

Artificial pacemaker and anesthesia

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Preop assessment

- Device assessment
- Patient evaluation and preparation

Preop assessment-Device

- Device assessment:
 1. Type of device
 2. Indication of device
 3. Pacemaker mode with its special function
 4. Device functioning status

Preop assessment-Device

- Clinical history and physical examination
- Manufacturers ID card / CXR to identify type of device
- 12 lead ECG with and without magnet
- Assessment of device functioning

Preop assessment-Patient

1. Patient level of dependency to device
2. Intraop factors interfering the device function
3. Consideration of reprogramming
4. Investigations

Preop assessment-Patient

1. History and evaluation of disease that mandated pacemaker
2. Continue antiarrhythmic drug and other cardiac drugs as mandated
3. Consider Electromagnetic and Mechanical Interference (EMI)

Conditions warrant pacemaker reprogramming

1. Pacemaker dependent patients
2. Major procedure in abdomen and chest
3. Rate adaptive feature of pacemakers
4. Suspension of antitachycardia function
5. Surgical procedures with high chances of EMI

Electromagnetic and mechanical interference and pacemaker

1. Radio wave frequency between 0 - 10^9 Hz and microwaves frequency 10^9 - 10^{11} Hz cause EMI
2. Shielding of pulse generator, bipolar leads, and filtering of incoming signals offers some protection against EMI
3. Frequencies 5 - 100 Hz overlap with intracardiac signals

Electromagnetic and mechanical interference and pacemaker

- High probability of EMI
 1. Electrocautery use
 2. Lithotripsy
 3. ECT
 4. Radiation therapy
 5. MRI
 6. Orthopaedic procedures

Electromagnetic and mechanical interference and pacemaker

- EMI effects on pacemaker:
 1. Asynchronous pacing
 2. Pacemaker inhibition or triggering
 3. Resetting or reprogramming pacemaker
 4. Damage to electronic circuits
 5. Burn injury to myocardium
 6. Inappropriate activation of rate adaptive feature and anti tachycardia therapy

Intraoperative management

1. Monitoring
2. Anesthetic technique
3. Measures to prevent device malfunctioning
4. Pacemaker failure trouble shooting
5. Preparation for temporary pacemaker and defibrillation

Monitoring

1. Continuous ECG
2. Signs of peripheral perfusion
3. Invasive monitoring

Cardiac status

Type of surgery

Pacemaker failure

Anesthetic technique

1. Tailored to cardiovascular disease status
2. Anesthetics and pacing threshold
3. Succinylcholine and pacemaker

Electrocautery and pacemaker

Uses radiofrequency of 300- 500 kHz

1. May affect pacemaker related to distance and orientation with the device

Electrocautery and pacemaker

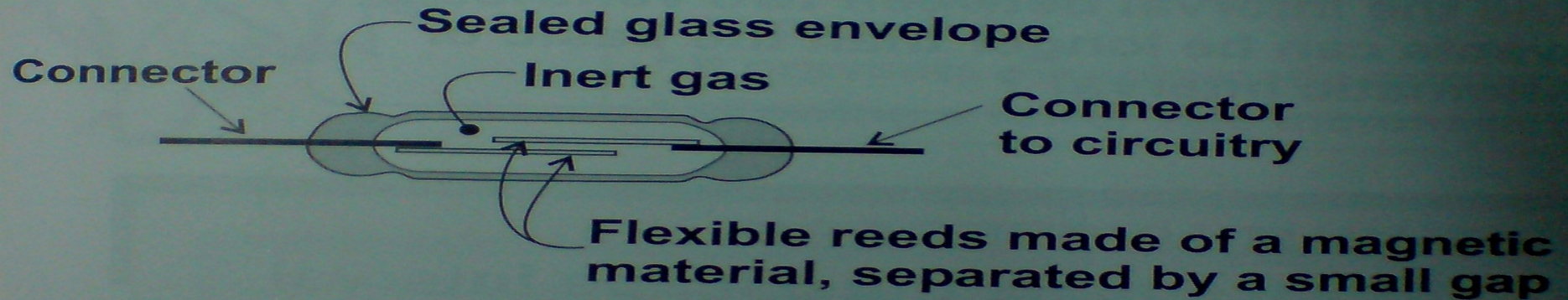
1. Unipolar vs Bipolar vs Ultrasonic scalpel
2. Distance to pulse generator
3. Unipolar return pad
4. Lowest energy possible in short bursts

