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Permanent cardiac implantable device damage during direct photon exposure for oncologic radiotherapy: a multicentre, in-vitro observation

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Backgroung. Direct photon exposure of cardiac implantable devices (CIEDs), both pacemakers (PMs) or implantable cardioverter defibrillators (ICDs), during oncologic radiotherapy (RT) courses may transiently or permanently affect normal device function.

Purpose: To evaluate CIED damage by direct exposure to doses up to 10 Gy in oncologic RT, commonly considered unsafe or even potentially harmful, 206 CIEDs (143 PMs and 63 ICDs) from three different centres, with at least 4 months to Elective Replacement Indicator (E.R.I.) were observed.

Methods. All CIEDs had a baseline telemetry interrogation. Single chamber devices were programmed in the VVI/40 mode and dual or triple chamber ones were programmed in the DDD/40 mode. Rate adaptive function was disabled. In ICDs, antitachycardia therapies were disabled with the ventricular tachycardia/fibrillation window left enabled. A centering Computed Tomography was performed to build the corresponding treatment plan and CIEDs were blinded randomized to receive either 2, 5 or 10 Gy (direct exposure) by a 6 MV linear accelerator in a home-made water phantom. An in-vivo dosimetry randomly assessed the effective dose received by the CIEDs. All CIEDs were interrogated immediately after exposure and monthly during a three-month follow-up.

Results. Immediately after photon exposure, no changes in device setting or software errors were observed in 205 CIEDs (99·5%). Reset to emergency back-up mode was observed in a PM (0·49% overall; 0·7% among PMs). Seven PMs reached the E.R.I immediately after exposure (3·4% overall; 4·9% among PMs). Sixteen ICDs (7·8% overall; 25·4% among ICDs) reported multiple ventricular tachycardia/fibrillation detections stored in the device memory. During follow-up, a non-reprogrammable software reset (emergency backup VVI/65 mode) was observed in one PM after a single dose of 2 Gy (0·49% overall; 0.7% among PMs), whereas an abnormal battery drain was observed in 6 PMs (2.9% overall; 4.2% among PMs). No battery issues were observed in ICDs. All reported events occurred regardless of either 2, 5, or 10 Gy direct exposure. Malfunctions were observed in only older CIEDs.

Conclusions. Recent CIEDs have shown to be safe during oncologic RT, withstanding direct exposure up to 10 Gy, commonly considered not recommended or even unsafe by manufacturers statements and clinical guidelines. Malfunctions occurred solely in older devices.