Inappropriate shock and battery switching to "End of Life" in a patient with biventricular ICD during magnetic resonance imaging

Manyetik rezonans görüntülemesi sırasında çift odakcıklı ICD'nin uygunsuz şok vermesi ve pilin 'Tükendi' uyarısı vermesi

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Summary– Presence of a cardiac pacemaker or implantable cardioverter defibrillator (ICD) is a relative contraindication to magnetic resonance imaging (MRI). Biventricular ICDs are often used in the treatment of advanced heart failure; however, reports on experience with biventricular ICDs are lacking in the literature. In this case report, we describe a pacemaker-dependent patient with a biventricular ICD on whom an MRI of the lumbar spine was performed without having realized the presence of the ICD.

Özet– Kişide kalp pili veya implante edilebilir kardiyoverter defibrilatör (ICD) varlığı manyetik rezonans görüntülemesi için göreceli olarak kontraendikedir. Çift odacıklı ICD'ler, ileri kalp yetersizliği tedavisinde sıklıkla kullanılmaktadır. Manyetik rezonans görüntülemesi ile çift odacıklı ICD'ler arasındaki etkileşim hakkında bilgi oldukça sınırlıdır. Biz bu olguda, çift odacıklı ICD'si olan pil bağımlı bir hastaya pilin varlığının farkında olunmadan lomber omurgayı görüntülemek için çekilen manyetik rezonans görüntülemesinin sonuçlarını sunduk.

Presence of a cardiac pacemaker or an implantable cardioverter defibrillator (ICD) is a relative contraindication to magnetic resonance imaging (MRI). Newer generation pacemakers are compatible with magnetic resonance under certain circumstances. Various effects on single-chamber ICDs have been reported, but there is little knowledge about the effect of magnetic resonance on biventricular ICDs.[1]

In this case report, we describe a pacemaker-dependent patient with a biventricular ICD on whom an MRI of the lumbar spine was performed without having realized the presence of the ICD.

Abbreviations:

ICD	*Implantable cardioverter defibrillator*
MRI	*Magnetic resonance imaging*

CASE REPORT

A 65-year-old woman was admitted to the hospital due to sudden cardiac death. She was successfully resuscitated without hypoxic brain damage. After comprehensive evaluation, she was diagnosed with idiopathic dilated cardiomyopathy, with an ejection fraction of 12%. An electrophysiology study was performed, and ventricular fibrillation was induced, but the rhythm following defibrillation was complete atrioventricular block at the infra-His location, with no underlying ventricular rhythm. A Contak Renewal 4 biventricular ICD (model H195, Guidant CPI, Inc., St. Paul, MN, USA) was implanted using a submuscular pectoral position. An Endotak Reliance (model 0/48, Boston Scientific, Marlborough, MA, USA) was used as the right ventricular lead, an Easytrak 2 (model 45/8, Boston Scientific, Marlborough, MA, USA) was used as the left ventricular lead, and a Fineline (model 4480, Boston Scientific, Marlborough, MA, USA) was used as the atrial lead. Approximately 33 months after implantation, MRI of the lumbar spine was performed at another center. Unaware of the presence of the biventricular ICD, 2 image sequences (0.2 Tesla) were obtained. During the last sequence, the patient experienced a single shock, and the procedure was terminated immediately.

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An ICD assessment was performed the following day. Following interrogation, a screenshot displaying "End of Life" (EOL) appeared and was followed by another screenshot displaying "General PG Fault." Interrogation of the stored electrograms revealed electromagnetic noise superimposed on normal sinus rhythm that was detected as ventricular fibrillation, and the ICD could not sense the atrial signals due to the electromagnetic effect. During the second sequences of MRI, the capacitors were charged 3 times, but no therapy was delivered in the first 2 attempts. In the final attempt, a 31 J shock was delivered (Figure 1). During interrogation, the final capacitor re-form was reported 3 days prior to MRI, with a battery voltage of 2.78 V. The impedances of atrial, right ventricular, left ventricular, and shock leads were 529, 914, 1076, and 41 ohms, respectively. At the first interrogation, the heart could only be paced via the left ventricular lead, and there was a sudden drop in battery voltage from 2.78 V to 2.69 V. Under temporary pacemaker, the patient was taken to the electrophysiology lab, where the capacitors were reformed twice. Following reformation of the capacitors, battery status indicator returned to normal, and the EOL indicator disappeared. As the patient was a sudden death survivor, had received appropriate shocks in the past, and was pacemaker-dependent, the decision was made to replace the ICD battery. No dislocation of the lead or injury to the pocket was observed.

The explanted ICD battery was sent to the manufacturer for further examination. A comprehensive series of diagnostic tests was conducted on the device, verifying the performance of pacing, sensing, and recording functions. It was concluded that the device exhibited battery depletion within the normal tolerance for this model, and the EOL battery indicator was triggered due to magnetic resonance exposure, but the allegation of "No Capture" could not be confirmed, as the device passed all sensing and pacing production tests.

