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# Safety of Tomotherapy in Brain Tumor Patient with Pacemaker In Situ – A Case Report

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**Abstract**:

Due to the population ageing and growth, there is an increase in the incidence of cancer cases and cardiovascular conditions. Hence, there is a higher possibility of having both diseases in a single patient during their lifetime thus; patients with implantable cardiac rhythm devices undergo radiotherapy (RT) for cancer. Controlling dose to pacemaker in Tomotherapy is challenging as a result we describe this case of a female with a brain tumor and pacemaker and receiving tomotherapy. A 55-year-old female complained of headache, increased aggression and weakness in right arm and leg in the last 1 month. She later on had an episode of seizure for which she was taken to a nearby hospital. The brain MRI was then done showing a 91*61*66 mm lesion in left frontal lobe, involving the left insular cortex and left paraslyvian temporal lobe. Histopathological exam showed Gemistocytic astrocytoma grade III tumor. In addition, the patient has a history of hypertension on regular treatment and a permanent pacemaker implant placed for intermittent complete heart block: the pacemaker is dual chamber and rate modulated of St Juid. A tomotherapy was planned with trying to keep dose to pacemaker as low as possible as it can cause a real challenge: A dose of 60 Gy/30 # was planned along with concurrent chemotherapy. During treatment patient didn't suffer any cardiac event and had grade II skin reaction near left fronto-temporal region with loss of hair in that area. This case report showed that the patient was safely treated on tomotherapy with absence of any cardiac events when adjusting the radiation dose according to the pacemaker.

**Key-words**: Tomotherapy; Pacemaker; Pacing-dependent; cardiac implantable electronic device (CIED); radiation therapy

## Introduction

Technology development in the field of cardiac devices increased the survival rate of patients with heart failure or potential lethal arrhythmias with also a rise in the number of implanted devices yearly. Nevertheless, almost 70% of patients with malignant diseases undergo radiotherapy (1).. Therefore, caution must be followed when treating patient with pacemaker by radiation given that radiation can affect the functioning of pacemaker even with indirect exposure to radiation.

The American Association of Physicists in Medicine (AAPM) Task Group 34 (TG-34) made a set of guidelines in 1993 on the management of oncology patients receiving radiotherapy with implanted cardiac pacemakers (2). The main recommendation to manage these patients is to receive an accumulated maximum dose of 2 gray. Previous evidence reported pacemaker malfunction following specific type and level of electromagnetic interference, however, it is not considered a serious and dramatic issue in almost all utilized radiation therapies (3).

Due to the population ageing and growth, there is an increase in the incidence of cancer cases and cardiovascular conditions (4). Hence, there is a higher possibility of having both diseases in a single patient during their lifetime thus; patients with implantable cardiac rhythm devices undergo radiotherapy (RT) for cancer.

On the other hand, some hazardous factors may still be present regarding the newer pacemaker devices. This limits decision making in part of radiation oncologist as there is no tolerance limit of pacemaker mentioned in any studies. Controlling dose to pacemaker in Tomotherapy is challenging as a result we describe this case of a female with a brain tumor and pacemaker and receiving tomotherapy.

## Case presentation

A 55-year-old female presented to the hospital with a complaint of headache, increased aggression and weakness in right arm and leg for 1 month. She later on had an episode of seizure for which she was taken to a nearby hospital. On 22 April 2021, the patient underwent routine blood investigation and CT SCAN of brain revealing a 2.6* 2.5 cm space occupying lesion involving left cerebral hemisphere with mass effect and midline shift. For more details, a brain MRI was then done showing a 91*61*66 mm lesion in left frontal lobe, involving the left insular cortex and left paraslyvian temporal lobe. It is involving genu of corpus callosum with extension into right paramedian frontal lobe. Consequently, the patient underwent craniotomy with decompression surgery after 2 days (24 April). Histopathological exam showed Gemistocytic astrocytoma grade III tumor. In addition, the patient has a history of hypertension on regular treatment and a permanent pacemaker implant placed for intermittent complete heart block: the pacemaker is dual chamber and rate modulated of St Juid.

The woman was then referred to radiotherapy department for further adjuvant treatment. Following surgery, the patient score was ECOG 3 "Capable of only limited self-care", conscious but not oriented, had aphasia with no bowel bladder control. On physical examination, the muscle strength was 4/5 in left upper and lower limb and 0/5 in right upper and lower limb. .MRI BRAIN was not preformed post-surgery given the risk due to pacemaker. However, the brain CT SCAN showed a 42*30*24 large ill-defined non-enhancing cystic area involving left frontal lobe extending to basifrontal region. Furthermore, she underwent primary evaluation for cardiovascular system and the baseline ECG and functioning of pacemaker. Cardiologist was kept on call for any emergency. Consent was taken from the patient and her relatives regarding the risk of any morbid cardiac event due to interference of pacemaker by radiation during the treatment.