Magnet and pacemaker

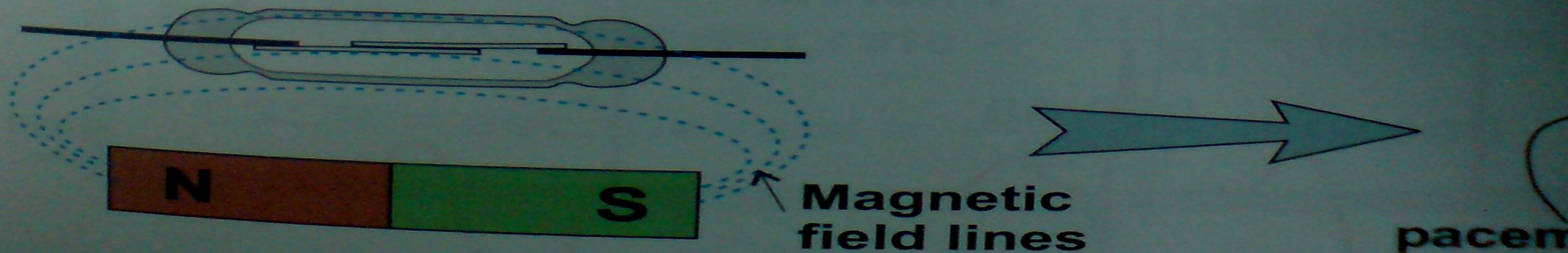
1. Activates magnetic reed switch
2. Model dependent behaviour with magnet

