

Practice Guidelines in Anesthesia-2



Indian College of Anaesthesiologists
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Foreword
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CHAPTER 2

Perioperative Management of the Patient with Pacemaker

Muralidhar Kanchi

INTRODUCTION

The first pacemaker's implantation to increase the heart rate was performed in 1958¹. Since then the number of cardiac pacemaker implantations. Done has grown phenomenally; approximately 400,000 pacemaker devices are implanted worldwide each year. With increasing life expectancy, aging population and increased incidence of cardiovascular disorders, a considerable number of patients will need pacemakers or pacemaker-cardioverter-defibrillator devices (PCDs)—a significant numbers of such patients are likely to present for incidental surgery. Hence, it is important to understand the pathophysiology of PCDs and the principles involved in their management when they present with PCDs present for surgery.

PACEMAKER CODES (TABLE 2.1)

To indicate the modes of pacing, a five-letter HRS/NASPE/BPEG (Heart Rhythm Society/ North American Society of Pacing and Electrophysiology/British Pacing and Electrophysiology Group) pacemaker code is widely used.² The first and second positions indicate the chamber(s) paced and sensed, respectively. The third position indicates the response to sensing. T and I indicate triggered or inhibited responses respectively. The letter D in the third position indicates both inhibited and triggered responses (e.g. a sensed atrial event triggers ventricular simulation, unless a sensed ventricular event inhibits ventricular stimulation first). The fourth and fifth positions describe programmable and anti-tachyarrhythmia functions, but these letters are rarely used in practice, except for R (fourth position), which indicates a rate sensor.

Table 2.1: NASPE/BPEG Five position pacemaker code.

I-Pacing	II-Sensing	III-Response	IV-Programmability	V-Tachycardia
0 – None	0 – None	0 – None	0 – None	0 – None
A – Atrium	A – Atrium	I – Inhibited	C – Communicating	P – Pacing
V – Ventricle	V – Ventricle	T – Triggered	P - Simple programmable	S – Shocks
D – dual (A+V)	D-Dual (A+V)	D-Dual (I+T)	M-Multiprogrammable	D- Dual (P+S)
S-Simple (A or V)	S-Simple (A or V)		R- Rate modulation	

Indications for Pacemaker

- Symptomatic sinus node disease
- Symptomatic atrioventricular node disease
- Long QT syndrome
- Hypertrophic obstructive cardiomyopathy
- Dilated cardiomyopathy

PREANESTHETIC EVALUATION AND PACEMAKER REPROGRAMMING

Systemic examination and optimization of coexisting disease(s) forms the basic backbone of preoperative management of a patient with a pacemaker. Preoperative investigations should be dictated by the patient's underlying disease(s), medication(s) and planned intervention. For programmable devices, interrogation with a programmer remains the only reliable method for evaluating lead performance and obtaining current program information. The anesthesiologist must review the patient's pacemaker history and follow-up schedule. Determining dependency on the pacemaker function might require temporary reprogramming to a VVI mode with a low rate. In patients from countries where pacemakers might be reused, better performance might not be related to length of implantation in the current patient.^{3,4} The safest way to avoid intraoperative problems is to reprogramme the pacemaker appropriately especially if monopolar electrocautery is used. For lithotripsy, consideration should be given to programming the pacing function from an atrial paced mode, as some lithotriptors are designed to fire on the R wave, and the atrial pacing stimulus could be misinterpreted as the contraction of the ventricle. Reprogramming a pacemaker to asynchronous pacing at a rate greater than patients underlying rate usually ensure that no over sensing or under sensing during electromagnetic interference (EMI) will take place, thus protecting

the patient. Reprogramming a device will not protect it from internal damage or reset caused by EMI.

