Herzschr Elektrophys 2017 · 28:257–259
DOI 10.1007/s00399-017-0509-z
Received: 28 March 2017
Accepted: 25 April 2017
Published online: 12 May 2017

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Electric smog: telemetry interference between ICD and LVAD

Introduction

A majority of patients receiving left ventricular assist devices (LVAD) are candidates for primary or secondary preventive implantable cardioverter/defibrillator (ICD) implantation [3]. Interactions between LVAD and ICD systems have been described as the LVAD may create electromagnetic interference impairing the obligatory wireless communication with the ICD. So far, interferences of LVAD and ICD have been mainly reported for devices from St. Jude Medical and Sorin Group in combination with the LVAD HeartMate II (Thoratec Corp., St. Jude Medical) [6]. Different maneuvers were introduced to minimize the interferences [1, 2, 4]. In some cases, generator replacement was indicated when these maneuvers were ineffective [5]. Through the years, telemetry interactions with the established LVAD models and ICDs seemed overcome. After the introduction of a new generation of continuous flow LVADs (HeartMate 3, St. Jude Medical)[7], we now report a case of tenacious telemetry interference between the HeartMate 3 LVAD and an ICD (Iforia 5, Biotronik).

Case report

The patient reported had received an LVAD (HVAD, HeartWare International, Inc.) in 2010 due to cardiac failure. After LVAD implantation, he received a single-chamber ICD (Lumax 340 VR-T, Biotronik) (**Fig. 1a**). He spent the following years in good clinical status. No device–device interferences were observed during routine follow-ups. Due to an LVAD infection in January 2016, the initial device (HVAD, HeartWare) had been explanted and replaced by a HeartMate 3 device (St. Jude Medical). No device–device interferences between the Lumax 340 and the HeartMate 3 were detected (**Fig. 1b**). In September 2016, the ICD reached its elective replacement indicators and ICD replacement was scheduled. ICD lead measurements were normal. Thus, only generator exchange was performed without complications (Iforia 5 VR-T, Biotronik; **Fig. 1c**).

During prehospital discharge test one day after implantation, no telemetry could be established. We tried several different maneuvers to interrogate the ICD previously published or discussed, including "pseudo Faraday cage" [4], pan method [2], different body positions and superextension of the arm. Telemetry remained inestablishable. Since the RF telemetry for remote monitoring does not depend on the initial handshake with the programmer, we installed a remote monitoring system (CardioMessenger 2, Biotronik) to allow connection and transmission of remote monitoring data. These showed a regular device status, parameters and automatic lead measurements for sensing and impedance. Automatic threshold testing failed due to signal quality. In order to avoid another ICD replacement, we made another interrogation attempt to gain telemetry contact three days later. Finally, it was possible to initialize the handshake by using all of the following maneuvers (**Fig. 2**):

- upright body position,
- superextension of the arm,
- "pan method" by positioning an iron pan above the LVAD, and
- maximizing the distance between LVAD and ICD by pushing the device superiorly.

By permitting this initial handshake for a few seconds, RF telemetry was established and normal device interrogation and programming was permitted. The patient was discharged the day after and routine ICD follow-ups were scheduled every 6 months besides remote monitoring.

Discussion

Interferences between LVAD systems and ICD have been described previously [1, 2, 4, 6]. These interactions are related to the distance between the ICD and the LVAD. However, maximizing the distance between the ICD and the LVAD is limited.

The Iforia ICD family is able to establish wireless RF telemetry with the programmer and does not need the programmer head for interrogation or programming of the device (SafeSync, Biotronik). However, for connection with the device, the programmer needs an initial "handshake", requiring an initialization by applying the programmer head for a few seconds. In our case, this handshake was impossible using the programmer

