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Case Report

Use of external defibrillator jacket to facilitate safe delivery of radiotherapy for lung cancer – A report of two cases



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ARTICLE INFO

Article history:

Received 4 May 2013

Accepted 4 December 2013

Available online 2 January 2014

Keywords:

ICD

Radiotherapy

Wearable defibrillator jacket

ABSTRACT

The increasing rate of implantable cardioverter defibrillator (ICD) implantation coupled with shared risk factors between lung cancer and ischemic cardiac disease means that the need for radiotherapy in cardiac device patients is set to become commonplace. We describe two cases referred to our electrophysiology service over a 6-month period. Both had been diagnosed with lung cancer in tissue directly posterior to a previously implanted ICD device. The cases highlight the risks to device function caused by ionizing radiation, the practical difficulties and ethical dilemmas of delivering radiotherapy to cardiac device patients safely and a novel setting for the use of a wearable defibrillator system.

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1. Introduction

The increasing rate of implantable cardioverter defibrillator (ICD) implantation coupled with shared risk factors between lung cancer and ischemic cardiac disease means that the need for radiotherapy in cardiac device patients is set to become commonplace. We describe two cases referred to our electrophysiology service over a 6-month period. Both had been diagnosed with lung cancer in tissue directly posterior to a previously implanted ICD device. The cases highlight the risks to device function caused by ionizing radiation, the practical difficulties and ethical dilemmas of delivering radiotherapy to cardiac device patients safely and a novel setting for the use of a wearable defibrillator system.

2. Case reports and discussion

Our first case had a biventricular pacemaker with defibrillator capability (D234TRK Consulta, Medtronic, Minnesota, USA) implanted for Mobitz Type 2 second-degree heart block on a background of severe, ischemic cardiomyopathy. Case 2 had a secondary prevention, dual chamber ICD (T167 Vitality 2 EL, Guidant, Massachusetts, USA) implanted after an episode of ventricular tachycardia.

For both patients, stage three squamous-cell lung cancer was diagnosed by local Respiratory Physicians and Positron Emission Tomography – Computed Tomography imaging clearly demonstrated the tumors lying directly posterior to the cardiac devices (Figs. 1 and 2).

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<http://dx.doi.org/10.1016/j.ihj.2013.12.004>

