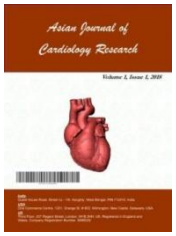

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MRI Scan Early after Implantation of an MRI Conditional Implantable Cardioverter-Defibrillator: Case Report

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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Case Report

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ABSTRACT

Introduction: MRI scans are not recommended for the first four weeks after device implantation. However, conditions like hypoxic-ischaemic encephalopathy can only be evaluated by MRI. A case where MRI brain was done in a patient with HIE four days after ICD implantation has been reported.

Case History: A 54 year old male with old anterior wall myocardial infarction presented with recurrent monomorphic, pulseless ventricular tachycardia. Anti-arrhythmic treatment resulted in severe junctional bradycardia for which temporary pacemaker was inserted. After 48 hours of stability, Medtronic Evera MRI XT DR SureScanTM Series DDMB2D1 implantable cardiovertor-defibrillator was implanted. During implantation, patient had ventricular fibrillation requiring prolonged (Comprehensive Cardiac Rehabilitation) CCR for 45 minutes.

Post-procedure, he remained comatose for more than 48 hours. Bedside EEG showed mild to moderate generalised encephalopathy which did not match the clinical picture. Therefore, MRI brain was done on fourth day after implant taking risk consent from the patient's wife. The MRI scan was done safely using SureScan mode. It showed mild changes of hypoxic encephalopathy suggesting a decent prognosis. The ICD lead positions and parameters were rechecked and found to be optimum.

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The patient slowly recovered over three weeks. He needed dialysis for acute kidney injury, antibiotics for ventilator associated pneumonia, tracheostomy for ventilation and percutaneous endoscopic gastrostomy for feeding. He was discharged with percutaneous endoscopic gastrostomy (PEG) in-situ and improving neurological status.

Conclusion: While a single case cannot make a recommendation, this case demonstrates that it not impossible to do an MRI scan safely in a patient very shortly after an ICD implant if the clinical situation warrants it.

Keywords: Implantable cardioverter-defibrillator; ventricular tachycardia; MRI scan; hypoxic ischaemic encephalopathy.

1. INTRODUCTION

Even after the introduction of Magnetic Resonance Imaging (MRI) permissible implantable cardiac devices, an MRI scan is not recommended for the first six to nine weeks after implantation [1-5]. However, sometimes an MRI scan is the only practical way to obtain required information and the circumstances do not permit delay. Ones such instance is evaluation for hypoxic-ischaemic encephalopathy (HIE) after a cardiac arrest with prolonged resuscitation.[6] Here, the author is presenting a case where an MRI scan of the brain was safely performed four days after implantation of an MRI conditional Implantable Cardioverter-Defibrillator for evaluation of hypoxic-ischaemic encephalopathy due to cardiac arrest during implantation procedure.

2. CASE HISTORY

A 54-year-old gentleman, with a history of anterior wall myocardial infarction 13 years ago with angioplasty done to the Left Anterior Descending (LAD) artery, presented with sustained ventricular tachycardia (VT) with cardiogenic shock (Fig 1). He was sedated, intubated and ventilated, given 150 mg intravenous amiodarone bolus, started on noradrenaline infusion, and given synchronised DC shock of 150 J. Sinus rhythm was achieved and the patient was started on amiodarone infusion. Beta-blocker was not given due to shock. Echocardiography showed akinetic and thin anterior wall with high intensity echo signal, suggestive of scarred LAD territory, with severe left ventricular dysfunction and an ejection fraction of 30%. In a few hours, his rhythm deteriorated to slow junctional rhythm. In order to permit adequate anti-arrhythmic therapy, temporary pacing was done. A coronary angiogram was done simultaneously which showed patent stent in the LAD and no lesions in the other coronaries. The blood work is shown in Table 1.