Regarding patient management, firstly the pre-operative and post-operative MRI was fused with planning CT SCAN for delineation of the tumor and critical normal structures. Second, a helical tomotherapy plan was generated keeping dose to pacemaker as low as possible as it can cause a real challenge: A dose of 60 Gy/30 # was planned along with concurrent chemotherapy. TABLE 1 show the dose received by nearby organ at risk and the pacemaker.

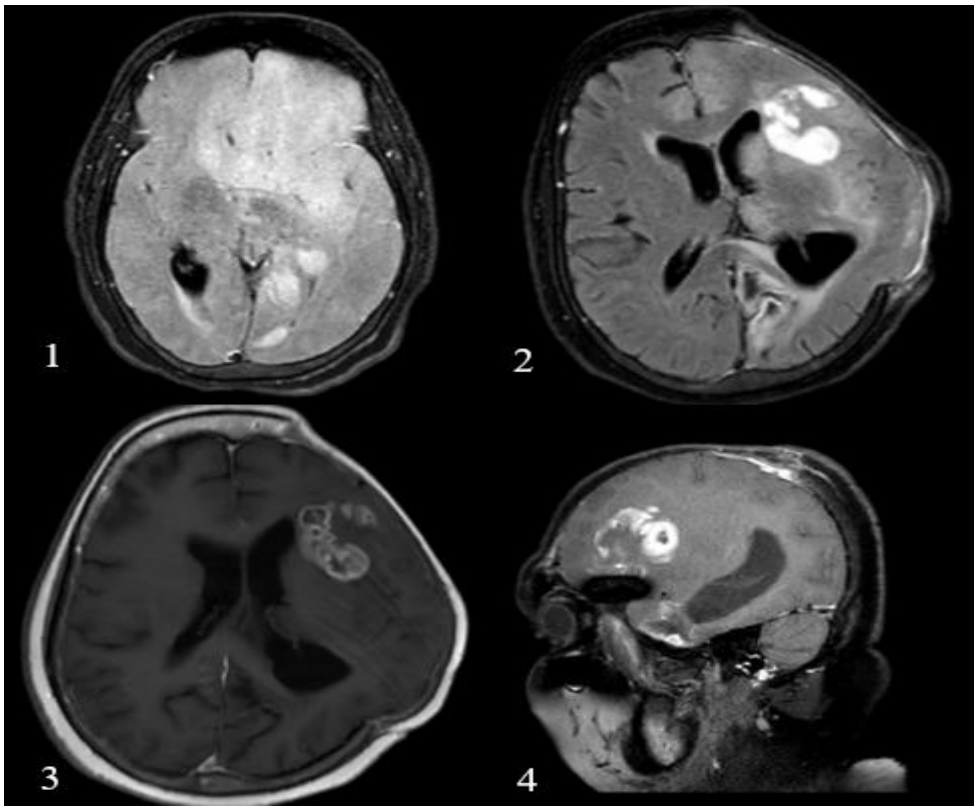


Figure 1: MRI results pre-operatively (1) and post-operatively (2-3-4)

**Table 1: The dose (cGy) received by a nearby organ at risk and the pacemaker**

| Normal structure | Dose received (cGy) | Mean Dose (cGy) | Dose (% of 6000 cGy Rx Dose) | Volume ($cm^3$) | Volume (%) |
|---|---|---|---|---|---|
| Optic chiasma | 5457 | 5416 | 91.7 | 0.00 | 0.00 |
| Right optic nerve | 5318 | 4889 | 91.7 | 0.00 | 0.00 |
| Left Optic Nerve | 5408 | 4897 | 91.7 | 0.03 | 1.2 |
| Brainstem | 5467 | 4343 | 91.7 | 0.00 | 0.00 |
| Right eye | 4274 | 2092 | 69.7 | 0.03 | 0.4 |
| Left eye | 3408 | 3980 | 64.9 | 0.03 | 0.5 |
| Left cochlea | 4059 | | 33.3 | 445.10 | 2.8 |
| Rt cochlea | 1817 | | | | |
| DEVICE | 36 | 22 | | | |

We also took into account the amount of dose which the pacemaker will receive due to on-board imaging during treatment.

DOSE RECEIVED BY PACEMAKER = dose received in plan + dose received due to on-board imaging

Patient was in semiconscious state and was not oriented hence frequent imaging was required during the treatment for better patient setup.

In this plan, pacemaker received a scattered dose of 22 cGy mean dose and 36 cGy max dose for 30 #. For in vitro dosimetry farmer ionisation chamber was placed in ARCCHECK phantom, the calculated dose was 22.2 cGy for 30 #. According to AAPM guidelines changes in the functioning of pacemaker is seen if the radiation dose received by it exceeds 2 Gy. Abrupt stopping of pacemaker has been seen at cumulative dose of 10 Gy to 30 Gy. From cardiologist team Pacemaker technical officer /pacemaker consultant (biomedical engineer) came for first 3 days and then every alternate day during radiation treatment. The pacemaker was reprogrammed and its functioning was assessed during radiation treatment. Patient's vitals were monitored during radiation. A crash cart with defibrillator was kept for any emergency during treatment. An in vivo dosimeter was kept near pacemaker to monitor actual scattered dose received by pacemaker during treatment. A small film covered with bolus was kept near pacemaker. On completion of treatment the dose received by film

was 40 cGy in 30#. The dose received by MVCT imaging on pacemaker was 24 cGy in 30#. Total dose received by pacemaker is 22.2 cGy + (0.8cGy in 30 #)24 cGy = 46.2 cGy. And if we consider in vivo dosimeter then it is 40 cGy. Both of our findings were comparable. ECG was taken once in week during treatment to look post radiation changes in functioning of pacemaker and was timely discussed with cardiologist.