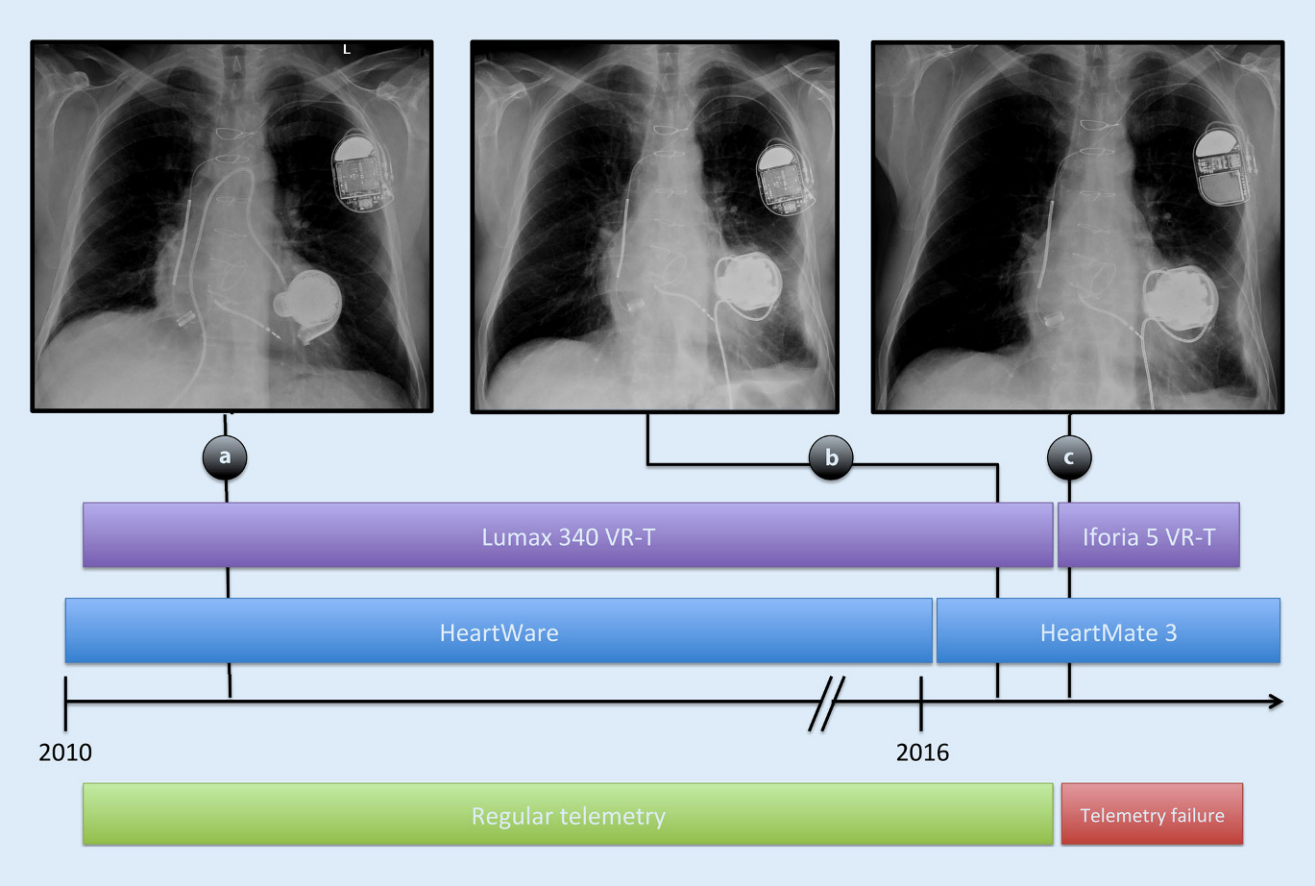

Fig. 1 ▲ Implantation of a HeartWare in 2010 followed by Lumax 340 VR-T implantation (*A*). Replacement of the ventricular assist device in 2016 due to infection of the device and implantation of a HeartMate 3 (*B*). No telemetry problems were observed with the Lumax 340 VR-T. After generator exchange and implantation of an Iforia 5 VR-T in 2016 (*C*), no telemetry connection could be established after implantation

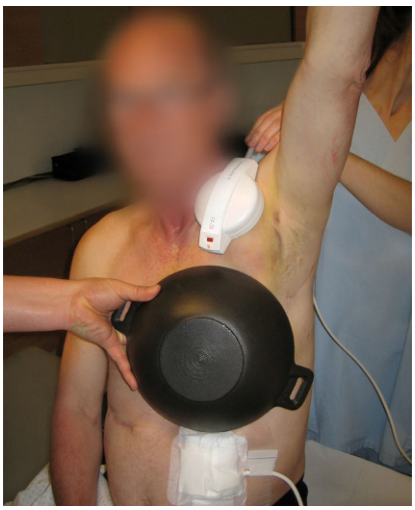

Fig. 2 ▲ Initialization of handshake between programmer and device by (1) upright body position, (2) superextension of the arm, (3) "pan method" establishing a pseudo Faraday cage above the LVAD

head until maximization of the distance between LVAD and ICD and shielding necessitating several maneuvers simultaneously.

In a preimplantation setting, the "handshake" with the device is usually done while the device is still in the box, enabling the wireless telemetry far from the possible interference field generated by the LVAD. As the wireless telemetry itself is not compromised by the LVAD, the implantation is uneventful and it is not possible to suspect a compatibility problem. This problem arises first, when the "handshake" for reinitialization of the wireless telemetry has to be renewed, which is typically not necessary during the implantation procedure.

