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CASE REPORT

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Radiofrequency ablation of a hepatic neoplasm in a patient with an abdominal pacemaker

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Abstract

We present the case of a 52 year-old male with a history of C-hepatitis and two liver neoplastic lesions treated by radiofrequency (RF) ablation. The patient wears an abdominally-implanted unipolar VVI pacemaker that did not show any signs of interference during RF pulses.

We describe the procedure performed and discuss the present knowledge regarding the possibilities of RF interference with the normal pacemaker functioning in several settings related to abdominal RF treatments. (Cardiol J 2009; 16, 3: 264–268)

Key words: pacemaker, radiofrequency ablation, interference, liver, abdomen neoplasia

Introduction

The number of patients with cardiac stimulation devices has been steadily growing over the last two decades [1]. These patients have also been increasing in age and they can be subject to other diseases and diagnostic procedures that can somehow interact with their stimulation device. On the other hand, technical advances in all fields of medicine have allowed patients with serious conditions to attain a lifespan that could not have been reached otherwise. They can receive treatments such as pacemakers for different conditions to improve their quality of life [2].

Most pacemakers or implantable defibrillators are at potential risk of electromagnetic interference, even if they have filters specially designed to avoid interference with their normal functioning. Most devices are designed to attenuate any interference outside the normal limits of 10 to 100 Hz (the usual range for intracardiac electrograms) [3] but it is well known that strong electromagnetic fields such as magnetic resonance imaging or magnetic catheter navigation systems are associated with the malfunction of devices or even physical damage to the circuitry or electrodes [1, 4]. It has also been described that intracardiac radiofrequency (RF) ablation procedures can be associated with pacemaker malfunction requiring different sorts of interventions [5–7].

Radiofrequency ablation procedures related to different solid tumors have also increased in recent years. The technique has become more widely available and has been used in the treatment of hepatic primary tumors or methastasic lesions in that organ [8, 9]. Nevertheless, experience regarding

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ablation procedures in other intrathoracic or abdominal organs is scarce, and so is the knowledge about the possible effects of such RF-based procedures on pacemakers' function. A report by Hayes et al. [3] showed two cases in two different scenarios, one of them referred to as a 'worst case scenario'. We report here another 'worst case scenario' with the aim of adding to the previous knowledge.

Case report

A 52 year-old man was being evaluated for progressive elevation of α-fetoprotein detected by serial determinations. He had a history of C virus hepatitis and chronic hepato-cellular damage. An α-fetoprotein level of 639 mg/dL prompted a computed tomography that was performed a month before the present intervention. That showed two focal lesions of approximately 2.5 cm diameter. One of them was in segment 2 near the hepatic dome; the other one was lateral, between hepatic segments 4 and 5. Both lesions showed contrast enhancement and portal wash-out. The surrounding parenchyma showed hepato-cellular chronic damage.

The patient had had a rheumatic mitral valve stenosis diagnosed in 1973 in another hospital. He was operated on at the time, and a Starr-Edwards mitral valve prosthesis was installed. He received several blood transfusions during that surgical procedure's perioperative interventions.

The patient was diagnosed with a sinus node dysfunction in 2002 whose first manifestation was atrial fibrillation. In September 2004 a VVI pacemaker was implanted. This had to be removed and relocated later that year because of an infection of the pocket site. After several complications, the pacemaker had to be relocated to an abdominal position. The pocket infection prompted an endocarditis episode and so the first mechanical valve had to be changed and a tricuspid valvuloplasty performed also. The next year, 2005, follow-up studies showed a severe para-prosthetic regurgitation. He then received a new Edwards-Mira mitral prosthesis that has not shown any new complications. Later in 2005, the pacemaker generator showed dysfunction data (not specified from the original hospital) and had to be replaced.

When the patient came to our hospital, he was wearing a Medtronic Sigma SSI 103® pacemaker, with the generator in an abdominal position, programmed in a unipolar stimulation and sensing mode with an epicardiac ventricular electrode.

