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Magnetic Resonance Imaging in People With Cardiac Implantable Electronic Devices: A Population Based Cohort Study

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Magnetic resonance imaging (MRI) is a widely used diagnostic tool with great benefits but has been considered contraindicated in people with cardiac implantable electronic devices (CIED). We investigated the occurrence of MRI in people with CIEDs and associated adverse events in a national cohort. Of 17,848 people included, 56 (0.3%) had at least one MRI; 16 of 16,102 (0.1%) with MRI non-compatible CIEDs and 40 of 1746 (2%) with MRI compatible CIEDs. Following MRI exposure, hospitalisations for potential serious adverse events were rare.

Keywords

Magnetic resonance imaging • Cardiac implantable electronic devices • Adverse events

Introduction

Magnetic resonance imaging (MRI) is a commonly used diagnostic tool. The use of MRI in Australia has increased substantially over the past 10 years; in the year 2004/05 just under 300,000 examinations were performed whereas in the year 2014/15 the number had increased to almost 1 million [1].

The presence of cardiac implantable electronic devices (CIED), which include permanent pacemakers, cardiac resynchronisation therapy (CRT) and implantable cardioverter defibrillators (ICD), has been considered a contraindication to MRI due to potential life-threatening interactions between the scanner and the CIED [2]. Potential effects from the magnetic and radiofrequency fields in the MRI suite include mechanical effects causing movement of the device or leads, heating of leads causing myocardial damage, reed switch interference, electrical reset, and over-and under-sensing causing interference with pacing function [3,4]. Severe injury and deaths have previously been reported in

conjunction with MRI in patients with pacemakers [5,6], although results from more recent clinical trials have demonstrated no significant adverse outcomes [7–9].

Magnetic resonance imaging compatible pacemakers were introduced on the Australian market in 2010. They are constructed with specific features considered not to pose a hazard in the MRI environment under specified conditions. Since 2015 MRI compatible ICDs have been available and recently CRT-D MRI compatible devices have been introduced to the market.

With an increase in the number of people with CIEDs [10] and an ageing population, a high proportion of people with CIEDs are expected to have an indication for MRI during their lifetime [3]. It is not clear how many people with CIEDs undergo MRI and whether this is associated with adverse events in clinical practice [11]. The objective of this study was to determine the proportion of people with CIEDs undergoing MRI in a national sample, and the impact, if any, on adverse events.

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Table 1 Number of MRI non-compatible and compatible CIEDs inserted each year.

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
MRI non-compatible	896	1677	1852	2065	2028	1890	1730 (96%)	1493 (94%)	1148 (80%)	707 (54%)	546 (47%)	70 (43%)	16,102 (90%)
MRI compatible	0	0	0	0	0	0	78 (4%)	93 (6%)	281 (20%)	592 (46%)	609 (53%)	93 (57%)	1746 (10%)
Total	896	1677	1852	2065	2028	1890	1808	1586	1429	1299	1155	163	17,848

Table 2 People with non-compatible CIED who had MRI scans; type of CIED, time from CIED insertion, type of MRI, days from MRI to hospitalisation and hospital diagnoses.

Patient	CIED Type ¹	Time from CIED insertion to MRI (months)	MRI type ²	Time from MRI to hospitalisation (days)	Primary hospital diagnosis
1	CRT-D	24	Tumour, spine		
2	ICD	16	Sciatica, spine		
		28	Derangement of hip or its supporting structures		
		35	Cervical radiculopathy		
3	CRT-D	75	Spinal canal stenosis		
		102	Derangement of knee or its supporting structures		
4	PM	18	Tumour of the brain or meninges		
5	PM	52	Myelopathy, spine	9	Acute upper respiratory infection
6	PM	13	Tumour of the brain or meninges		
		42	Tumour of the brain or meninges		
		72	Tumour of the brain or meninges		
7	PM	48	Sciatica, spine		
8	PM	41	Tumour of the brain or meninges		
9	PM	78	Tumour, spine		
10	PM	16	Derangement of knee or its supporting structures		
11	PM	82	Trauma, spine		
12	PM	59	Stroke, head	18	Bacterial arthritis
		108	Tumour, spine		
13	CRT-P	37	Derangement of hip or its supporting structures	10	Left ventricular failure
14	PM	13	Derangement of knee or its supporting structures		
15	PM	78	Tumour of the brain or meninges		
16	CRT-D	67	Tumour of the brain or meninges		

Abbreviations:

¹PM: permanent pacemaker, ICD: implantable cardioverter defibrillator, CRT: cardiac resynchronisation therapy with defibrillator (CRT-D) and without defibrillator (CRT-P).²MRI type: description based on Medicare Benefits Schedule codes.

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