Case report

Title

Radiotherapy and pacemaker: 80 Gy to target close to the device may be feasible.

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Summary

Modern pacemakers using complementary metal-oxide semiconductors (CMOS)-technology are sensitive to radiation. The guidelines recommend caution at doses above 2 Gray (Gy). Repositioning should be discussed if cumulative dose and dose rate exceeds 10 Gy and 0.2 Gy min\(^{-1}\).

We report a case of a man with mechanical mitral valve prosthesis and pacemaker due to sick sinus syndrome (Vitatron T20®). Five years later, a left-sided lung cancer was diagnosed. Radiotherapy was planned. Moving the pacemaker out of the radiation field would require either use of a lead extender and tunneling or implantation of third electrode through the right subclavian vein already occupied by a venous port. The pacemaker was left in site and the patient received hyperfractionated intensity modulated radiotherapy with 1.6 Gy twice daily to a total dose of 80 Gy. The calculated maximum, minimum and mean doses to the pacemaker were 48 Gy, 9 Gy and 25 Gy, respectively. For short periods, the pacemaker received up to 7 Gy min\(^{-1}\) through direct radiation. At control afterwards, the technical parameters were normal. The radiation dose significantly exceeded the pacemaker guidelines. The circuits in Vitatron T20®, similar to current Medtronic®, Sorin® and Boston Scientific® devices have thin CMOS-gates (≤ 1.5 μm). This may contribute to their resistance to irradiation. The approach must however be carefully individualized. Leaving the pacemaker in place during high dose radiotherapy can be considered if the patient is not pacemaker-dependent and the drawbacks of a repositioning are significant.
Abstract

A 65 years old man with mechanical mitral valve prosthesis and pacemaker developed a leftsided lung cancer. He received radiation therapy to a total dose of 80 Gy. The pacemaker was left in place and showed no signs of malfunction after the therapy.
Case report

Modern pacemakers using complementary metal-oxide semiconductors (CMOS)-technology are sensitive to radiation. The guidelines recommend avoidance of pacemaker exposure to the unshielded beam and caution at doses above 2 Gray (Gy) (1)(3). Repositioning should be discussed if the cumulative dose and dose rate exceeds 10 Gy (2) and 0.2 Gy min-1 (3).

We report a case of a 65 years old man with a mechanical mitral valve prosthesis. In 1994 a DDD-pacemaker was implanted due to sick sinus syndrome (Vitatron Diamond® 800, connected to two Medtronic® 4023 unipolar electrodes with passive fixation). The patient developed atrial fibrillation and when the pacemaker reached ERI in 2005 it was electively replaced by a single chamber device (Vitatron T20®).

Five years later, a cancer was diagnosed in the left superior pulmonary lobe and mediastinum in immediate proximity of the pacemaker (figure 1). Chemotherapy was given through a right-sided venous port and radiotherapy was planned. Moving the pacemaker out of the radiation field would require either use of a lead extender and tunneling or implantation of a third electrode through the right subclavian vein already occupied by the venous port. As pacing need was modest, we decided to complete radiotherapy with the pacemaker left in site. The initial test values were normal. The pacemaker was reprogrammed to 000-mode under initial telemetry supervision. During the following two weeks, the patient was followed at the outpatient clinic, with no bradycardia-related symptoms.

The patient subsequently received hyperfractionated intensity modulated radiotherapy with 1.6 Gy twice daily in 50 fractions during 5 weeks to a total dose of 80 Gy with 6 opposing fields in 43 segments using a 6 megavolt photon beam. The calculated maximum, minimum and mean doses to the entire pacemaker were 48 Gy, 9 Gy and 25 Gy, respectively. The
pacemaker was exposed to direct radiation in one of the beams, thus receiving up to 7 Gy min\(^{-1}\) for short periods. A pacemaker control during this period showed unchanged normal values. At control immediately after the radiotherapy, the technical parameters were normal (threshold 0.625V, electrode impedance 400 ohm, battery impedance 400 ohms). A measurement one year later showed unchanged values (threshold 0.5V, electrode impedance 450 ohm, battery impedance 0.5 kohm).

We present an uncomplicated case of a pacemaker receiving a radiation dose significantly exceeding the guidelines (1). Several reports describe adequate pacemaker function after irradiation with 45-70 Gy close to the device (4-6). A review describes device malfunction in less than 30% after radiation therapy (7). Pacemakers with thin CMOS gates are relatively resistant. At a cumulative in-vitro dose of 246 Gy, five of six 3 ug devices were operative (but none of the older 5 and 8 um devices) (8). However, to our knowledge, no clinical report has previously described a dose to target of 80 Gy close to the pacemaker. The circuits in Vitatron T20®, similar to current Medtronic®, Sorin® and Boston Scientific® devices have a gate thickness of ≤ 1.5 µm, which may be one explanation for their relative resistance to irradiation. The approach must however be carefully individualized. The decision to leave the pacemaker in place during high dose radiotherapy can be considered if the patient is not pacemaker-dependent and the drawbacks of a repositioning are significant.
References

A 3-D volume-reconstruction of the planning target volume (PTV) dose-field. The pacemaker, the right ventricular electrode and the right atrial electrode (disconnected and isolated) are seen immediately outside the field volume. The venous port enters the upper caval vein through the opposite subclavian vein.