The next day, his blood pressure improved, and he was successfully weaned from ventilator and extubated. He had one more episode of

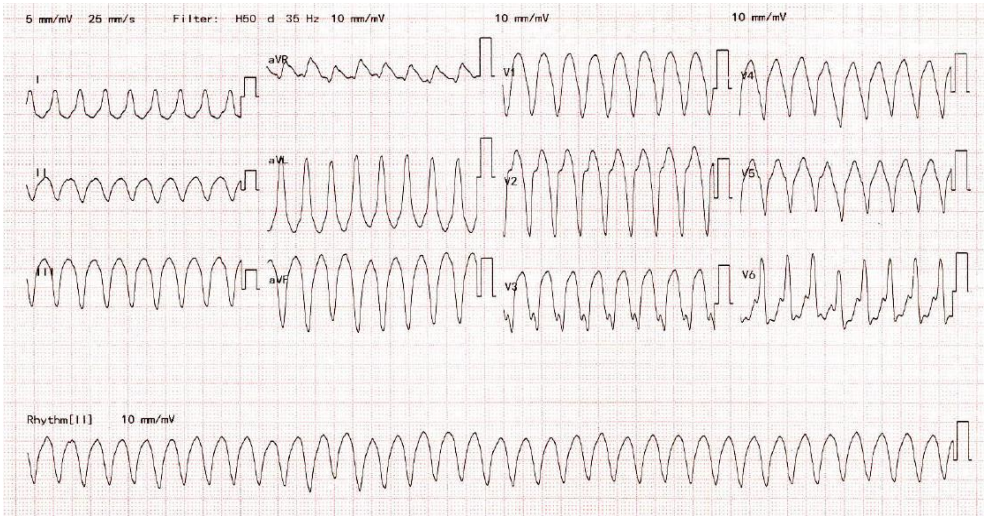

Fig. 1. 12 Lead electrocardiogram of the patient on presentation showing monomorphic ventricular tachycardia

Table 1. Blood work of the patient

Day	Haematocrit	White cell count (per mm^3)	Neutrophils(%)	Blood urea nitrogen (md/dl)	Serum creatinine (mg%)	Serum sodium (mEq/L)	Serum potassium (mEq/L)	Serum procalcitonin (ng/ml)
1	43.70	11360	49	7.01	0.90	141	3.8	
2	40.00	16410	80	15.88	0.90	139	4.7	
3	35.90	16200	91	20.59	1.43	142	3.2	
4	35.40	14290	80	31.01	1.98	145	3.7	
5	33.60	12890	88	49.50	3.07	147	3.3	
6	33.60	13810	87	68.18	3.26	151	3.5	
8	31.10	8930	80	83.13	3.20	156	3.1	
10				67.72	2.61	156	3.6	
11	30.90	21810	93	64.45	2.70	154	4.4	92.58
13	30.10	14810	82	74.72	3.40	146	3.4	
14	29.60	15830	82	87.33	3.34	152	3.6	
15	28.00	13050	75	101.81	3.00	149	3.5	14.00
17				79.39	2.57	152	5.1	
18	24.80	6990	74	74.72	2.6	152	4.6	
25	31.60	11810	81		1.49	136	3.7	

sustained VT which was reverted with a synchronised DC shock of 50 J. A second bolus of amiodarone (150 mg) and lignocaine bolus (70 mg) was administered, and lignocaine infusion was started at 70 mg/hour. Oral bisoprolol was started at 2.5 mg once daily. The next 48 hours were arrhythmia free; therefore, he was taken for ICD implantation.

Implantation was done under local anaesthesia with sedation with the left subclavian route. The Medtronic Evera MRI XT DR SureScan^{TM} Series DDMB2D1 ICD was implanted using MR Conditional, series 5076, screw-in atrial lead (52 cm) and MR Conditional, series 6947 screw-in, bipolar, ventricular lead (65 cm). Both Subclavian vein punctures, pocket dissection, and ventricular lead implantation proceeded uneventfully.

During atrial lead implantation, the patient developed ventricular fibrillation (VF). Cardio-cerebral resuscitation (CCR) was started promptly and continued without stopping. Multiple unsynchronised DC shocks at 250 J (bipolar) failed to revert the rhythm. He was intubated and ventilated. An extra 300 mg bolus of amiodarone and 140 mg bolus of lignocaine was given, and lignocaine infusion was increased to 140 mg per hour. Atropine and adrenaline boluses were given as per standard CCR protocol. After 35 minutes of continuous CCR, slow ventricular rhythm was achieved. The temporary pacemaker was adjusted to obtain a stable paced rhythm of 90/min. Blood pressure was stabilised using noradrenaline infusion. After 30 minutes of observation the procedure was completed, and the patient was shifted to intensive care in an unconscious state on ventilator.