THE MAGNETIC REED SWITCH

NORMAL REED SWITCH OPEN CONTACT WITHOUT MAGNETIC FIELD

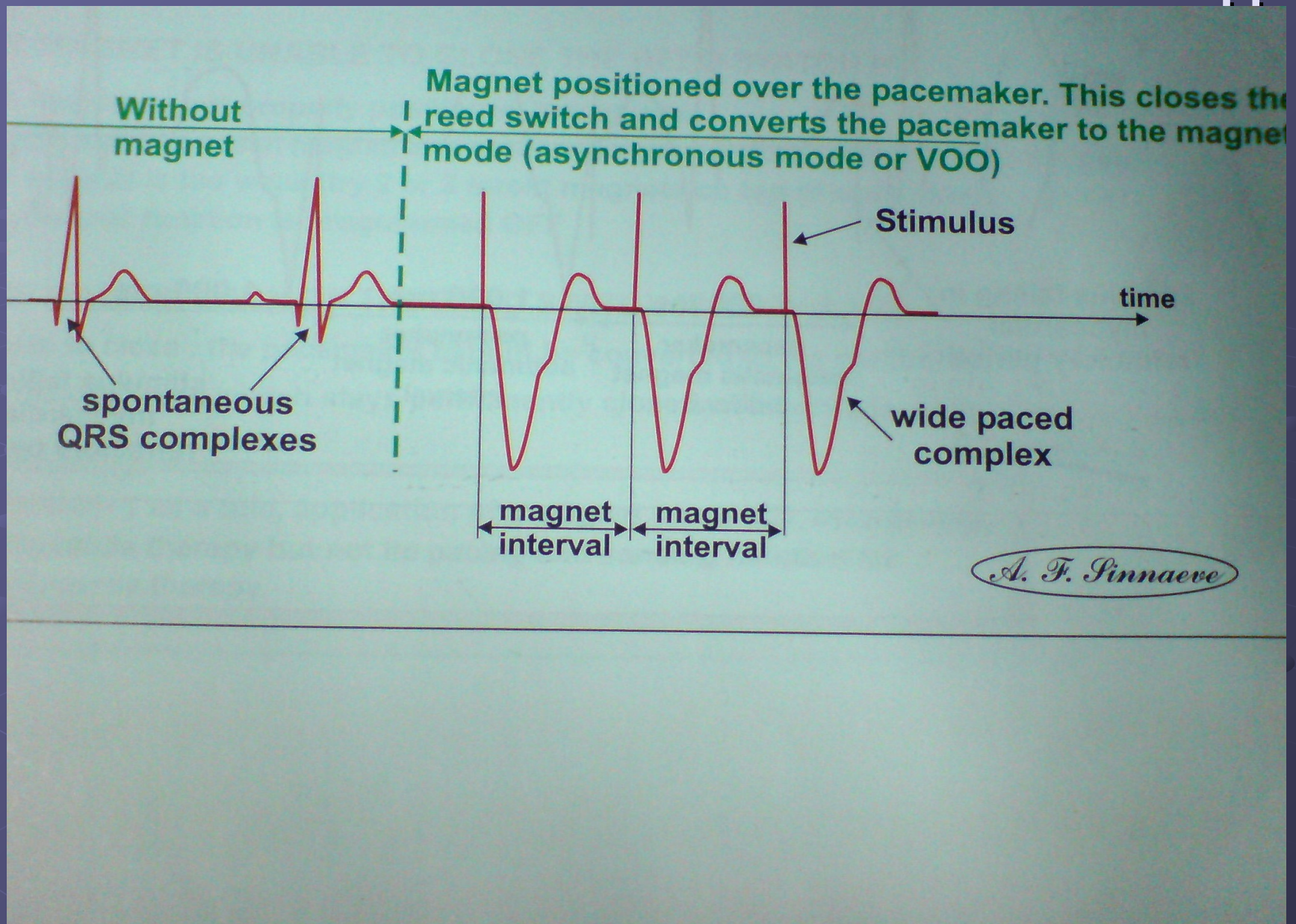


NORMAL REED SWITCH CLOSED CONTACT WITH MAGNETIC FIELD



Pacemaker magnet behaviour

1. Asynchronous pacing – most common
2. No apparent rate or rhythm change
3. Brief asynchronous pacing and then return to programmed value
4. Continuous or transient loss of pacing



Pacemaker failure

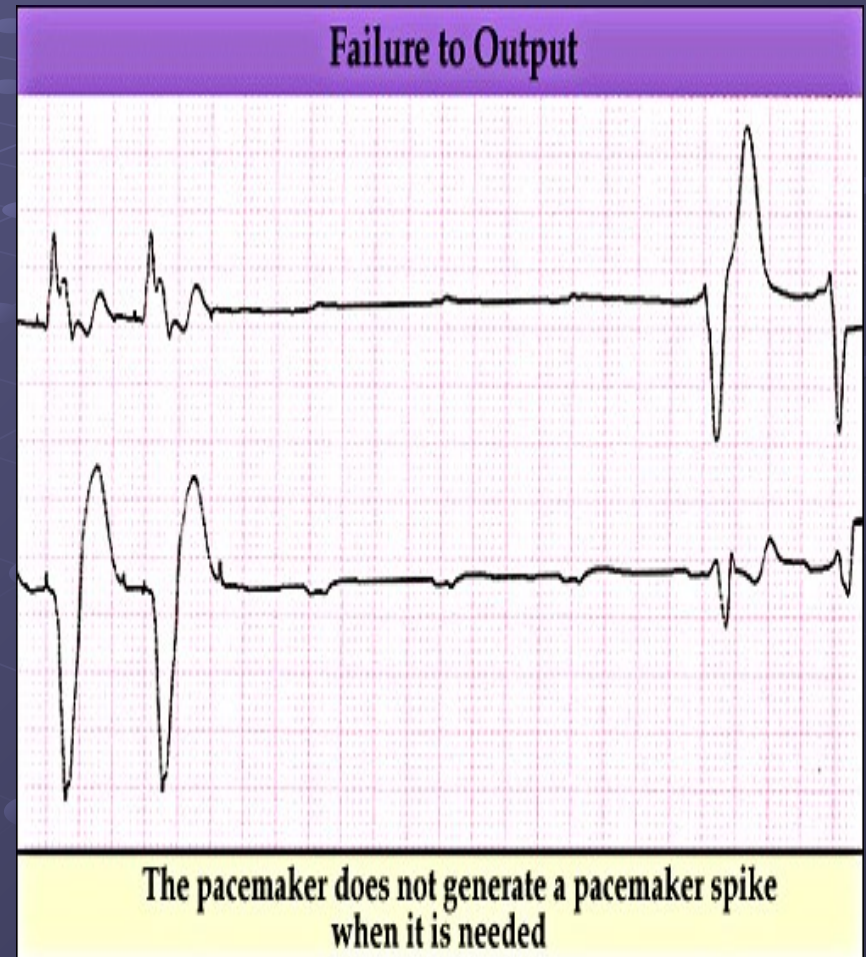
1. Recognise
2. Assess haemodynamic status
3. Identify the cause
4. Manage

