Guidelines for Perioperative Management of Cardiac Pacemakers and Implanted Defibrillators

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Summary and Key Recommendations

- Patients with cardiac implantable electronic devices (CIEDs) must be identified at pre-assessment.
- Efforts should be made to determine the reason for the implant, the type of device and degree of pacemaker-dependency.
- The device should have been checked within the previous 6-12 months depending on the type of device and its age.
- ICDs must have their shock mode temporarily turned off for the duration of the procedure if diathermy is to be used.
- A defibrillator with external pacing facility must be available in the theatre, and pads should be placed on the patient if they are pacemaker dependant.
- Bipolar diathermy should be used whenever possible.
- If monopolar diathermy is essential, the diathermy plate should be placed as far as possible from the device, avoiding the device being between the diathermy forceps and the plate.
- Monopolar diathermy should never be used close to a device.
- Placing a magnet over a pacemaker is NOT recommended.
- In an emergency or if a technician is unavailable, placing a magnet over an ICD will usually turn off the shock function as long as it remains in place.
Introduction

In 2013-14, more than 70,500 people had a pacemaker fitted in England, and more than 10,000 had an implantable cardioverter defibrillator (ICD) fitted. As the population gets older; this number continues to rise. The blanket term Cardiac Implantable Electronic Devices (CIEDs) is now commonly adopted by healthcare professionals to describe pacemakers, ICDs, and implantable loop recorders (ILRs).

Most pacemakers are inserted for the treatment of persistent, symptomatic bradycardia, and some patients have no underlying rhythm and are therefore pacemaker-dependent and will become asystolic if the pacemaker stops working. ICDs are inserted for the treatment of ventricular arrhythmias (VT/VF), while CRT (cardiac resynchronisation therapy) devices are used to optimize ventricular activation and improve cardiac function in heart failure.

Many of these people will need some form of general surgery, either in a planned elective procedure or as an emergency. In either setting, it is vitally important that appropriate care be provided so that the techniques used in surgery, particularly diathermy / electrocautery, do not cause harm to the patient or their device.

Cardiac Implantable Electronic Devices

Pacemakers and defibrillators are designed to sense intra-cardiac electrical signals and deliver therapy according to need. However, diathermy/electrocautery (and other sources of electromagnetic interference (EMI)) can be misinterpreted by CIEDs as intrinsic cardiac activity and result in inappropriate inhibition of pacing and potentially asystole in a pacing dependent patient. EMI may also result in the induction of fixed rate pacing, or software reset. However, most EMI is usually transient in its effect, with resumption of normal device function upon withdrawal of the interference. Permanent device effects are uncommon and encountered usually in the setting of powerful magnetic fields only (eg. gamma radiation or very strong magnetic fields).

ICDs are implanted in patients who are at risk of life-threatening ventricular arrhythmia, most commonly those with poor ventricular function as a consequent of coronary artery disease, but also in patients with dilated or hypertrophic cardiomyopathy, channelopathies eg. Brugada and long QT syndromes. If an ICD senses external electrical activity, it may interpret this as VT or VF, and deliver inappropriate anti-tachycardia pacing and/or DC shock therapy, which if delivered to a heart in an otherwise stable rhythm may cause cardiac arrest.

Implantable loop recorders are diagnostic devices which permit long term monitoring of cardiac rhythm in suspected intermittent arrhythmia. Whilst they do not represent any additional risk during surgery, EMI from diathermy will be stored as episodes of tachycardia and where possible it would be desirable to interrogate the device before surgery and clear the stored memory after.

Magnets and Cardiac Implantable Electronic devices

Placing a magnet over an unknown device is not recommended. Pacemakers react in different ways to magnets being placed over them, depending on their manufacturer’s settings. Almost all will revert to an asynchronous fixed pacing mode at a rate set by the manufacturer. Asynchronous fixed pacing can cause life threatening arrhythmias if a mis-timed stimulus causes a premature ventricular complex to occur at the critical time during the T wave of the preceding beat. This so-called R-on-T phenomenon, may trigger polymorphic VT or VF.

In general; a magnet placed over an ICD will suspend anti-tachycardia therapy (ATP) and defibrillation, for the duration of the placement of the magnet. Any pacing function will be unaffected. Alternative
means for defibrillation must therefore be available, so it’s essential to place external pads on the patient before surgery begins if these could not be placed easily during surgery. Care must be taken as if the magnet slips; the ICD will usually revert to its original settings. It is essential a magnet is readily available in theatre complex for management of patients with implantable electronic devices.

Classification of Pacemakers and ICDs

Pacemakers may be single chamber, dual chamber or biventricular, depending on where they sense native cardiac impulses, where they direct their pacing impulses, and how many leads are present. They are commonly described according to the NBG Pacemaker Code illustrated below. E.g. VVI pacemaker paces the Ventricle, senses the Ventricle, and Inhibits pacing when native ventricular activity is sensed. Rate modulation refers to the ability of the pacemaker to adapt to different physiological states e.g. increased heart rate during exercise, or the ability to sense and respond to changes in acid-base status. Multisite pacing is an indication that the pacemaker can stimulate at multiple sites within the same anatomical area e.g. multiple sites within the atria. Most pacemakers are either VVI or DDDR (leads in both right atrium and ventricle, triggered and inhibited + rate modulation)

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Fig 1: The North American Society of Pacing and Electrophysiology (NASPE) and the British Pacing and Electrophysiology Group (BPEG) NBG Pacemaker Code 2002.