For the next 48 hours, the patient remained comatose without sedation. Bedside electro-encephalograph (EEG) showed mild to moderate generalized encephalopathy. While this finding was encouraging in terms of prognosis, it did not correlate with the clinical picture. The patient also developed acute kidney injury (AKI), which precipitated heart failure. The patient remained comatose for the next 24 hours with no change in neurological status. The neurologist felt that the only way to prognosticate confidently was to obtain an MRI of the brain. The author also felt that waiting for four weeks before MRI was not an option. Accordingly, the patient's wife was explained the risk involved, and after obtaining informed consent, the patient was prepped for MRI, though Medtronic tech support strongly disagreed with the decision.

The ICD was programmed with SureScan mode and the patient underwent MRI brain with 1.5 Tesla MRI scanner. The SureScan mode provides either asynchronous or disabled pacing (to be chosen as per clinical situation) and disables tachyarrhythmia detection. DOO mode was chosen for this patient. It prevents complete electrical reset [7]. Multiplanar, multisequence MRI was performed with T1, T2 and FLAIR imaging. In addition, TOF MR angiogram of the neck and intracranial vessels was performed. SAR value of the system was 1.58 W/kg. The study lasted for 55 minutes with continuous monitoring throughout. The ICD parameters were rechecked after the MRI and found to be unaltered (Table 2). The ICD was reset to its previous programme. A check fluoroscopy was done which showed the lead positioning to be unchanged (Figs. 2a & 2b).

The MRI showed evidence of cytotoxic oedema involving bilateral corona radiata, thalami, internal capsules along with patchy involvement of brainstem (Fig 3). The cerebral cortex appeared unaffected.

The patient underwent slow low efficacy dialysis (SLED) for AKI, tracheostomy for prolonged intubation, correction of anaemia, correction of electrolyte aberrations, and aggressive therapy for heart failure.

The patient's sensorium slowly improved but muscle power recovery was slow, suggestive of critical illness polyneuropathy. Nerve conduction study was postponed as the patient still needed invasive ventilation. On the 10th day after ICD implantation, he developed fever. The neutrophil count and serum procalcitonin were elevated. Chest radiograph showed right lower zone pneumonia and urine showed pus cells. Blood, urine and tracheal secretion cultures were sent. Fortunately, the ICD pocket did not appear to have any obvious signs of infection. Broad spectrum antibiotics were started (colistin, tigecycline and teicoplanin). Invasive cardiac monitoring was started in order to fine tune ionotropic support, fluid administration and dialysis. Over the next 48 hrs, the patient slowly improved, with reduced inotrope requirement and improving urine output. The tracheal culture grew *Klebsiella pneumoniae,* sensitive only to tigecycline, polymyxin B and colistin. The blood culture also grew *Klebsiella* species sensitive to

tigecycline, polymyxin B, colistin, tetracycline, levofloxacin, tobramycin and fosfomycin. Consequently, colistin and tigecycline were continued for 10 days.

Over this time period, the patient could be weaned of ventilator and inotropic support. His urine output increased to more than 3 litres per day (polyuric phase). Dialysis was discontinued. The tracheostomy was uneventfully closed. He was shifted out of intensive care and physiotherapy was begun. Nerve conduction study was done which confirmed critical illness polyneuropathy. Due to persistent swallowing difficulty, percutaneous endoscopic gastrostomy was done. The patient was discharged after a total of three weeks in hospital, with advice for in-home nursing care and physiotherapy.

Interrogation of the ICD is planned after one month during follow up.

Table 2.

Parameter	**Before MRI Scan**		**After MRI Scan**	
Lead	**Atrial**	**Ventricular**	**Atrial**	**Ventricular**
Pacing Impedance	380 ohms	513 ohms	380 ohms	513 ohms
Defibrillation Impedance		RV- 37 ohms SVC- 45 ohms		RV- 37 ohms SVC- 45 ohms
Pace Polarity	Bipolar	Bipolar	Bipolar	Bipolar
Capture Threshold	0.5 V @ 0.4 ms	0.5 V @ 0.4 ms	0.5 V @ 0.4 ms	0.5 V @ 0.4 ms
Programmed Amplitude/ Pulse Width	3.5 V/ 0.4 ms	3.5 V/ 0.4 ms	3.5 V/ 0.4 ms	3.5 V/ 0.4 ms
Measured P/R Wave	2.3 mV	10.5 mV	2.3 mV	10.5 mV
Programmed Sensitivity	0.3 mV	0.3 mV	0.3 mV	0.3 mV