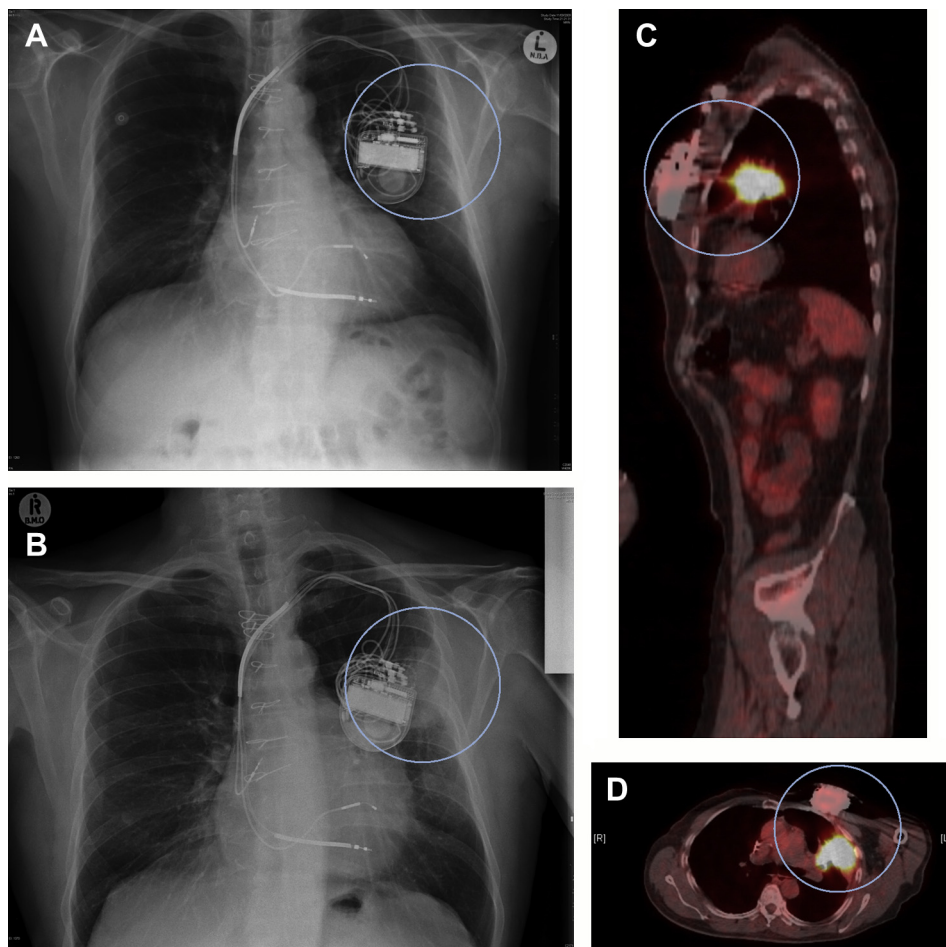


Fig. 1 – Imaging for Case 1. Plain film radiography of the chest at the time of device implant (A) and at presentation to the respiratory team (B), a new opacity is clearly seen. Positron Emission Tomography – Computerized Tomography imaging of the lung mass in transverse (C) and sagittal (D) planes demonstrating relationship to cardiac device.

Advice from the Oncology Multi-Disciplinary Team was that, treated with radical chemo-radiotherapy, the median two-year survival was approximately 30%, with a proportion of patients cured of their cancer. With palliative chemotherapy alone the prognosis was significantly worse. The patients were referred to our service to advise on the safety of delivering radiotherapy with an ICD in situ, and to consider strategies to facilitate cancer treatment. The radiotherapy courses were to be 55 Gray (Gy), delivered in 20 fractions.

Consensus guidance on the management of cardiac device patients requiring radiotherapy was limited to a 1994 publication by the American Association of Physicists in Medicine.¹ It dealt exclusively with bradycardia devices, and recommended a maximum cumulative dose to a device of no more than 2 Gy.

In 1997, last published a review including a description of the complementary metal oxide semiconductor (CMOS) technology used in modern cardiac devices.² He documents increased potential for radiation induced malfunction compared to older, bipolar semi-conductor technology. CMOS circuits use silicon as a semiconductor and silicon dioxide as an insulator. Whilst ionizing radiation effects tend to be transient in the semiconductor, in the silicon dioxide

insulator accumulation of positive charge carriers can lead to the formation of aberrant electrical pathways and to device malfunction. Last's review concludes that "there does not appear to be any consistent way to predict how a device will fail or at what dose failure will occur".

Current experimental evidence supports this variation in resilience to ionizing radiation as characteristic of high-energy devices also. Hurkmans et al³ irradiated new ICDs. Included in the study were 5 identical devices, of which 1 malfunctioned at a cumulative dose of less than 0.5 Gy whilst another was functioning up to 120 Gy.

Given the possibility of cure offered by radical chemo-radiotherapy, the limitations to such treatment created by an overlying device and the concern expressed in the literature regarding device malfunction during radiation exposure, we advised removal of the pulse generators in order to safely deliver radiotherapy to the underlying cancer. The leads remained in situ.

A permanent ventricular pacemaker implanted on the contralateral side to the cancer provided interim pacing support for the pacemaker-dependent first case. This was explanted at ICD re-implantation.