DISCUSSION

In spite of recent reports with favorable outcomes of MRI examinations in patients with an ICD,[2,3] presence of an ICD or pacemaker remains a major con-

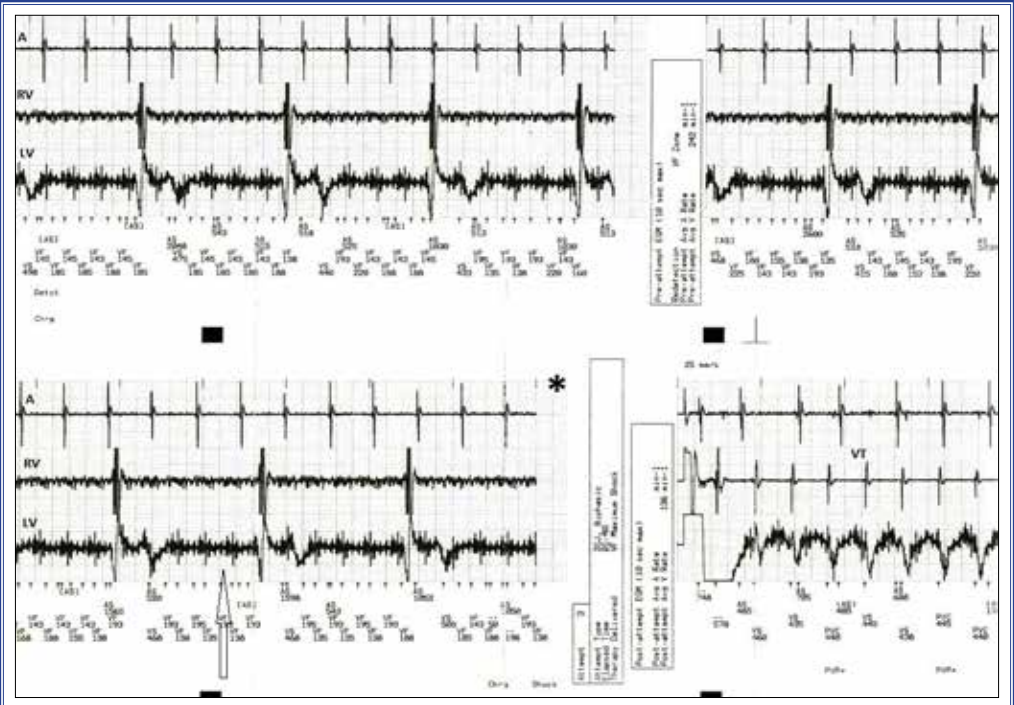

Figure 1. Electromagnetic noise superimposed on sinus rhythm detected as ventricular fibrillation. Detection, redetection and therapy delivered (31J biphasic shock) during MRI. The marker channels are on top, A: Atrial; LV: Left ventricular; RV: Right ventricular. The electrograms A, RV and LV are below the marker channels. Arrow: Electromagnetic noise that detected as ventricular fibrillation. *: Time of 31 joule shock that delivered to obtain sinus rhythm. VT: Non-sustained ventricular tachycardia after shock delivered.

traindication to the performance of an MRI study in most institutions. Possible potential hazardous effects include translational attraction and torque of ferromagnetic objects, lead heating due to radiofrequency energy used by the magnetic resonance, asynchronous pacing due to the effect of the magnetic field on the reed switch, changes in pacing thresholds, loss of communication with the device, transient change to elective replacement indices, and inappropriate shocks due to electromagnetic interference.[1] In this case, inappropriate shock was delivered by the device. The battery status indicator switched to EOL due to prolonged charge time, the cause of which is largely unknown. There was a temporary increase in the pacing threshold in the right ventricular lead. This may be due to energy heating at the electrode tip during MRI. Similar reports have been published for single-chamber ICD devices.[4,5] In studies where safety of biventricular ICDs was reviewed, non-pacemaker-dependent patients were selected, and therapies were turned off prior to MRI study;[2,3] one of these studies was restricted to only patients undergoing MRI for cranial examination.[2] Factors such as scanned part of the body and strength of magnetic field are the most important magnetic resonance-related factors. Extremity and cranial magnetic resonance studies that do not expose the device to significant magnetic field are considered relatively safe. Translational attraction is accepted proportionally to the strength of the magnetic field, which is higher than the magnetic force, causing a higher risk for device displacement.[6] In our case, the magnetic resonance study was inadvertent, so the therapies remained on, and the device was exposed to the magnetic field. The electromagnetic interference caused an inappropriate shock in this case. Another problem was the acute threshold increase in the right ventricular lead. This occurred as a result of the low magnetic field (0.2 Tesla) that the device was exposed to. This might be due to extreme heating of the lead tip or a micro-dislodgement that was not possible to detect.

Even if necessary measures are taken to prevent harmful interactions between the device and the magnetic resonance, acute temporary threshold increase may have catastrophic results for pacemaker-dependent patients. In this pacemaker-dependent patient, the presence of a left ventricular lead, the threshold of which was not affected, prevented the development of such a condition.

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Anahtar sözcükler: İmplante edilebilir kardiyoverter defibrilatör; uygunsuz şok; manyetik rezonans görüntüleme.