The manufacturer of the HeartMate 3 reports communication difficulties or inabilities with Biotronik ICDs (Iforia 5 HF-T, Iforia 5 VR-T, Ilestro 7 VR-T DX, Ilestro 7 HF-T RF) and Sorin ICDs (Paradym RF CRT-D) on its web page (http://www.thoratec.com/medical-professionals/vad-product-information/heartmate3-reported-icd-experience.aspx).

There is no official recommendation of any ICD manufacturer on this issue. The first device implanted in our case, the Lumax 340 VR-T did not show any interferences with either the HeartWare or with the HeartMate 3. This might be due to the fact that the header of the Lumax has a larger antenna than the Iforia. This diverging geometry might lead to differences in vulnerability for electromagnetic interference. However, we tried to interrogate the Lumax 340 VR-T after explant by placing the device on the heart. No telemetry could be established. This might indicate a general interference with the programmer head frequency of 64 kHz used in all Biotronik devices.

In the current case of generator change, superextension of the arm and manual pushing of the can was possible in the existing device pocket. In newly implanted systems, these maneuvers should be avoided.

Conclusion

This is the first description of an interference of a HeartMate 3 LVAD and an Iforia 5 ICD. We were able to overcome this interference using several maneuvers simultaneously. As the interference affects the initial "handshake" of device and programmer head, but not the RF telemetry, we suggest to place the ICD above the LVAD before implantation and to test for possible telemetry interferences. In addition, once the device has been placed in the pocket, we strongly suggest to disconnect RF telemetry and then try to re-establish communication via the programmer head before wound closure. In case of interferences, we recommend choosing an alternative ICD device that allows telemetry without interference in patients with LVAD.

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Compliance with ethical guidelines

Conflict of interest. D. Duncker received lecture honorary, travel support, and a fellowship grant from Biotronik, Boston Scientific, Medtronic, Sorin, St. Jude Medical, Zoll. T. König received lecture honorary, travel support, and a fellowship grant from Biotronik, Boston Scientific, Medtronic, Sorin, St. Jude Medical. R. Michalski received a fellowship grant from St. Jude Medical. H. Oswald received lecture honorary from St. Jude Medical and is a consultant for Biotronik and Medtronic. J.D. Schmitto is a consultant for Thoratec Corporation. J. Bauersachs received lecture honorary from HeartWare and Thoratec Corporation/St. Jude Medical. C. Veltmann received lecture honorary from Biotronik and J. Müller-Leisse declares that she has no competing interests.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Abstract · Zusammenfassung

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Electric smog: telemetry interference between ICD and LVAD

Abstract

Electromagnetic interferences between implantable cardioverter/defibrillators (ICD) and left ventricular assist devices (LVAD) impacting telemetry have been described in previous generations of ICD as well as LVAD, but have been predominantly overcome in current ICD generations. After introduction of a new fully magnetically levitated centrifugal continuous-flow circulatory pump, we report a case of tenacious telemetry interference between the HeartMate 3 LVAD and an ICD after battery exchange to an Iforia 5. Initialization of the initial telemetry handshake was only possible using several specific maneuvers simultaneously. In order to exclude device–device interference, we suggest to place the ICD above the LVAD before implantation and to test for possible telemetry interferences.

Keywords

Implantable cardioverter–defibrillator · Left ventricular assist device · Telemetry interference · Electromagnetic fields · Case report

Elektrosmog: Telemetrie-Interferenzen zwischen ICD und LVAD

Zusammenfassung

Elektromagnetische Interferenzen zwischen implantierbaren Kardioverter-Defibrillatoren (ICD) und Linksherzunterstützungssystemen (LVAD), die zu einer Beeinträchtigung der Telemetrie führen, wurden bereits in früheren ICD- und LVAD-Generationen beschrieben, konnten aber in aktuellen ICD-Geräteserien überwiegend überwunden werden. Nach der Einführung des neuen, vollständig magnetisch gelagerten HeartMate 3 berichten wir über einen Fall von sehr hartnäckiger Telemetrie-Interferenz zwischen dem LVAD und einem Iforia 5 nach Aggregatwechsel. Die Initialisierung der Telemetrie war erst unter Zuhilfenahme mehrerer spezieller Manöver möglich. Um Interferenzen zu vermeiden, sollten diese nach Möglichkeit vorab bedacht und ausgeschlossen werden.

Schlüsselwörter

Implantierbarer Kardioverter-Defibrillator · Linksherzunterstützungssystem · Telemetrie-Interferenz · Elektromagnetische Felder · Fallbericht

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