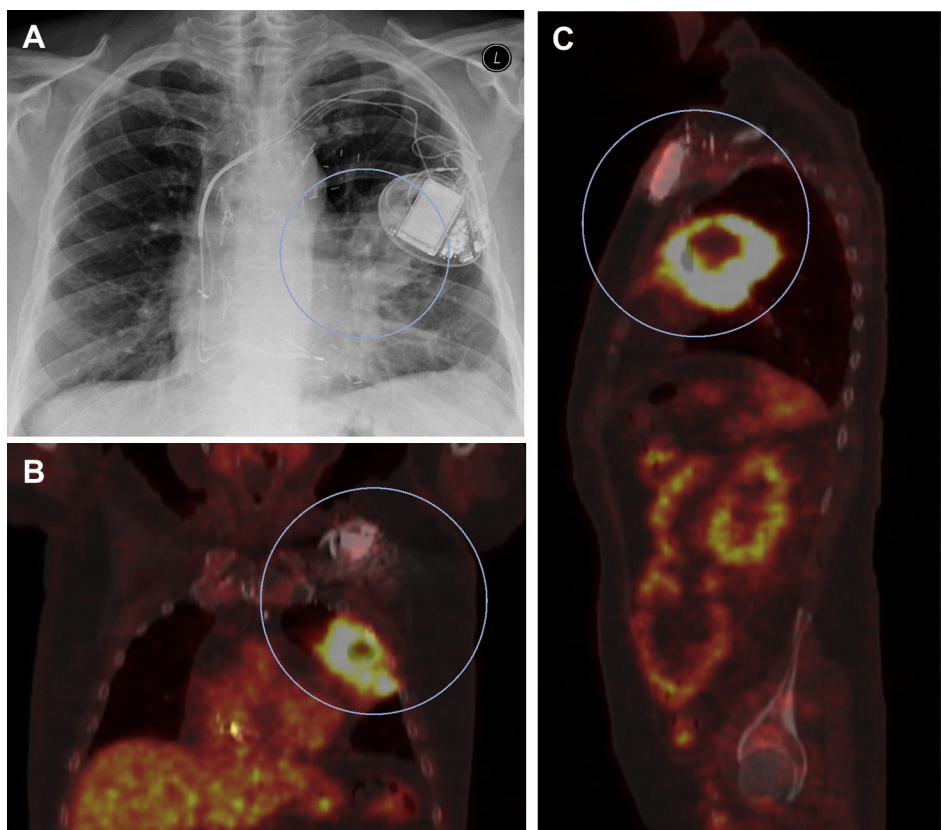


Fig. 2 – Imaging for Case 2. Plain film radiography of the chest at the time of presentation to the respiratory team (A), an opacity is seen between the cardiac silhouette and the device. Positron Emission Tomography – Computerized Tomography imaging of the lung mass in coronal (B) and sagittal (C) planes demonstrating relationship to cardiac device.

Our strategy raised two specific issues regarding the continued provision of protection from Sudden Cardiac Death (SCD) in patients known to be at significantly increased risk of non cardiac mortality due to their cancer. First, whether to re-implant pulse generators after radiotherapy? Second, if device reimplantation were planned, how to provide interim SCD protection?

There is no specific guidance on the ethics of reimplantation in patients requiring device explantation. International guidelines suggest ICD therapy is suitable for patients “who have a reasonable expectation of survival with a good functional status for more than 1 year”.⁴ We felt this was applicable to both cases based on the estimates given by the Oncologists. Following a full and frank discussion, both patients elected to undergo device reimplantation after radiotherapy.

The issue of interim protection from SCD was discussed with both patients prior to explantation. We elected to offer temporary protection using a wearable defibrillator jacket worn under clothing in direct skin contact. The “Zoll Life-vest™” wearable defibrillator system (ZOLL Medical Corporation, Pittsburgh, USA) is able to monitor cardiac rhythm and deliver automated shocks if ventricular fibrillation is detected. The use of wearable defibrillator jackets has been described in groups with transient high risk of malignant ventricular arrhythmia.⁵ It is also recommended as bridging therapy in patients requiring temporary removal of an infected implanted defibrillator by American and European Guidelines.⁴

At completion of radiotherapy treatment, when radiation induced inflammation was sufficiently resolved, a new generator was implanted onto the chronic leads. It was noted that the tissues were fibrous and reimplantation required careful surgical technique.

Subsequent to our management of these cases, The Dutch Society of Radiotherapy and Oncology published new guidance on the management of radiation oncology patients with a pacemaker or ICD.⁶ Both cases would be considered “high risk” by their assessment and the guidance advises to “reconsider radiotherapy” and only “in exceptional cases a decision to start radiotherapy can be made”. Relocation of the cardiac device is mentioned, but without description of how this would be achieved whilst minimizing procedural risk and yet facilitating relocation to a site considered to receive a lower radiation dose.

3. Conclusion

Our strategy of temporary pulse generator removal allowed both patients to undergo a full course of potentially curative radiotherapy. To our knowledge, this is the first description of a wearable defibrillator system being used to facilitate temporary removal of an ICD for radiotherapy to be safely delivered. It offers an attractive solution to a clinical problem that, with increasing numbers of complex devices being implanted

worldwide and considerable overlap in risk factors for lung malignancy and cardiac disease, is likely to be seen more frequently.

Conflicts of interest

All authors have none to declare.

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