Case Report

Cardiovascular implantable electronic devices may tolerate high dose radiotherapy: an updated case report with long term follow-up

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Abstract: Cardiovascular disease was common in the clinic and cardiovascular implantable electronic devices (CIED) was one of the modalities for patients with cardiovascular disease with rate issues. There was a concern regarding radiotherapy for cancer patients with CIED due to potential CIED malfunction after radiotherapy in which a threshold of 5 Gy was considered as high risk according to the report by American Association of Physicists in Medicine [Med Phys 2019;46(12):e757-e788]. We had previously reported the short term (5 months) outcome of a case of cT1N0M0 esophageal squamous cell carcinoma with CIED treated with radiotherapy 60 Gy/30 Fx with CIED dose of 57.77 Gy at the lead of the CIED though the maximal dose at the CIED generator was 0.39 Gy [Therapeut Radiol Oncol 2013;20(3):235-242]. In this update, we reported the long term (>4 years) outcome of this patient in that there was no CIED malfunction during this follow-up period. The lead of CIED may tolerate high dose radiotherapy after long term (more than 4 years) follow-up in some cases. However, clinical studies of larger sample size and longer follow-up were needed to clarify the real clinical risk when CIED received high radiotherapy dose.

Keywords: Cardiovascular implantable electronic devices (CIED); radiotherapy; case report

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Introduction

Cardiovascular disease was common in the clinic and cardiovascular implantable electronic devices (CIED) was one of the modalities for patients with cardiovascular disease with rate issues. As cancer incidence and prevalence increased, more and more patients with CIED may need to be treated with radiotherapy. The radiotherapy dose commonly used in cancer treatment was high and it may

be dangerous to delivery this high dose radiotherapy to CIED.

However, it was well known that radiotherapy may led to malfunction of CIED [either implantable cardiac pacemakers (ICP) or implantable cardioverter defibrillators (ICDs)] (1). An earlier report (TG-34) by American Association of Physicists in Medicine (AAPM) published in 1994 suggested to consider patients with CIED dose >2 Gy as high risk (2). An updated report (TG-203) published by AAPM in 2019 (1) had loosened the threshold for high risk as 5 Gy but it was still a concern for patients with CIED close to radiotherapy targets because curative radiotherapy often employed dose much higher than 5 Gy. We present the following case in accordance with the CARE reporting checklist (available at https://dx.doi.org/10.21037/tro-21-18).

Case presentation

A case of cT1N0M0 esophageal squamous cell carcinoma with ICP was treated with radiotherapy. The patient information, clinical finding, and cancer treatment information as well as early follow-up result of ICP function had been described previously (3). In brief, he had pacing dependent left bundle branch block with congestive heart failure and received permanent ICP implantation (Medtronic Insync III 8042 with active leads of A lead Medtronic 5594-53 & V lead Medtronic 5076-58) in Aug 2009 as cardiac resynchronization therapy. He received curative intensity modulated external beam radiotherapy to esophageal tumor for 60Gy/30 fractions within Jun 2012–Jul 2012 using 6 MV X-ray in 400 MU/min. After he completed radiotherapy dose of 60 Gy in 30 fractions, the maximal ICP dose was 57.77 Gy in the lead whereas the maximal dose in the ICP generator was 0.39 Gy. He achieved complete clinical response of his esophageal squamous cell carcinoma 2 months after radiotherapy and received regular cancer follow with computed tomography and/or endoscope subsequently. He was also followed by cardiologists (lastly 49 months after radiotherapy) and ICP remained functioning well during follow. However, 45 months after radiotherapy, routine surveillance computed tomography (CT) with subsequent endoscopic ultrasound (EUS) plus biopsy and positron emission tomography (PET) (*Figure 1*, see the four images of PET) revealed regional and distal lymph nodes metastases without local recurrence over esophageal mucosa. He received best supportive care (BSC) thereafter by his preference under share care by palliative specialists then progressive disease was confirmed by CT 50 months after radiotherapy, then he died peacefully 52 months after high dose radiotherapy without clinical evidence of ICP malfunction clinically. The timeline of this patients was shown in *Figure 2*.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the research ethics committee of our institute [CMUH106-REC3-119 (CR2)] and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

In the updated AAPM TG-203 report, higher than 5 Gy to CIED was considered as high risk of CIED malfunction though dose tolerance up to 20 Gy was also possible (1). Similar threshold (5 Gy) had also been recommended by the cardiology literatures (4). These dose cut-off points were used for risk classification but not as an upper limit for tolerable dose for CIED.

Possibly due to the concern of potential malfunction after high dose radiotherapy, there were few clinical studies available in the literatures. In the in vivo studies summarized in table IV of TG-203 (1), only two studies had reported patients treated with more than 50 Gy (5,6). Tsekos *et al.* reported a case of recurrent neuroendocrine carcinoma treated with radiotherapy of 50.4 Gy in 28 fractions. The pacemaker received full prescribed dose and no malfunction was noted during radiotherapy although decreased magnetic frequency of the pacemaker was noted. However, no follow-up data after radiotherapy was reported (5). Among the eight patients reported by Wadasadawala *et al.* (6), only one non-small cell lung cancer patient received 60 Gy in 30 fractions with pacemaker within radiation port and there were no malfunction of pacemaker within 9 months' follow-up. The other seven patients had either received 39 Gy in 13 fraction or pacemaker out of radiation port. Therefore, our updated case reported provided clinical evidence that CIED may tolerance high dose radiotherapy after long term (more than 4 years) follow-up. However, our results should also be interpreted with caution because the Dmax to ICP generator was only 0.39 Gy