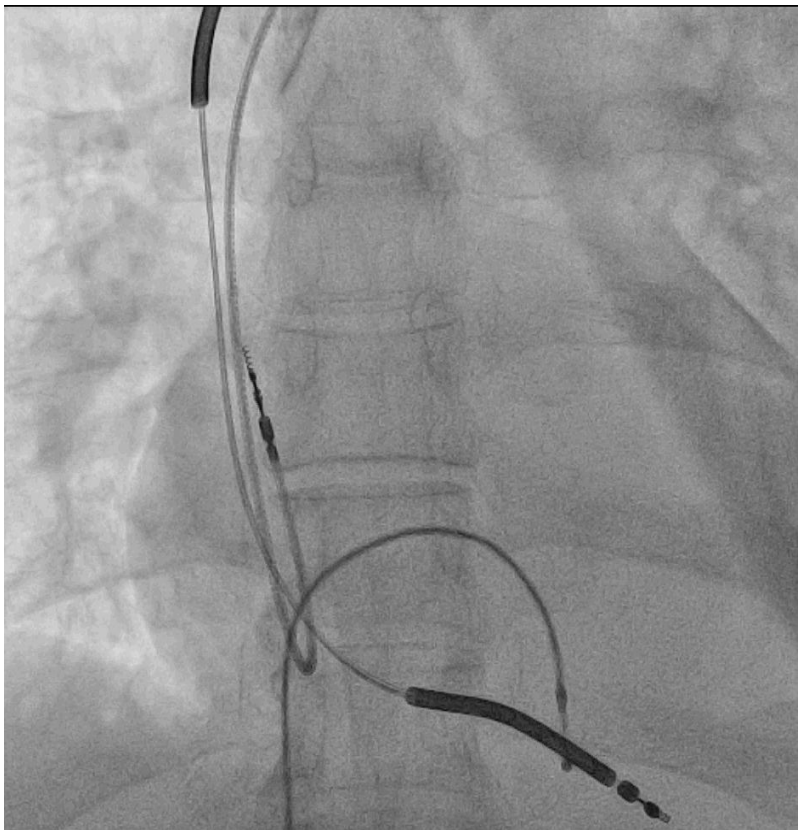

Fig. 2a. Fluoroscopy image of ICD leads before MRI scan

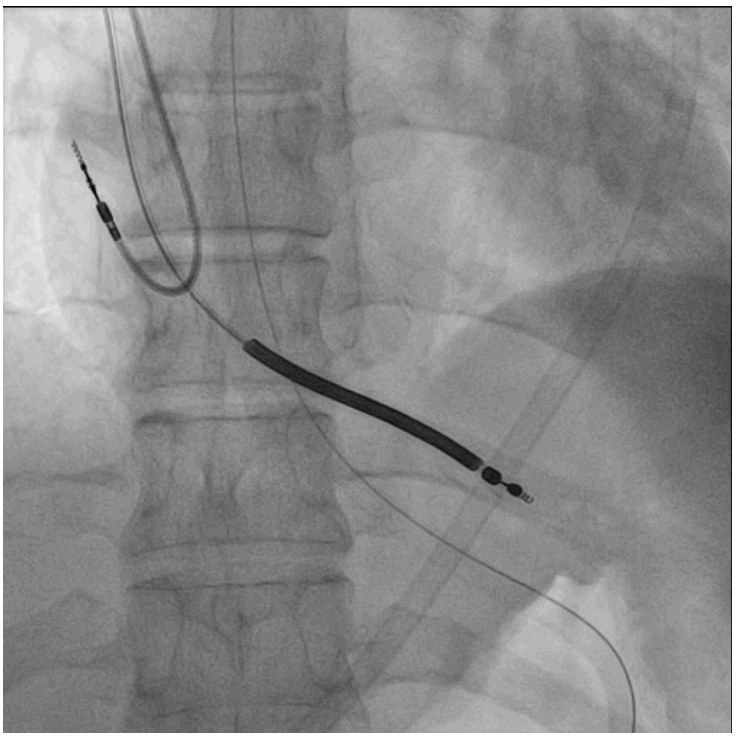

Fig. 2b. Fluoroscopy image of ICD leads after MRI scan

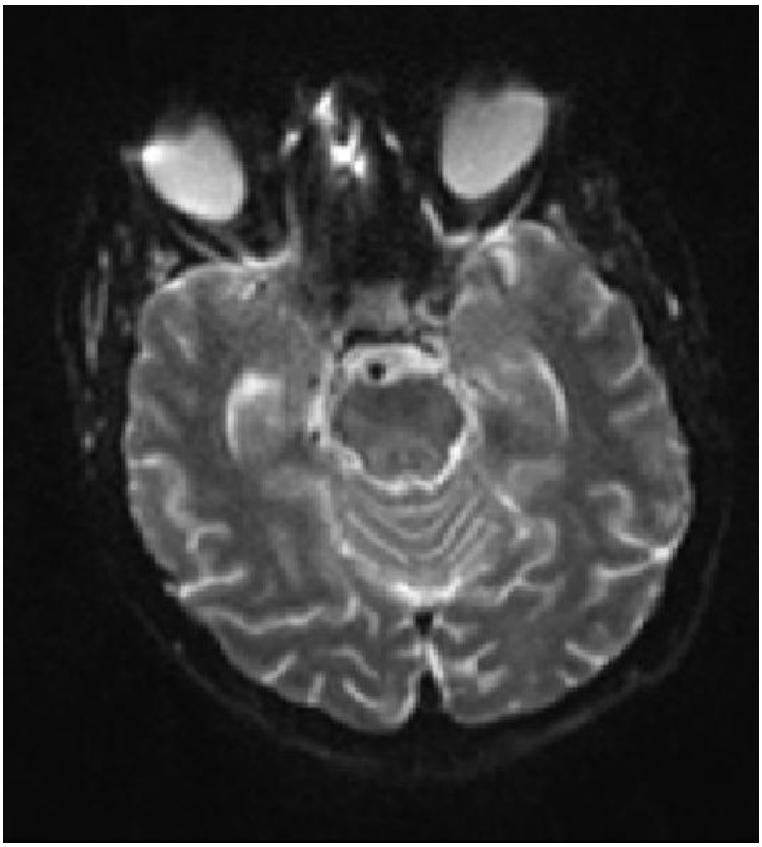

Fig. 3. MRI brain image showing evidence of HIE involving bilateral basal ganglia

3. DISCUSSION

The incidence of ICD implantation and the utilization of MRI scanning have been steadily increasing over the years. Consequently, it has been estimated that around half of the patients who have an ICD will need an MRI scan during their lifetime [7]. MRI conditional devices are an attempt to safely meet this need without ethical and legal quandaries. However, even with MRI conditional devices, MRI scanning is not recommended during the first four to six weeks after implantation [1-5]. Consequently, there is a small group of patients who, for various reasons, need an MRI scan in the first four weeks after implantation, but cannot undergo the same.

In such cases, an alternative to MRI is usually used, like Computed Tomography (CT) scan, nuclear imaging, etc. Some conditions, however, are not satisfactorily evaluated by any alternative means. One such condition is HIE. MRI scan is the most informative tool for evaluating HIE, with Electroencephalography a useful supplemental tool [6].