On the day of the procedure, the pacemaker interrogation showed a rate of 60 beats per minute, pulse width 0.5 ms, amplitude 5 V, sensitivity 2.8, with a ventricular refractory period of 330 ms, ventricular lead impedance 439 Ω and unipolar sensing and pacing mode. Interrogation showed also 2.74 mA battery voltage, 1956 Ω battery impedance, measured stimulus amplitude 4.36 V and 18 μj. The stimulation threshold was 2.5 V. We made a threshold test that showed sinus rhythm at a 40 bpm rate, and so the pacemaker was programmed to a VOO mode and 60 bpm rate before the first RF pulse was administered.

Interventional radiologists performed an ultrasound-guided approach to the previously described lesions in hepatic segments 2 and 4–5 (Fig. 1). A LeVeen Co-Access needle electrode system® (Boston Scientific, 55, Av. Des Champs Pierreux, TSA 51101, 92729, Nanterre, CEDEX, France) with 15 cm longitude and 3.5 cm length array was used for the ablation procedure. The radio frequency generator is a Boston Scientific Corporation RF generator SC 545® (Boston Scientific Corporation, One Boston Place, Natick MA, 01760-1537 USA). The system uses four grounding electrodes applied to the anterior and posterior aspects of both tighs, which cannot be relocated to minimize the electric field.

For the ablation of the dome lesion, an anterior approach was used through the abdomen's midline. The needle's insertion site was approximately 4 cm next to the pulse generator. The needle was advanced toward the hepatic lesion with ultrasound guidance. In that site, two RF applications were done, the first for nine minutes with 150 W and an average impedance of 60 Ω, the second for two and a half minutes with 105 watts and 60 Ω. The neoplasm was about 7 cm of the device's generator. Both pulses were interrupted when measured impedance rose up to 300 Ω.

To ablate the second lesion, an antero-lateral approach was used through the rib cage in order to reach the lesion that was approximately 14 cm away from the pulse generator (Fig. 2). In that location, two RF pulses were administered, the first of nine minutes, 150 W and 60 Ω, the second of one and a half minutes, 105 W, 58 Ω.

During the first RF, we could not identify any RF-generated interference modifying the pacemaker's functioning (Fig. 3A). The patient showed a spontaneous increase in heart rate up to 70 bpm in sinus rhythm, with normal atrioventricular (AV) interval. Since the pacemaker was on a VOO mode, the stimulation artifacts were clearly visible on the T wave (Fig. 3B). The same Figure 3B shows an increase in ventricular rate with complete AV block.

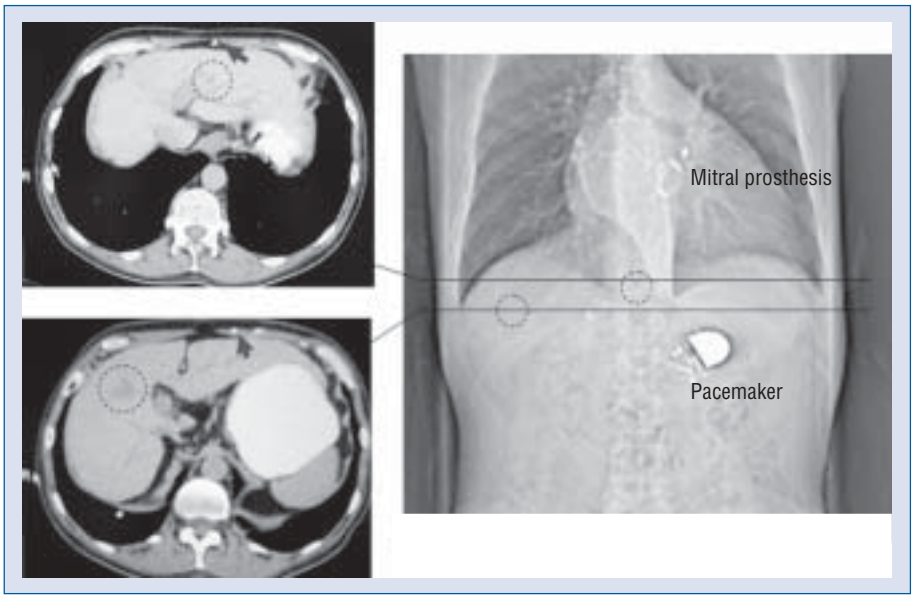

Figure 1. Aproximate location of hepatic lesions; the arrowheads indicate the location of the pacemaker's electrode.

