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Management of cardiac implantable devices in patients undergoing radiotherapy

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Abbreviations: CIED, cardiac implantable electronic devices; PPM, permanent pacemaker; ICD, implantable cardioverter defibrillators; ATP, antitachycardia pacing; CRT, Cardiac resynchronization therapy.

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The size of the problem

Cardiac implantable electronic devices (CIEDs) include permanent pacemakers (PPMs) and implantable cardioverter defibrillators (ICDs). They are commonly used devices with over half a million PPMs and 100,000 ICDs implanted annually in Europe.[1] Radiotherapy (RT) is a well-established treatment for malignancies and other proliferative disorders, with between 50% and 70% of oncology patients requiring RT at some point in their illness.[2,3] In 2012, it was estimated that the annual rate of RT in patients with a CIED was 4.33 treatments per 100,000 person years[4]. Therefore, it is important that health care professionals involved in the care of this complex group of patients are aware of the potential issues and familiar with relevant guidance and best clinical practice.

CIEDs

The majority of PPMs consist of a pulse generator (can), which contains the battery and electronics, and the leads (insulated wires) that are in contact with the heart.[5] The leads, which travel intravenously, act as a "two-way street" with the sensing of spontaneous cardiac electrical activity as well as electrical transmission to the heart in order to pace.[6] Typically, PPMs are implanted to treat bradycardia and pacing can occur continuously or intermittently (when required). For simple bradycardia pacing, the leads are sited in the right atrium, the right ventricle, or both.

In the majority of cases, the pulse generator is implanted in the left prepectoral region but it can be positioned subpectorally or on the right side, also occasionally in the axilla or even in the abdomen. More recently, leadless PPMs have been introduced that are entirely self-contained (pulse generator, sensing, and pacing electrodes all within one capsule that is delivered to the right ventricular apical septum.[7]

Patients have differing degrees of dependency on their PPMs. For those with complete heart block, or patients postatrioventricular node ablation, the PPM is vital for the maintenance of a stable cardiac rhythm (pacemaker dependency).

ICDs have the same functions as a basic PPM but are also able to provide antitachycardia therapy if required. This is in the form of defibrillation or antitachycardia pacing (ATP; a burst of extra beats at a faster rate than the arrhythmia). ICDs are implanted as primary preventative devices in patients who are at an increased risk of dangerous ventricular arrhythmias or for secondary prevention in patients who have survived such an event. In contrast to PPMs, they are often implanted in younger patients who may have a genetic predisposition to sudden cardiac death. ICDs reduce the risk of sudden cardiac death in patients with heart failure[8,9] and are indicated in patients with an ejection fraction $<35\%$, who are on optimum medical therapy, in New York Heart Association classes II-III and who are expected to live for >12 months.[10]

Cardiac resynchronization therapy (CRT) or biventricular pacing involves an additional lead, which is usually epicardial and placed in the coronary sinus.[11] CRT devices are implanted in selected patients with heart failure to enable simultaneous pacing of the left and right ventricles. In contrast to single or dual chamber PPMs where the aim is to pace as little as possible, with CRT devices the aim is to achieve constant ventricular pacing. This enables resynchronization, an improvement in cardiac function and a reduced mortality risk.[12,13] If a patient requires both CRT and an ICD then one device can perform both functions (CRT-D).

Potential dangers of RT in patients with a CIED

The potential problems with CIEDs can be divided into three main groups[14]:

- Transient issues caused by interference that occur during the period of irradiation only. This includes loss and/or inhibition of pacing, rapid or inappropriate pacing, and/or oversensing, which may lead to inappropriate ATP or an inappropriate shock.[15]

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