In this case, the EEG suggested mild disease with good prognosis, but the clinical picture was far more disturbing. Prognostication of HIE is vital as further management is determined by the expected prognosis.[8,9] A four-week delay in prognostication of this condition is unacceptable. Therefore, MRI scan was required to confirm or refute the prognosis suggested by the EEG and had to be done even though only four days had passed since ICD implantation. Fortunately, screw-in leads are less likely to change position.[10] Also, the Medtronic Sure Scan system has robust data for use during full body MRI [7]. ICD parameters and lead position remained unchanged after the MRI.

To the best of the author's knowledge, this is the only case reported of an MRI scan performed on a patient just four days after an ICD implantation. Needless to say, a single case cannot change recommendations. This case only tells us that it is at least possible to do a non-thoracic 1.5 MRI scan four days after implantation of Medtronic Evera MRI XT DR SureScan™ Series DDMB2D1 ICD with screw-in leads. It is better to take steps to avoid such a situation. However, if we do encounter such a situation, this case demonstrates that we are not completely helpless as long the risks are understood.

4. CONCLUSION

Desperate times call for desperate measures. Prognostication of HIE is vital to determine management and requires an MRI scan of the brain. This case demonstrates that it is not impossible for a non-thoracic MRI scan to be done very early after implantation of an MRI conditional system.

CONSENT

The author declares that written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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