Pre-operative Management

Patients with any CIED need to be identified at pre-operative assessment screening. Often the patient has a registration card, and the type of device, manufacturer and model number should be noted. The reason for the implant (e.g. low ejection fraction) needs to be verified and documented as part of the pre-admission process.

The cardiology department should be contacted for advice, following a local protocol. Most patients will not need their device interrogated by a cardiac technician prior to surgery if their pacemaker was checked within the previous year, and ICDs within the previous six months (without any shocks being delivered in this interim).

It is important to determine:

- Type of device and manufacturer (Pacemaker / ICD / ILR)?
- Implanting hospital, follow-up hospital?
- Date of last follow-up?
- Reason for insertion of CIED?
- If the patient is pacemaker dependant i.e. at risk of asystole in the event of pacing inhibitions?
- If the battery is near depletion? This will determine the asynchronous rate and may result in the device not functioning at all if affected by diathermy and the battery is low.
• Device location? CIEDs are usually implanted in the left or right pre-pectoral region; however, some devices may be located in left lateral chest wall and very rarely the abdomen.

• What effect placing a magnet over the CIED will produce?

• What settings are programmed for an ICD to detect and treat VT/VF?

If the patient has an ICD, a cardiac technician should be requested to turn the defibrillation setting off immediately prior to surgery, and back on immediately afterwards. If the cardiology department cannot provide this service or it is outside normal hours, advice should be sought as to whether placing a magnet over the device is an appropriate alternative. Any anti-arrhythmic or beta-blocker therapy should be continued peri-operatively, and not withheld. This may necessitate giving small intravenous doses post-operatively if the patient is nil by mouth.

Intra-operative Management (Elective Surgery)

• There must be an external defibrillator with external pacing capability within the operating room, and if the patient is pacemaker-dependant, we recommend placing the pads on the chest prior to surgery.

• Be aware that shivering, large tidal volumes and succinylcholine induced fasciculations may be interpreted by a pacemaker in demand mode or an ICD, as intrinsic cardiac activity, and severe bradycardia, asystole or defibrillation may ensue.

• Make sure the ECG monitor is in non-paced mode (so that pacing spikes are not interpreted as complexes in the event of asystole).

• Place the diathermy plate as far from the device as possible and avoid the device being between the operation site and plate e.g. if the device is in the in upper left chest, place plate on right thigh for surgery below the chest.

• Do NOT place a ring magnet over the device, unless advised to do so by a Cardiac Physiologist / Cardiologist who knows the details of that patient’s device and programming.

• Monopolar diathermy should not be used near a pacemaker generator or ICD (eg ipsilateral upper anterior chest wall, shoulder or neck area) due to high risk of EMI and attendant risks already described.

If diathermy must be used:

• Use bipolar diathermy where possible, to minimise electrical interference.

• If monopolar diathermy is essential, use away from the device, and in short bursts, 1 second or less, with ECG monitoring to observe the effect on the rhythm. Pure cut is better than blend or coagulation.

• Between each 1 second burst of diathermy there should be a 3 second delay to allow recovery from any asystole that occurs during the delivery of diathermy.

• If a serious arrhythmia develops during diathermy, treat the arrhythmia as usual, stop using diathermy, complete the operation as safely as possible and contact a device physiologist as soon as possible.

• In the event that the patient becomes asystolic, has a ventricular arrhythmia, or any pulseless electrical activity during a surgical procedure, resuscitation and medical intervention should take place without delay in the usual manner of managing a cardiac arrest – irrespective of the patient’s device.

Emergency Surgery (out of normal hours)

• If cardiological advice is not available, a magnet will usually cause a suspension of the shock function in an ICD. The magnet needs to be secured over the device with tape for the duration of the procedure.
• In a patient with an ICD which has not had the shock mode switched off, there must be a 10 second delay between each 1 second burst of diathermy to reduce the possibility of triggering an inappropriate shock.

Postoperative Management

• A 12-lead ECG should be performed as soon after surgery as practical. If the heart rate is below 50bpm on the 12-lead ECG there may be a problem with the device and a device physiologist should be contacted as soon as possible.
• The device technician must be called when the patient with an ICD enters recovery in order to switch the shock mode back on.
• A pacemaker / ICD check should be performed post-operatively prior to discharge if the patient has experienced arrhythmias intra-operatively, if a magnet was placed over the CIED, or if it is thought that diathermy may have damaged the CIED or leads. If the pacemaker was not interfered with prior to, or during surgery, and no adverse cardiac events occurred, the pacemaker can be interrogated at it's next routine interval.

Wireless pacemakers

The first wireless pacemaker (which is the size of a large vitamin tablet - Micra Transcatheter Pacing System 2.6mm x 6.7mm) was approved by the FDA in April 2016. The first one fitted outside of a clinical trial was implanted at the James Cook University Hospital in the same month. It is usually implanted in the right ventricle where it can deliver ventricular pacing. The usual battery life is approximately 12 years. Patients presenting for surgery with these devices in situ should be treated as per the guidelines above. The only difference is placing a magnet over the Medtronic Micra™ Transcatheter Pacing System (TPS) will not result in the pacemaker reverting to asynchronous mode. Thus patients who are pacemaker dependant will be at risk of asystole if the pacemaker interprets extrinsic electrical interference as intrinsic cardiac activity.

References

1. MHRA 2006. Guidelines for the Perioperative management of patients with implantable pacemakers or implantable cardioverter / defibrillators, where the use of surgical diathermy is anticipated.
2. BHRS 2019. British Heart Rhythm Society guidelines for the management of patients with cardiac implantable electronic devices (CIEDs) around the time of surgery.