Pace maker failure

1. Failure to pace
2. Failure to capture
3. Undersensing / failure to sense
4. Oversensing

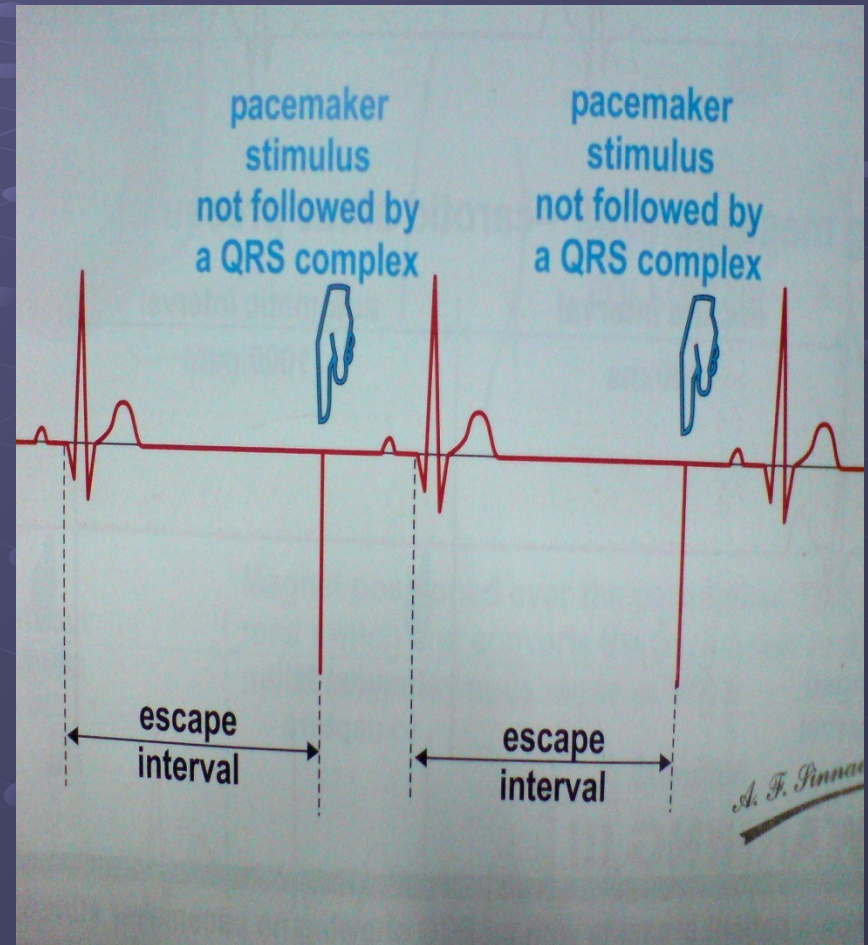
Failure to pace

- Loss of pacing artifact in ECG in the absence of spontaneous QRS wave



Failure to capture

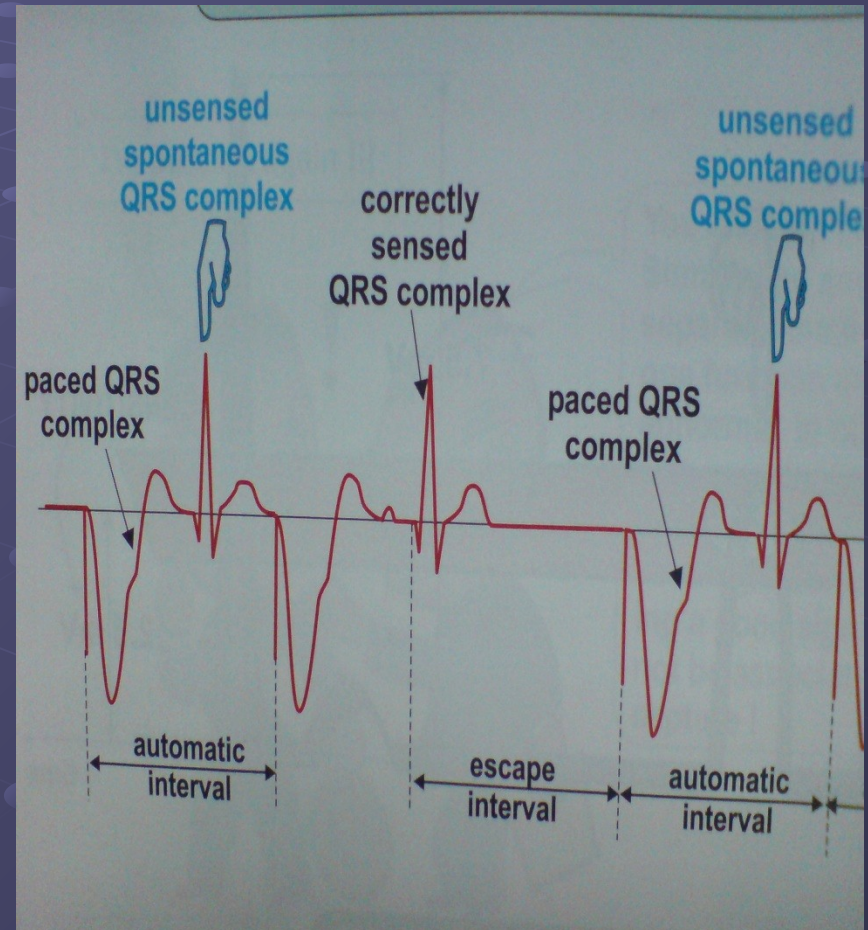
1. Absence of 'P' or 'QRS' wave following atrial or ventricular artifact in ECG



