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Tips and tricks in treating a patient of carcinoma lung with coexistent implantable cardioverter defibrillator

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Abstract
Non communicable diseases are the major cause of morbidity and mortality globally. Hence it is not infrequent to find cancer patients where the primary oncological management has to be modified to take into account the coexisting chronic diseases. We hereby share our experience in treating a patient with carcinoma lung and having an implantable cardioverter defibrillator (ICD). This patient was treated with radiation and concurrent chemotherapy.

Introduction

With improvement in technology and the rising scope of medical sciences, a positive impact has been observed on human life span. But with increasing life expectancy, the prevalence of non communicable diseases also increases. Clinicians often face clinical dilemmas while treating such patients with coexisting multiple chronic diseases. A number of patients with malignancy also have underlying cardiac insufficiencies. As a therapeutic measure for their cardiac condition they often have a cardiac implantable electronic device (CIED) in situ. CIED has a variable interaction with radiation therapy which is used either as a diagnostic or a therapeutic modality for the management of malignanacy. Radiation induced CIED failure was reported to be 2.5% in pacemakers and 6.8% in ICDs[1]. Therefore an ICD is likely to be more responsive than a pacemaker to radiation hence more cautious efforts are required when planning and delivering radiation to patients with ICD[2].

In this case report we present a single institution experience of treating a patient of advanced carcinoma lung with implantable cardioverter defibrillator (ICD) in the field of radiation. We have also made an attempt of highlighting the important points in managing such patients as per the AAPM TG 203[3] report.

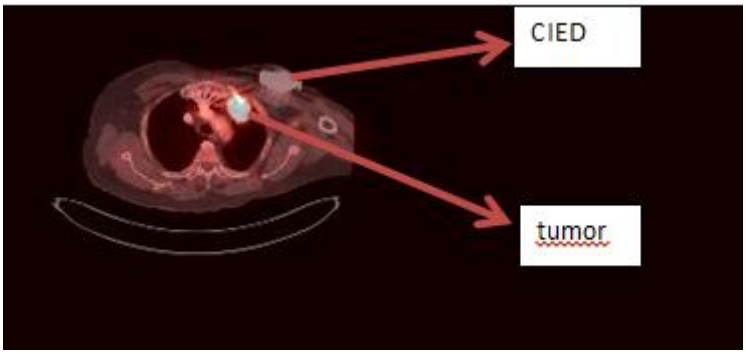
Case Report

A 60 year old male with history of cardiac morbidity (ventricular tachycardia) and ICD (implantable cardioverter defibrillator) in situ presented to our hospital as a diagnosed case of carcinoma left lung. Histopathology from the lung mass revealed moderately differentiated adenocarcinoma. PET CT scan showed FDG avid

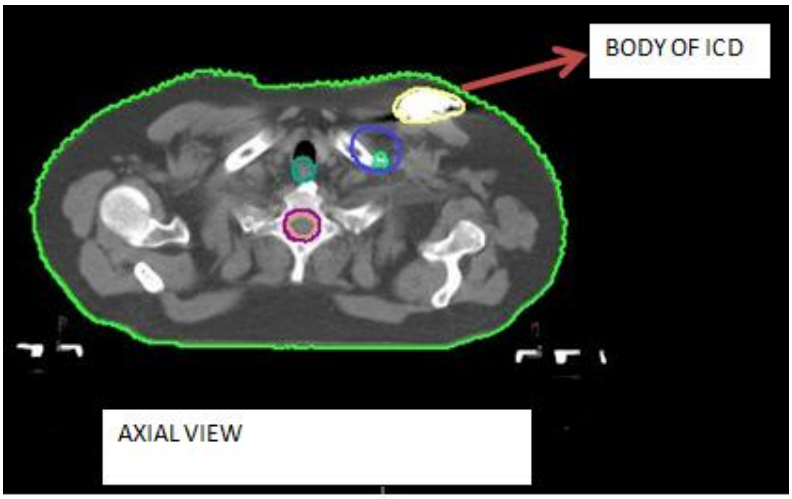
spiculated mass in the anterior segment of upper lobe of left lung with contiguous invasion of the medial end of left 1st rib with metastatic mediastinal lymphadenopathy, with absence of disease anywhere else in the body. The ICD was found to be located in the proximity of the tumor (shown in the picture below). After a multimodality discussion patient was planned for radical concurrent chemoradiation. A baseline evaluation was done by the cardiologist for the functionality and degree of cardiac dependence on the ICD. He was pacing independent hence his ICD was turned off during planning CT scan. Exposure to radiation was minimum during the simulation scan. After acquiring the planning CT scan with optimal immobilization, target volume delineation was done as per RTOG protocol 1106[4].The ICD body and stem were delineated separately (as shown in the picture below).During planning 6 MV photons were selected in order to avoid neutron exposure. The radiation plan was made using fixed field IMRT technique using MONACO treatment planning system. Direct projection of radiation fields was avoided during planning with Gantry angles of 150°,120°, 90°,60°,30°& 0°. Dose calculation was performed using Monte Carlo photon algorithm (version 5.11.03). The Mean and Maximum dose received by the body of the ICD was 5.34Gy and 44.98 Gy respectively and that of the stem was 17.63Gy and 63.68 Gy respectively. 99% of the tumour volume was covered by 95% of the prescribed dose. Rest of the organs at risk were well within the tolerance limit. The dose received by CIED was higher due to close proximity to the tumour and the treatment field. Radiation was delivered by linear accelerator (Elekta Synergy 6 MV; ELEKTA Medical Systems). He received 60Gy in 30 fractions at the dose rate of 2Gy per day along with Nanoxel (Paclitaxel nanoparticle) and carboplatin based chemotherapy. Imaging during the treatment was done using KV imaging. Daily adjustment was done for the defibrillator, it was switched off daily with a heavy magnet by the cardiology technician. Our patient belonged to the high risk category as per the AAPM TG203[3], although he was pacing independent but the ICD received a dose of >5Gy. So,the radiation oncologist, medical physicist, radiation technologists, cardiologist and a CIED technician worked in a synchrony during his treatment.