PREOPERATIVE EVALUATION

- Complete history and physical examination mandatory
- Most have underlying cardiovascular disease
 - ◆ Functional status
 - ◆ Progression of disease
 - ◆ Associated disease (comorbid states, diabetics mellitus and hypertension common)
 - ◆ Current medication
 - ◆ Compliance with therapy
 - ◆ ECG -rhythm strip
 - ◆ Chest X-ray especially if cardiac disease/ biventricular (BiV) pacemakers or automatic implantable cardioverter defibrillator (AICD)
- Pacemaker interrogation to evaluate performance⁵
- Reprogram to asynchronous mode
- Reprogram pacemaker to a rate higher than intrinsic rate
- Suspend antitachycardia function
- Rate-responsiveness is disabled⁶⁻⁸

INTRAOPERATIVE MANAGEMENT

- A. **Monitoring:** Level and invasiveness of monitoring should be dictated by the patient's underlying disease(s), medication(s), and planned intervention.
 - i. *ECG:* Continuous monitoring of ECG is obligatory to detect pacemaker discharges. The noise filtering on the ECG monitor must be changed to permit demonstration of the pacemaker discharge. Devices such as a nerve stimulator can interfere with detection and display of the pacemaker pulses.⁹

- ii. Continuous monitoring must necessarily include the ability to ensure that myocardial activity is converted to mechanical systoles and pulsatile blood flow. The simplest of the monitor of pulsatile blood flow is the 'finger-on-the-pulse'. However, clinically, mechanical systoles are best evaluated by pulse oximetry, plethysmography, or arterial waveform display.
- iii. Arterial blood pressure monitoring either noninvasive or invasive is mandatory to assess the adequacy of tissue perfusion.
- iv. Some patients might need an increased pacing rate during the preoperative period to meet an increased oxygen demand.
- v. An esophageal Doppler monitor or a transesophageal echocardiogram can be used to evaluate stroke volume, pacing frequency and its relationship to cardiac output. This will be necessary in high-risk surgery.
- vi. Monitoring of arterial blood gases, serum electrolytes and acid-base status will be needed if it is a major surgery and/or patient is at high-risk for decompensation.
- vii. A pulmonary artery catheter (PAC): Presence of pacemaker by itself is not an indication for the insertion of a central venous, pulmonary artery catheter. If CVP or PAC is indicated for other reasons, care should be taken during insertion of guidewire to not only prevent dislodgement of freshly placed pacing lead but also to avoid arrhythmia.^{10,11}

B. Anesthetic technique: With respect to anesthetic technique, no studies have one technique proved to be superior over the other. The choice of anesthetic technique

Table 2.2: Interference with pacemakers.

Electromagnetic interference (EMI)
■ Mechanical and other interferences
■ Ventilators
■ Cellular phones
■ Whole-body vibrations
■ Skeletal myopotentials
■ Electroconvulsive therapy
■ Succinylcholine fasciculations
■ Myoclonic movements
■ Direct muscle stimulation

should be dictated by the physical condition of the patients and surgical need. Either of inhalational or narcotic technique can be used successfully. However, drugs that cause fasciculation (suxamethonium), myoclonic movements (etomidate, ketamine) may be avoided. Similarly shivering is not desirable in a patient with a pacemaker. A number of reports of prolongation of the QT interval with the use of isoflurane, desflurane, or sevoflurane have been published, whereas halothane appears to reduce this interval. No interactions have been reported for enflurane. The pacemaker may be interfered with the environment in the operating rooms; this is highlighted in Table 2.2.

C. Caution: The use of monopolar electrocautery (ESU) remains the major intraoperative issue for the patient with a pacemaker. The following guideline is recommended regarding the use of cautery: (1) cautery tool and current return pad are positioned in such a way that the current path does not pass through the cardiac implantable electronic device (CIED), (2) avoid proximity of cautery electric field to the pulse generator, (3) use short intermittent bursts at the lowest feasible energy

level, (4) bipolar cautery is preferred during surgery in patients with implanted pacemakers, (5) use of ultrasonic/harmonic scalpel, (6) 'coagulation' ESU will likely cause more problems than no blended 'cutting' ESU, (7) Magnet placement during electrocautery might allow reprogramming of an older (pre-1990) generator; however, newer generators are relatively immune to such effects. Note, however, that strong EMI can produce an electrical reset or a detection of battery depletion, which might change the programming mode, rate or both. If monopolar electrocautery is to be used, then the current return pad should be placed to ensure that the electrocautery current path does not cross the pacemaking system. For cases such as head and neck surgery, the pad might be best placed on the shoulder contralateral to the implanted device. For breast and axillary cases, the pad might need to be placed on the ipsilateral arm with the wire prepped into the field by sterile plastic cover.