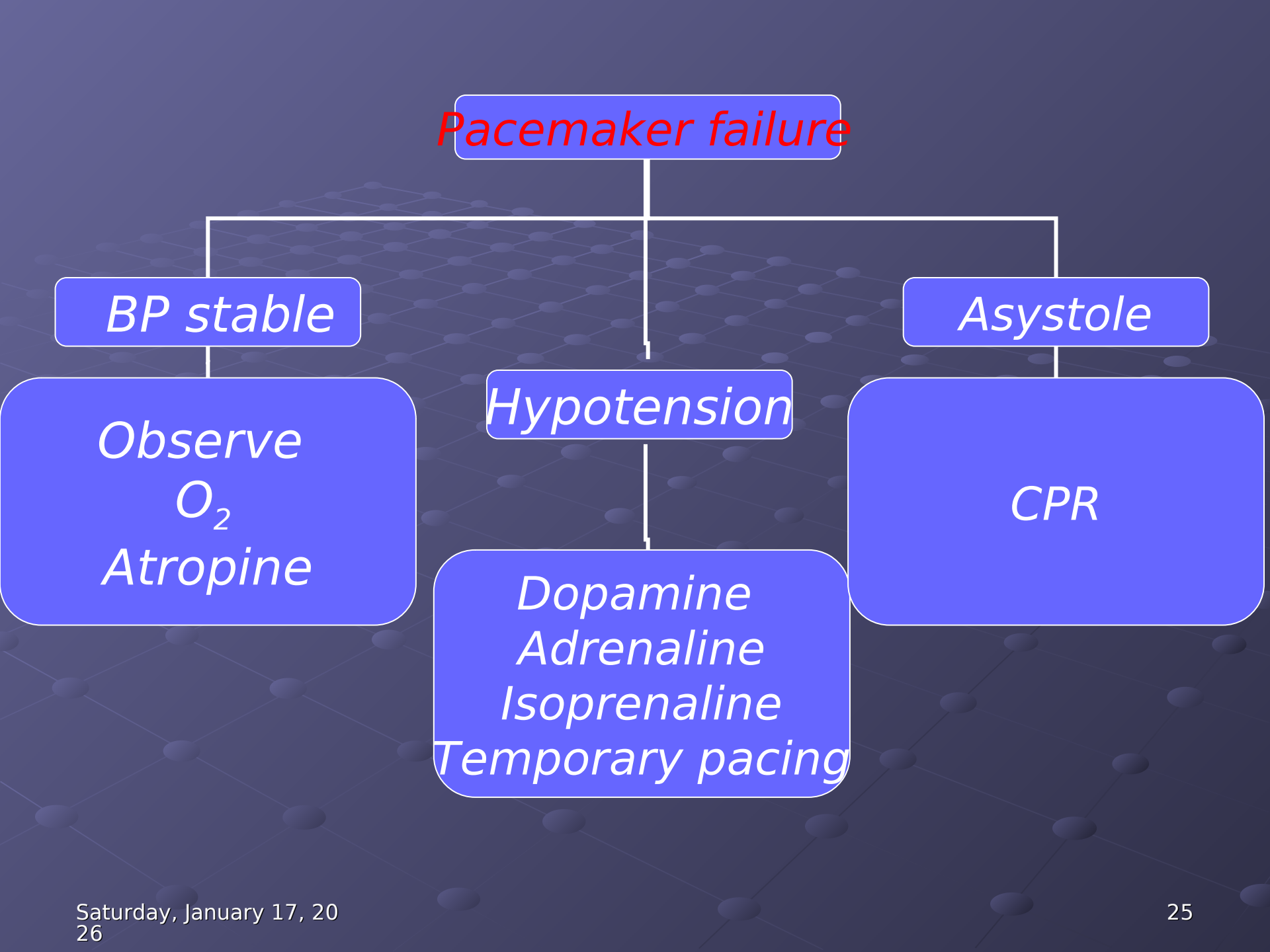
Under sensing

1. Pacing artifact in the middle of spontaneous 'P' or 'QRS' wave

-no
change in
automatic interval



Pacemaker failure



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graph TD; A[Pacemaker failure] --> B[BP stable]; A --> C[Hypotension]; A --> D[Asystole]; B --> E[Observe<br/>O<sub>2</sub><br/>Atropine]; C --> F[Dopamine<br/>Adrenaline<br/>Isoprenaline<br/>Temporary pacing]; D --> G[CPR];
```

BP stable

*Observe
O₂
Atropine*

Hypotension

*Dopamine
Adrenaline
Isoprenaline
Temporary pacing*

Asystole

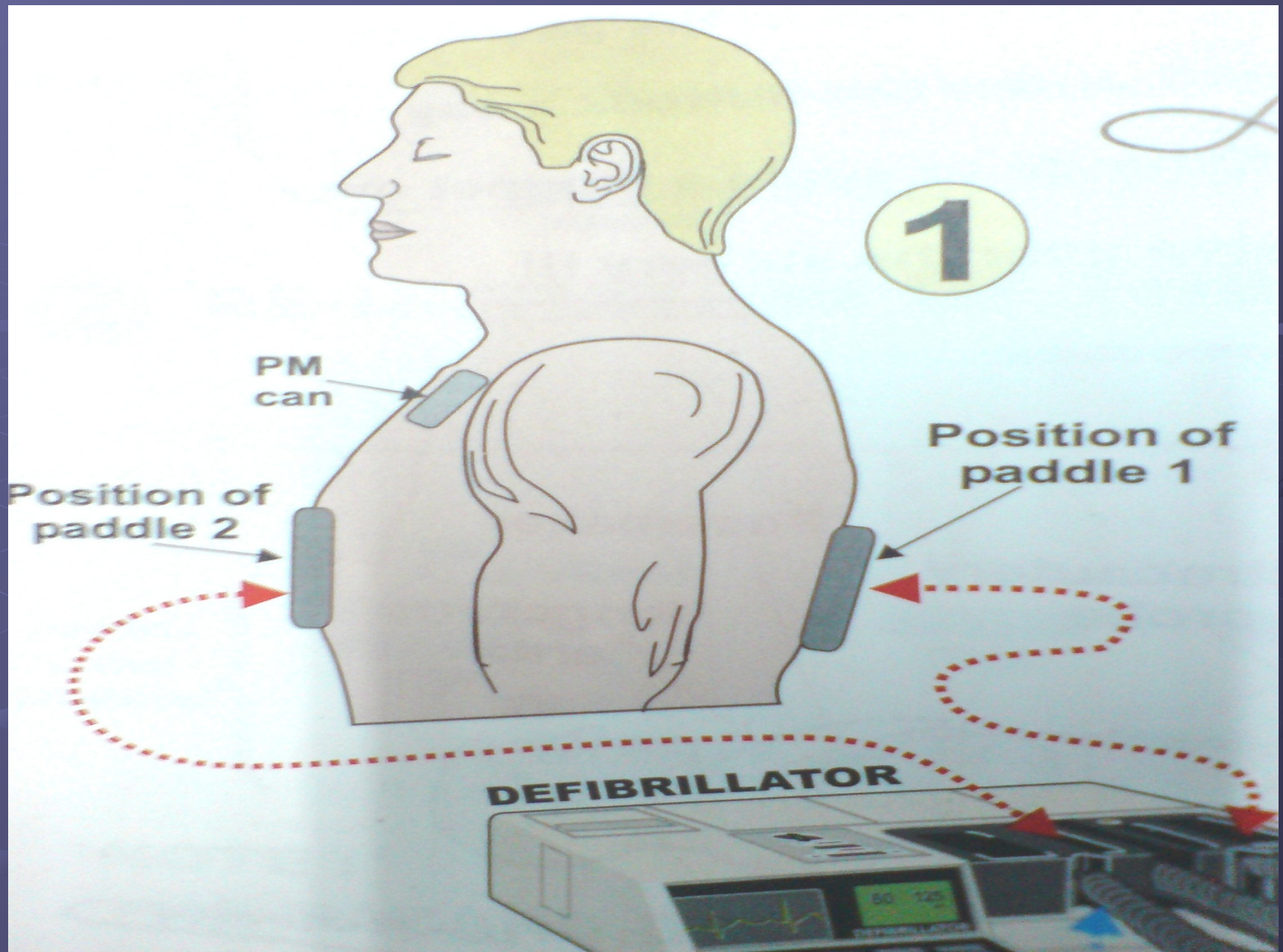
CPR

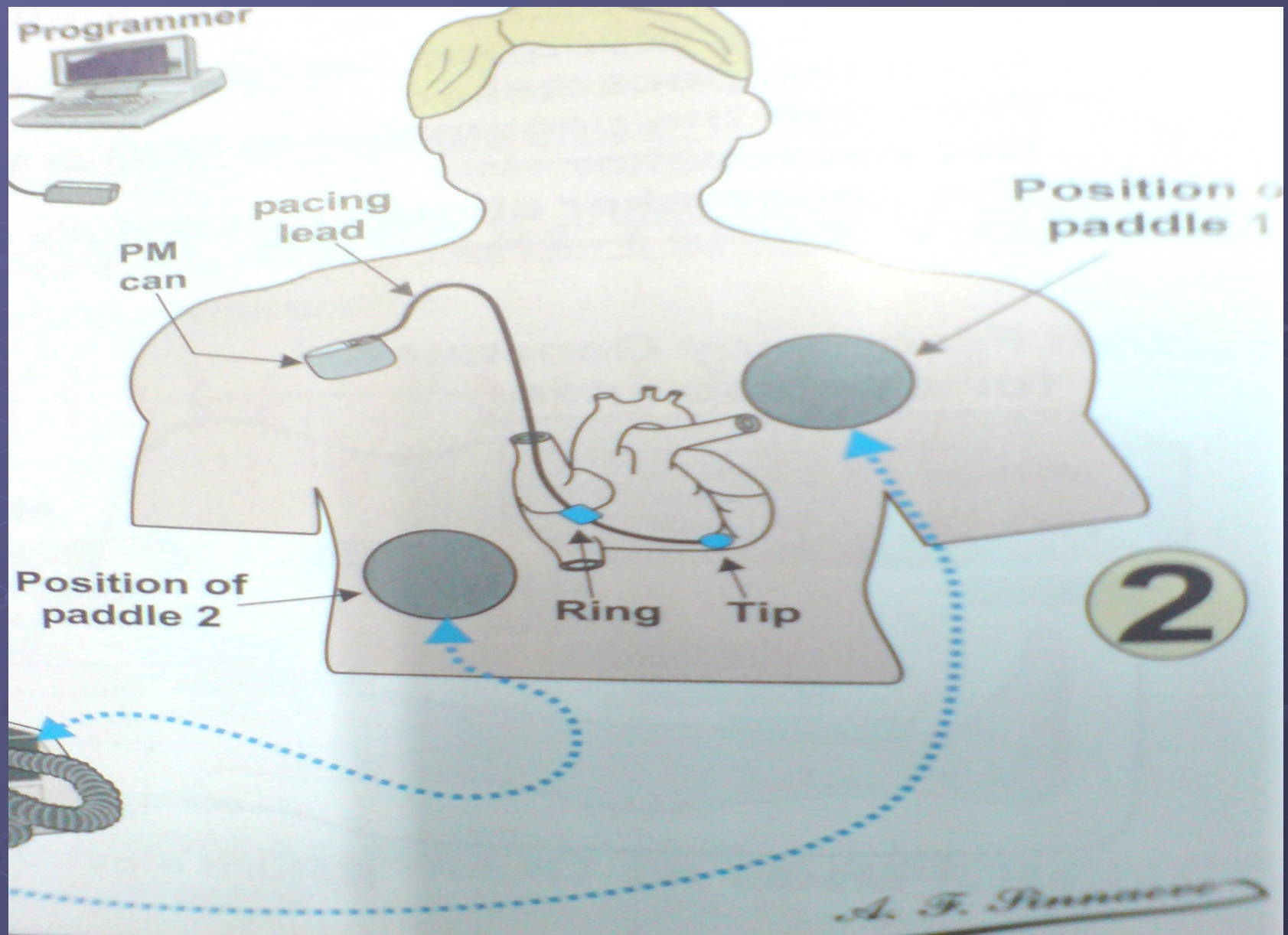
Factors increasing pacemaker threshold

1. Myocardial ischaemia/infarct
2. Electrolyte disturbance
3. Acidosis or alkalosis
4. Hypoxia or hypercapnia
5. Abnormal antiarrhythmic drug level especially Class I and beta blockers

Defibrillation

- Defibrillation
- 1. Discontinue any obvious source of EMI
- 2. Restore antitachycardia function if available in device and BP stable
- 3. Pad or paddle position
- 4. Defibrillation and cardioversion dose
- 5. Post shock interrogation/ reprogramming





MRI and pacemaker

1. Torque effect on pulse generator
2. Magnetic field gradient closes magnetic reed switch
3. MRI produces radiofrequency waves of 30- 3000Hz

MRI and pacemaker

1. Latest models has less chance of torque effect
2. RF waves cause inappropriate pacing
3. Heat energy through leads- burn injury