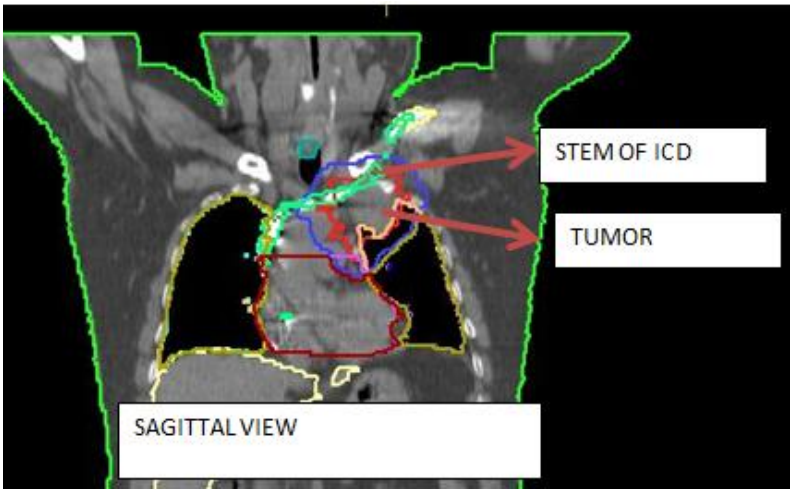
Since the CIED was <10cm from the edge of radiation field, in vivo dosimetry was done using thermoluminescent dosimeter. The device was deactivated with a heavy magnet prior to each treatment session. Patient vitals were vigilantly monitored from the treatment consoleby a trained member from the cardiac team. A crash cart with external defibrillator was placed close to the treatment area. After each treatment, an electrocardiogram (ECG) was done to monitor for any cardiac changes. Patient was reviewed at regular intervals by the implanting physician. A strict documentation was maintained by the cardiology technician and the oncology team.

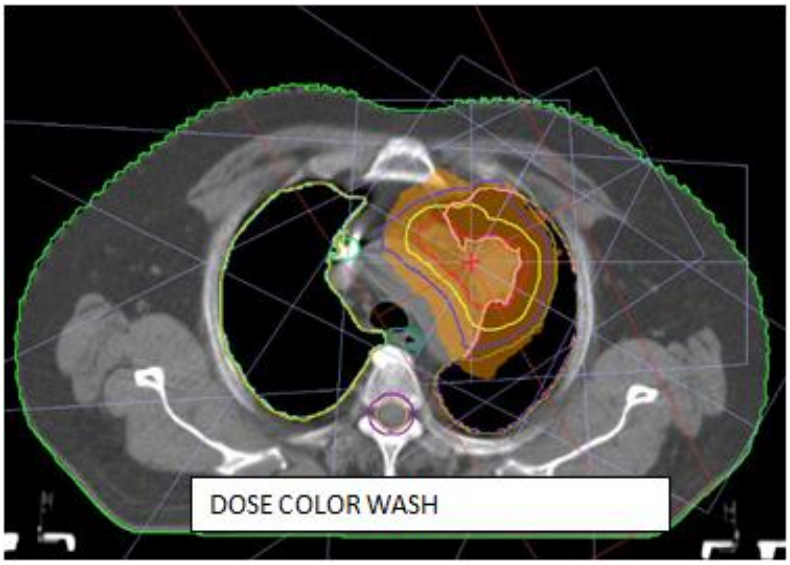
The patient responded well to the oncology treatment. Six months post completion of radiation therapy patient has shown response to therapy and no evidence of any cardiac deterioration. Hence radiation therapy can be successful when vigilantly performed in such clinical condition.