HEMODYNAMICS OF PACING IMPORTANCE OF ATRIAL FUNCTION

- Properly timed atrial systole could enhance ventricular stroke volume by 50%.
- Atrial contribution to ventricular volume is divided into initial rapid ventricular filling, diastasis, and atrial systole.
- Force and timing of atrial contraction and atrial compliance greatly influence the effect of atria on ventricular filling and contractility.
- Low atrial compliance restricts the increase in peak and mean atrial pressures during passive ventricular filling which occupies

more than one half of ventricular diastole and pacing with non-sequential pacing modes results in low atrial compliance.

The use of an ultrasonic cutting device, commonly called a "harmonic scalpel" has been recommended to prevent EMI while providing the surgeon with the ability to both cut and coagulate tissue.¹²⁻¹⁵ There are a number of case reports demonstrating successful surgery without EMI issues in these patients.

Competing Rhythms

- Myocardial ischemia
- Severe metabolic/physiologic disturbance
- Digitalis toxicity
- Exposure to high catecholamine levels
- Long QT interval
- Hypothermia

MRI: At this time, magnetic resonance imaging (MRI) deserves special mention.^{16,17} In general, MRI has been contraindicated in pacemaker and ICD patients. However, reports suggest that MRI is probably safe for some patients with newer devices, as well as any patient who will be wide awake in the MRI tunnel, who is not dependent upon his or her pacemaker for heart rhythm or survival, who will not need medication to undergo the MRI, and who can communicate regularly with the MRI care team. Nevertheless not all MRI sequences and energy levels have been studied, and caution is advised.

HOW TO MINIMIZE ELECTROMAGNETIC INTERFERENCE WITH PACEMAKERS?

- Use bipolar cautery
- If unipolar, ground plate should be arranged in a path as far away as possible from pacemaker

- Monitor pulsatile flow of blood to detect pacemaker inhibition
- Request surgeon to reduce electrocautery time; not more than 1 second bursts every 10 seconds
- Program pacemaker to asynchronous operation: if this is not possible, place a magnet over the device (caution: Not all pacemakers switch to asynchronous mode with a magnet)
- Shield pulse generators from beams of ionizing radiation
- Do not place the cardioverter – defibrillator paddles directly over the pulse generator; use lowest possible energy shocks in the event of atrial/ventricular fibrillation
- Have the device checked for function after exposure to strong EMI
- Battery-powered cautery does not interfere with pacemaker function; have an alternative mode of temporary pacing available in the OR.