4. MRI generally considered contraindicated in patients with pacemakers

MRI and pacemaker

- **Sommer et al** in a prospective study assessed effects of MRI on pacemaker **82 patients** undergoing **extrathoracic site** MRI. In this study they found no pacemaker inhibition or arrhythmia induction or any other serious injury during or after procedure. Hence they concluded MRI is safe and can be performed under due precautions
 - Circulation 2006; 114(2): 1285

MRI and pacemaker

- Nazarian et al studied **55 patients** (31 with pacemakers and 24 with AICD) undergoing **cardiac and non cardiac MRI** and found no significant adverse effects. They also concluded **MRI can be safely** performed in these patients considering the benefits in these patients
 - Circulation 2006; 114 (12):1277

MRI and pacemaker

- Both these above studies were done under ECG and pulse oximetry monitoring and after appropriate reprogramming of the cardiac rhythm management device. Hence recommended these precautions to be followed during the procedure and MRI can be safely done in patients with CRMD.

Lithotripsy and pacemaker

1. Pacemaker circuitry damage
2. Focal point of beam directed away from generator
3. Atrial pacing and rate adaptive function need to be disabled
4. Contraindicated in patients with piezoelectric circuit implanted in abdominal wall

Lithotripsy and pacemaker

● **Albers DD et al** found that lithotripsy can be performed safely done after appropriate reprogramming of the CRMD provided **focus of beam is 5 cms away** from the device.