During treatment patient didn't suffer any cardiac event and had grade II skin reaction near left fronto-temporal region with loss of hair in that area.

**DISCUSSION**:

The major finding of this case report is that the 55-year-old cancer patient presenting with a permanent pacemaker received tomotherapy with no adverse cardiac events, showing the safety of the treatment when administered with proper precautions. There are very few case papers which described the tolerance of pacemaker device. Electromagnetic radiation and radiation can lead to complete malfunction of pacemaker during treatment and with higher doses it even can lead to permanent damage. Malfunction can occur from dose as low as 0.5 Gy to up to 120 Gy (5). The response of pacemaker to radiation differs from pacemaker to another; some might tolerate higher radiation doses while others get malfunction even with the least amount of scattered dose. According to Medtronic®, their devices should be able to tolerate radiation doses of 1 to 5 Gy, depending on the model (6) On the contrary, St. Jude Medical® and Boston Scientific® cannot rule out that their devices might fail even at scatter radiation, permitting no dose limit to be regarded as safe (7). Malfunction can be of 3 types a) transient effect b) reverting to backup setting c) permanent damage.

Pacemaker has two modes sensing and pacing mode. For normal rhythmic functioning of pacemaker, pacemaker is set on only pacing mode so that there are no breaks in treatment due to malfunction of pacemaker. This pacing mode is set by pacemaker consultant to a rate which is decided by the cardiologist. Then after treatment the pacemaker is reset to its original mode. All this can lead to more usage of the battery but it does not significantly affect the overall life of the pacemaker.

According to literature high energy photons affect the functioning of pacemaker. The device should be at least 3-5 cm away from the field of radiation (8–10). Functioning of pacemaker should be checked before during and after treatment.

**CONCLUSION**

This case report showed that the patient was safely treated on tomotherapy with absence of any cardiac events when adjusting the radiation dose according to the pacemaker.

## REFERENCES

1. Baehr A, Conrads L, Oertel M, Frommeyer G, Scobioala S, Eich HT, et al. Impact of different radiation techniques and doses on cardiac implantable electronic devices. Z Med Phys. 2021 Aug;31(3):327–35.

2. Marbach JR, Sontag MR, Van Dyk J, Wolbarst AB. Management of radiation oncology patients with implanted cardiac pacemakers: report of AAPM Task Group No. 34. American Association of Physicists in Medicine. Med Phys. 1994 Jan;21(1):85–90.

3. Salerno F, Gomellini S, Caruso C, Barbara R, Musio D, Coppi T, et al. Management of radiation therapy patients with cardiac defibrillator or pacemaker. La radiologia medica. 2015 Dec 26;121.

4. Zaremba T, Jakobsen AR, Søgaard M, Thøgersen AM, Riahi S. Radiotherapy in patients with pacemakers and implantable cardioverter defibrillators: a literature review. EP Europace. 2016 Apr 1;18(4):479–91.

5. Hurkmans CW, Scheepers E, Springorum BGF, Uiterwaal H. Influence of radiotherapy on the latest generation of implantable cardioverter-defibrillators. Int J Radiat Oncol Biol Phys. 2005 Sep 1;63(1):282–9.

6. Wen Y. Medtronic Annual Report. [cited 2022 Jun 15]; Available from: https://www.academia.edu/35266126/Medtronic_Annual_Report

7. Riva G, Alessandro O, Spoto R, Ferrari A, Garibaldi C, Cattani F, et al. Radiotherapy in patients with cardiac implantable electronic devices: clinical and dosimetric aspects. Medical Oncology. 2018 Apr 17;35.

8. Solan AN, Solan MJ, Bednarz G, Goodkin MB. Treatment of patients with cardiac pacemakers and implantable cardioverter-defibrillators during radiotherapy. Int J Radiat Oncol Biol Phys. 2004 Jul 1;59(3):897–904.

9. Hudson F, Coulshed D, D'Souza E, Baker C. Effect of radiation therapy on the latest generation of pacemakers and implantable cardioverter defibrillators: A systematic review. J Med Imaging Radiat Oncol. 2010 Feb;54(1):53–61.

10. Tondato F, Ng DW, Srivathsan K, Altemose GT, Halyard MY, Scott LR. Radiotherapy-induced pacemaker and implantable cardioverter defibrillator malfunction. Expert Rev Med Devices. 2009 May;6(3):243–9.