans were performed in 47 patients. In the cardiac scans, the images were non-diagnostic only in 4 patients due to extensive artifact from the implanted cardiac defibrillator (ICD). In 65 patients, LGE was detected without

Characteristics	Patients
Total patient (n)	142
Gender (m/f)	117/25
Age (years)	63±12
Implanted device; type (n)	142
- ICD	106
- Pacemaker	36
Implanted device; manufacturer (n)	142
- Medtronic	60
- Boston Scientific	35
- Biotronic	12
- St Jude	35
Pacemaker (PM) dependent	29
- PM patients	10
- ICD patients	19
Abandoned leads (n)	13 in 11 patients
- Atrial leads	1
- Ventricular pacing lead	1
- ICD lead dual coil	4
- CRT lead in SVC	2
- Epicardial pacing leads	4
- SVC coil	1
Implantation < 8 weeks	1 (41 days post implant)
Cardiac MRI	94
Non-Cardiac MRI (n)	47
Device at ERI prior to MRI	1
Device at EOL prior to MRI	1
Total scans performed (n)	162
- single scan	140
- two scans	12
- > two scans	8

Abbreviations: PM= pacemaker, ICD= implantable cardioverter defibrillator, CRT= cardiac resynchronization therapy, SVC= superior vena cava, ERI = battery: elective replacement indicator, EOL= battery: end of life.

Figure 1 Patients' characteristics.

artifact. No LGE was identified in 25 scans. Only one patient developed ventricular tachycardia (VT) during a spine scan and was removed from the scanner for device reactivation, which terminated VT without consequences.

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Parameters	Pre MRI	Post MRI	1 week post MRI	3 Mo post MRI	p-value (pre/post)
Battery					
- mV, n=82	2.96±0.31	2.94±0.32	2.92±0.41	2.91±0.34	ns
- %, n=17	86±27	85±13	78±13*	73±15*	<0.05
- years, n=43	8.5±2.7	8.3±2.6	8.1±2.7*	8.1±2.8	<0.05
P-wave amplitude (mV)	3.38±2.1	3.43±2.1	3.1±1.83	3.47±2.2	ns
R-wave amplitude (mV)	12.92±9.7	12.9±9.8	11.38±5.44	11.55±5.26	ns
R-wave amplit. LV lead(mV)	19.94±5.5	19.1±6.96	20.87±0.52	13.17±7.55	ns
Atrial lead impedance (Ω)	477±159	474±159	480±183*	479±127	<0.05
Ventricular lead imp. (Ω)	492±143	490±143	471±141	485±146	ns
LV lead impedance (Ω)	708±338	703±339	712±327*	671±307	<0.05
Shock lead impedance (Ω)	57±17	58±17	54±14*	57±18	<0.05
SVC shock impedance(Ω)	55±9	54±9	54±9	56±10	ns
Atrial lead capture (V)	0.79±0.48	0.79±0.5	0.75±0.31	0.71±0.33	ns
RV lead capture (V)	0.89±0.32	0.92±0.33	0.91±0.41	0.92±0.36	ns
LV lead capture (V)	1.48±0.8	1.55±0.85	1.48±0.77	1.52±0.76	ns

Abbreviations: LV = left ventricle, RV = right ventricle, SVC= superior vena cava. *Comparison of pre MRI data to 1 week or 3 month post MRI data with a p-value <0.05.

Figure 2 Pacemaker and ICD data prior and post MR imaging.

No other adverse events were noted. The device parameters essentially remained the same immediately, 1 week, and 3 months after the scans (Figure 2).

Conclusions

In the analyzed cohort of 142 patients, only in one pacemaker dependent patient, the heart rate dropped from 90 to 50 bpm during spinal imaging using a fast spin echo sequence (specific absorption rate (SAR) = 1.89 W/Kg) due to elevated noise rate of the ICD. In this patient, a prior cardiac scan was performed a week earlier where no problem was observed, as the cardiac LGE sequences have low SAR of 0.11 W/Kg. Therefore, with the protocol described in this study, CMR imaging can be safely performed in CIED patients without exposing the patients to risk, despite pacemaker dependency, presence of abandoned leads, and other CIED contraindications. This study recommends that CMR imaging be available to more CIED patients who can benefit from it.

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