This study was done on **20 patients**

- J Endourol 1995; 9(4):

3011

Lithotripsy and pacemaker

- **Asroff et al** described a **case report** of 75 yr male with pacemaker **safely undergoing lithotripsy** after inactivating rate adaptive function of device. They also **suggested** pacemaker generator not be located in the abdominal wall

- J Endourol 1997; 157(3) : 189

Electroconvulsive therapy & pacemaker

1. Little current pass through heart
2. Seizures may cause inappropriate activation of AICD and rate adaptive feature of pacemaker
3. Other features may left intact
4. In patients with inactivated AICD be prepared for external defibrillation if VT/VF occurs

Automatic Implanted Cardioverter Defibrillator and anesthesia

1. Pacing and shocking function
2. Precautions similar to pacemaker
3. Deactivate cardioversion and defibrillation function of AICD

Automatic Implanted Cardioverter Defibrillator and anesthesia

- Magnet and ICD:
 1. Pacemaker function is rarely altered
 2. Suspends anti tachyarrhythmia therapy
 3. Some ICD have no magnet response
 4. Most are permanently disabled
 5. Hence recommended not to be used in patients with ICD

Automatic Implanted Cardioverter Defibrillator and anesthesia

- External defibrillation in patients with AICD
 1. Apply external defibrillator pad before surgery
 2. Remove EMI source
 3. Reenable antitachycardia function