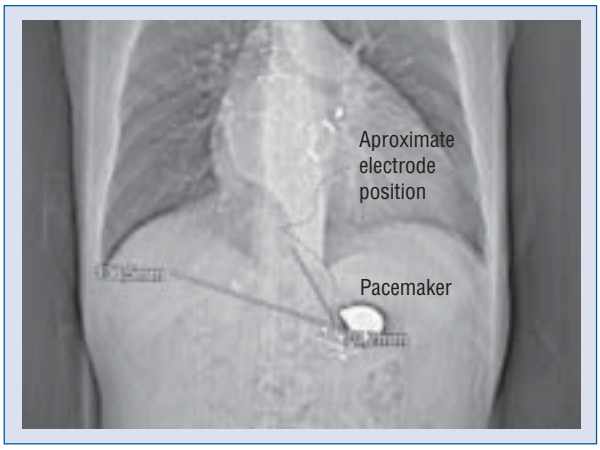

Figure 2. Distance of hepatic lesions from pacemaker.

That later returned to 60 bpm but with the pacemaker in VOO mode there was no sensing of the ventricular activity. The apparent AV conduction could have been sympathetic activity related to the RF pulse. Or it could have been an isorhythmic dissociation. Since we had no intracardiac catheters, the answer could not be determined.

We then reprogrammed the generator to a VVI stimulation mode for the last set of RF pulses in the lateral hepatic lesions and at a 50 bpm rate to limit the R on T phenomenon (Fig. 3C). No RF-induced interference was detected in either (Fig. 3D).

Interrogation of the device after the first and second sets of RF pulses did not show any significant differences in the battery or electrode status (Table 1). Another threshold test was performed at the end of the procedure and then we optimized the stimulation parameters. No complications were detected during or immediately after the procedure.

Discussion

Modern societies are exposed to a wide variety of electromagnetic wave sources. The biological effects of such an electromagnetic surrounding are apparently negligible, even if specific studies directed towards identification of potential biological harm are scarce. Researchers have focused on cancer risk, genetic mutations and devices' interactions (cell phones — pacemakers) [10–14]. Although there are potential risks for interference within several devices, there is little information available about this particular situation in which two different medical equipments can have a potentially harmful interaction.

Perhaps the most important fact regarding this case is that even in conditions of proximity of the hepatic lesions to a pulse generator that is unipolar and in the limits of the pathway to the grounding electrodes, no significant interference was registered. We could hypothesize that the filtering capacities of the pacing device can safely distinguish the interference's frequency range, but that is beyond