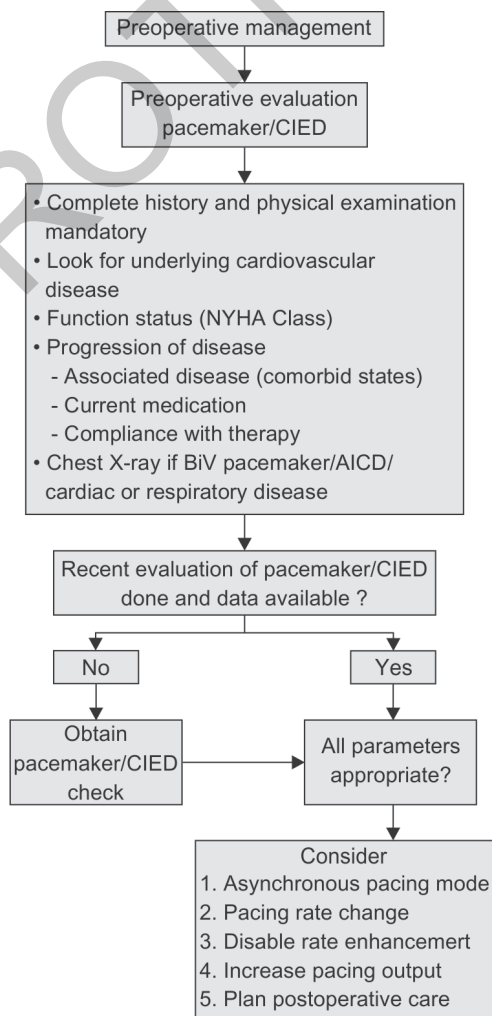
SPECIAL PROCEDURES IN PATIENTS WITH IMPLANTABLE GENERATORS

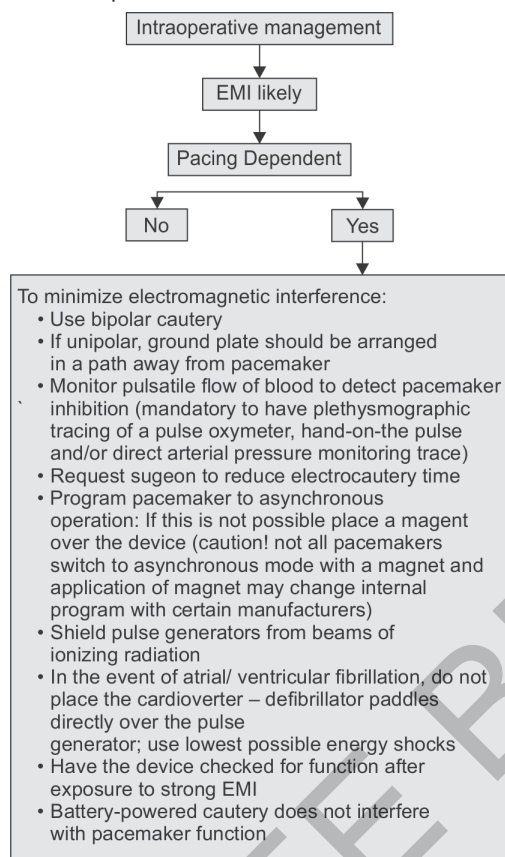
- Magnetic resonance imaging (MRI)—absolutely contraindicated by most generator manufactures, and deaths have been reported.
- Lithotripsy—acceptable with precautions to protect the generator and possible programming out of an atrial pacing mode.
- Transurethral resection (bladder, prostate), and uterine hysteroscopy—procedures using monopolar electrocautery that can be easily accomplished after device reprogramming.
- Electroconvulsive therapy—requires asynchronous (non-sensing) mode.
- Nerve stimulator testing/therapy—inappropriate detection of transcutaneous

electrical nerve stimulation, neuromuscular, and chiropractic electrical muscle stimulation as ventricular tachycardia or fibrillation has been reported (Flowcharts 2.1 to 2.3).

ALGORITHM FOR MANAGEMENT OF PATIENTS WITH PACEMAKERS

Flowchart 2.1: Preoperative management of patients with pacemaker.



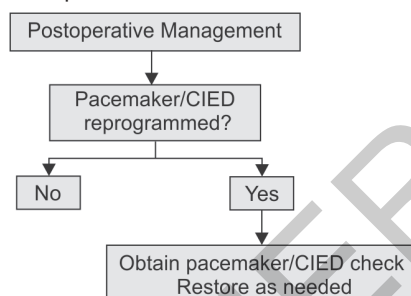
Flowchart 2.2: Intraoperative management of patients with pacemaker.


CONCLUSION

Aging population and patients presenting with complex cardiac disease states dictate that many patients with cardiac implantable electronic devices will present for surgical services. Safe and efficient perioperative management of these patients depends on understanding pacing, indications for use and techniques to monitor/maintain cardiac function during surgery.

ACKNOWLEDGMENTS

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Flowchart 2.3: Postoperative management of patients with pacemaker.


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Practice Guidelines in Anesthesia-2

The second volume of *Practice Guidelines in Anesthesia* is in your hands. This is a unique effort by Indian College of Anaesthesiologists (ICA) an academic wing of Indian Society of Anaesthesiologists (ISA). It contains twenty six current topics that cover the recent practice guidelines for preoperative preparations, perioperative problems and their management during anesthesia, pain management and critical care therapy. This book is recommended for postgraduate students, trainees, practicing anesthesiologists and those involved in intensive care. The readers would find it valuable in managing the patients that require anesthetic care, pain management and care of the critically ill.

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