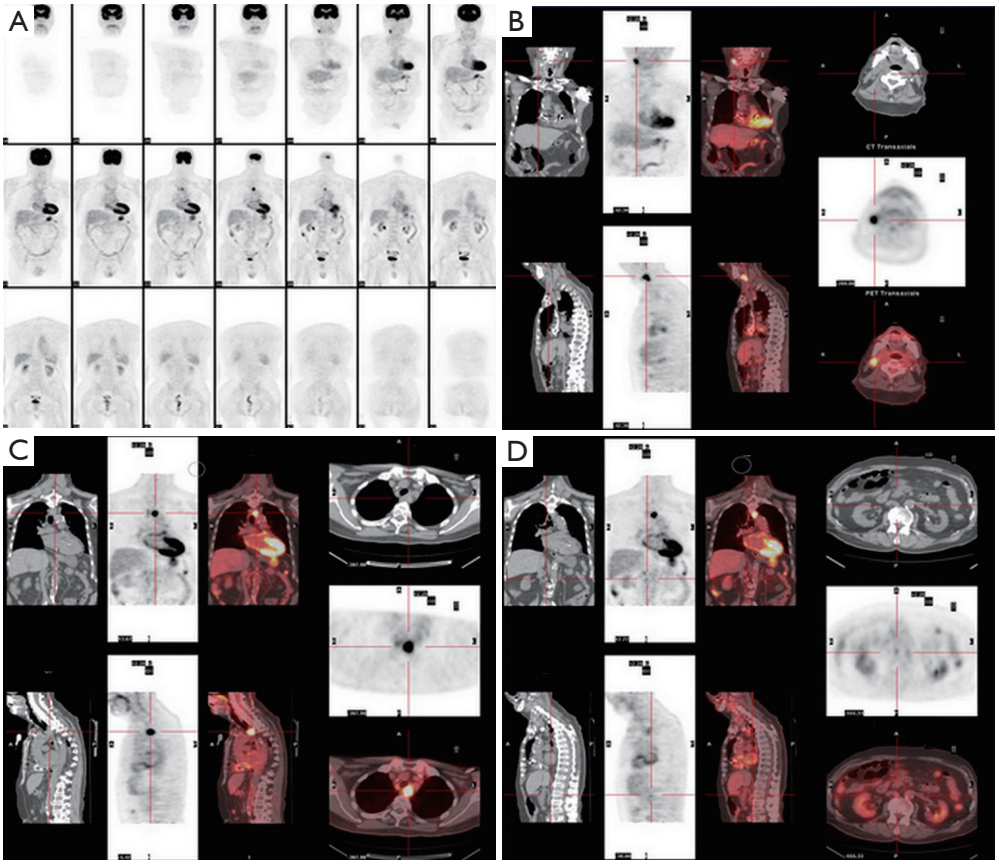

Figure 1 Positron emission tomography at 46 months after radiotherapy showed multiple lymph node metastases from neck (level II) to abdominal (pericaval). (A) Coronal topography; (B) neck; (C) chest; (D) abdominal.

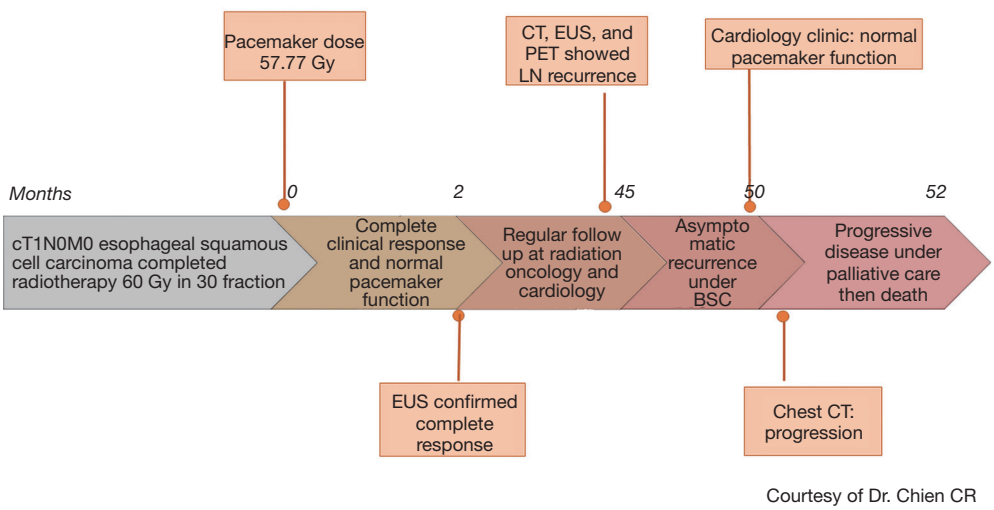

Figure 2 Timeline. BSC, best supportive care; CT, computed tomography; EUS, endoscopic ultrasound; LN, lymph node; PET, positron emission tomography.

in our patient whereas the high dose region (the lead of ICP) may tolerate high dose as mentioned in TG-203. Currently TG-203 stated "It is not known whether they (leads) should be considered as part of the CIED. The most practical option is therefore to include them until this issue is better understood." On the contrary, in vitro studies had reported 32% malfunctioned device at dose ≤50 Gy (1). Therefore, clinical studies of larger sample size and longer follow-up were needed to clarify the real clinical risk when CIED received high radiotherapy dose.

Conclusions

Our updated case report provided clinical evidence that CIED may tolerate high dose radiotherapy after long term (more than 4 years) follow-up which was rarely reported in the literatures. However, clinical studies of larger sample size and longer follow-up were needed to clarify the real clinical risk when CIED received high radiotherapy dose.

Take-away lesson: The lead of CIED may tolerate high dose radiotherapy after long term (more than 4 years) follow-up in some cases.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in studies involving human participants were in accordance with the ethical standards of the research ethics committee of our institute [CMUH106-REC3-119(CR2)] and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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