PET CT images showing CIED and the tumor







Discussion

The management of this patient was done in accordance with the AAPM TG 203 report[3] (American association of physicists in medicine task group). Incorporation of advices from HRS[5] (Heart Rhythm Society) and AAPM TG34[6] were also done.

Measures at Staff Level

Treating patients with CIEDs involves close integration between the radiation oncologist, medical physicist, radiation technologists, cardiologist and a CIED technician. The radiation team should know the purpose of the CIED, the risk level patient falls under, the monitoring measures required and their frequency, what can be the expected problems and whom to inform in case of any emergency.

A harmony between the radiation team and the cardiology team is required to know the pacing dependency of the patient and whether switching the ICD anti tachycardia therapy OFF will be appropriate. Although most of the radiation oncologists do not communicate the concerns regarding radiation safety with the implanting physicians[7].

	Low risk(<2GY)	Medium risk (2-5Gy)	High risk (>5Gy or neutrons)
Resuscitation protocol revised	✓	✓	✓
Pacemaker magnet,pulse oximetry, AED at treatment unit	available	available	Available
Communication with cardiology team	✓	✓	✓ along with ECG monitoring weekly
CIED interrogation	Before first and after last treatment fractions	At mid treatment	Weekly once the device receives >5Gy

Measures taken before Treatment

- Selecting the imaging aperture- try not to irradiate the device
- Selecting the imaging modality-use KV imaging where possible
- Beam energy- use photons ≤10 MV and avoid physical wedges, proton and neutron beams.
- Assess the risk category of the patient
- Consult the manufacturer for dose and dose rate tolerance of the CIED

Measures at Simulation

- Prevent direct irradiation of the CIED for more than 3 seconds

- If time for irradiation is >3 seconds then observe the patient for any deleterious side effects
- Turn OFF the device for nondependent CIED patients

Measures at the level of Planning

- Contour the body and stem of the CIED separately
- Body of the CIED is the most electronically sensitive portion
- If possible do not place the CIED under direct radiation field
- Use multiple treatment beams from different gantry angles, intensity modulation to prevent direct exposure of the device and minimize the dose to it while ensuring adequate coverage of the target.
- Placing a lead shield or 1-1.5 cm of bolus over the CIED can protect from elevated superficial dose due to electron scatter from linear accelerator head
- Prefer lower dose rates and dose threshold between 2 to 5 Gy
- If possible keep the generator of the CIED atleast 5cm from the collimated field edge

Measures taken during Treatment

- If CIED is > 10cm from the edge of radiation treatment area, in vivo dosimetry is not necessary
- For a device < 10 cm in vivo dosimeter should be placed and after assessing the cumulative dose, the patient should be managed according to risk categorization
- Patient should be observed for any cardiac symptoms and reported immediately to the treating cardiologist
- Deactivation of the device in cases it can be done
- A crash cart with external defibrillator should be available in the treatment area
- Cardiac monitoring with ECG should be done after each treatment at least for first week of the treatment
- A proper documentation should be done with patient labeling on the radiation chart, the patient should preferably be taken during the morning hours in presence of ACLS (advanced cardiac life support) trained staff, a proper consent in patient friendly language should be taken notifying about the potential side effects of radiation on the device.

Conclusion

Such patients with CIED suffering from thoracic malignancies are a challenge to the treating oncologists especially when the device is placed in close proximity to the tumor. The oncologist often faces a clinical dilemma since the dose needed by the tumor to respond is beyond the safe tolerance by the CIED. Such high risk patients need a strict vigilance during planning and treatment. A good communication between the oncologist and the implanting physician often proves beneficial.

Hence radiation therapy can be successfully used as a method of treatment in such cases , though a meticulous planning and execution is found to be the key to success.

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