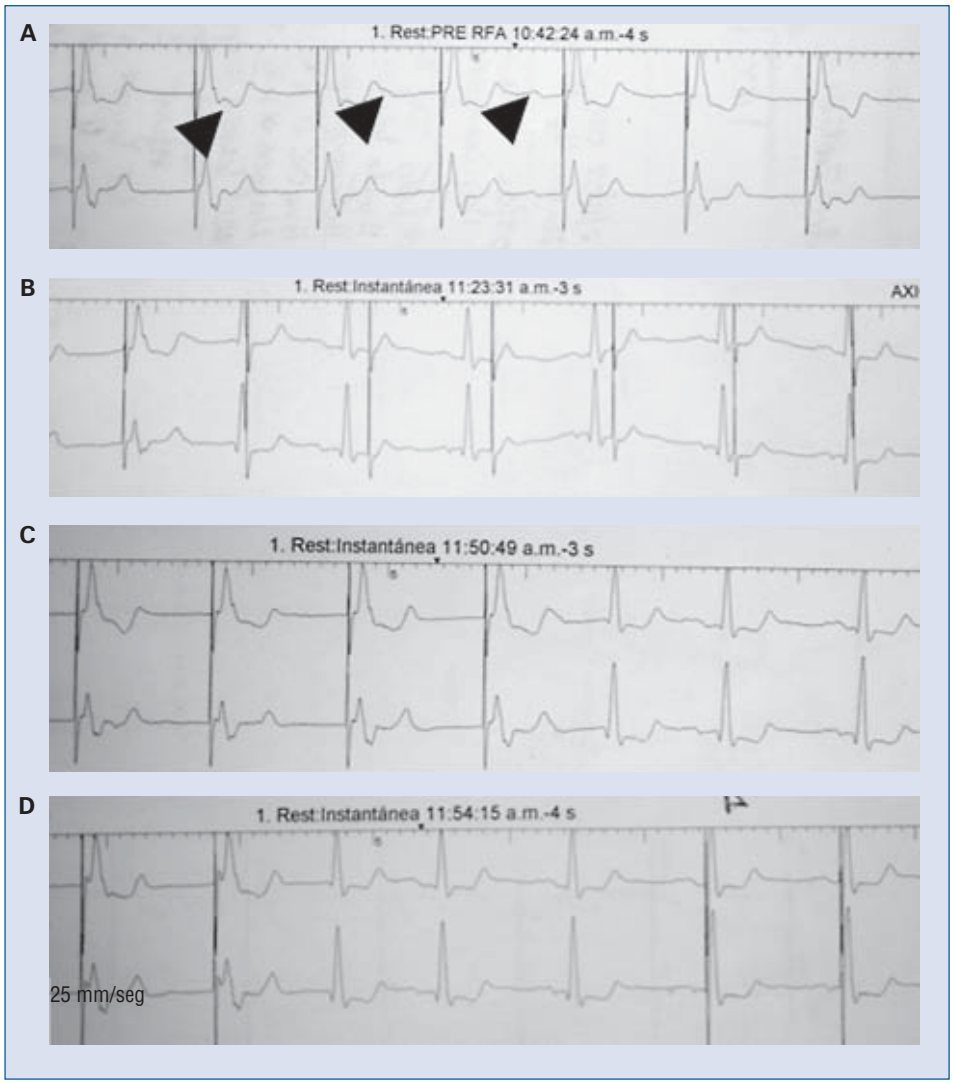

Figure 3. Electrocardiographic appearance during the radiofrequency (RF) procedure; **A.** Pre ablation unipolar VOO programming with P waves visible (arrowheads); **B.** Unipolar VOO programming during ablation with sinus rhythm present, fusion beats and R on T phenomenon; **C.** VVI programming before a new RF pulse with adequate ventricular sensing and pacemaker inhibition; **D.** VVI programming during RF pulse with adequate ventricular sensing and pacemaker inhibition. Two fusion beats are present.

Table 1. Pacemaker's interrogated parameters.

Parameter	Preablation	Post ablation VOO	Post ablation VVI
Battery impedance [Ω]	1956	2011	1838
Battery voltage [v]	2.74	2.74	2.74
Pulse duration [ms]	0.49	0.49	0.49
Pulse amplitude [v]	4.36	4.37	4.37
Pulse amplitude [μj]	18	17.3	17.3
Lead current [mA]	9.4	9	9
Lead impedance [Ω]	417	437	439
Stimulation threshold [v]	2.5		2.5

the scope of this paper. Another possibility is that the higher heart rate during RF could be interpreted as a certain form of interference, but it also could be related to a sympathetic activity increase related to the RF application, specifically due to some pain, even if the patient was mildly sedated.

The only potential complication came from the fact that an increase in heart rate prompted an R on T situation that was corrected resetting the pacemaker to VVI mode, even in the theoretical risk of having inhibition of the pacing device that did not happen.

There is a recurrent concern regarding the potential sources of electromagnetic interferences that could affect pacing or antitachycardia devices. A number of surgical interventions of several types use electrocautery or RF sources that raise concern about the potential harm of such interventions on the normal functioning of permanently implanted electronic devices [15–19]. The experience with abdominal ablation procedures shows procedure-related complications that occur mainly on the electrode imaging-guided placement and on complications related to thermal injury. Apparently there has been little research regarding the influence on other implantable devices. The work by Rhim et al. [9] mentions only 20 patients (2004) and the work by Hayes et al. [3] only two. None of the cases reported so far has showed pacemaker malfunction or interference related to such procedures, nor in patients with implantable cardioverter-defibrillators [15].

There are current recommendations issued by Heart Rhythm Society regarding precautions that must be observed while performing RF or electrocautery-related interventions [20] especially in patients wearing an cardioverter-defibrillator or pacemaker. But even though caution must obviously be taken, it seems that such interventions are safer than previously thought. Perhaps the filters in modern pacemakers in the ranges previously mentioned allow a safe RF application without further regard. More experience needs to be obtained because there are still safety 'grey zones', and every case that adds data to the available information can be valuable.

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