 4. If above measures fails provide external defibrillation with precaution as for pacemakers

Postoperative care

- Monitoring
- Device interrogation
- Reprogramming

Summary

- Pacemaker and AICD implanted patients undergoing elective surgery:
 1. Contact pacemaker or AICD clinic or manufacturer
 2. Reprogram the device function in selective group of patients

Summary

- Pacemaker and AICD implanted patients undergoing elective surgery:
 1. Monitoring and anesthesia technique with due considerations to patients CVS status
 2. Avoid electrocautery use. If necessary consider use of bipolar or harmonic scalpel
 3. Be ready for alternate mode of pacemaker and defibrillator if necessity arises

Summary

- Pacemaker and AICD implanted patients undergoing emergency surgery:
 1. Try get information regarding pacemaker or AICD at earliest possible or if time permits
 2. Initiate invasive arterial pressure monitoring in addition to standard monitoring

Summary

- Pacemaker and AICD implanted patients undergoing emergency surgery:
 1. If pacemaker failure is associated with haemodynamic instability consider magnet application
 2. Consider magnet application with AICD only when EMI source cannot be stopped and it is associated with haemodynamically destabilising inappropriate shocks
 3. Interrogate device following either elective or emergency surgery at the earliest possible and consider appropriate resetting if required



Thank you

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