



Pacemakers and Cardioversion

Sept 2014

Pacemakers

Modes

Fixed rate

Delivers at fixed rate regardless of patient's heart; risk of discharging on T wave; rarely used

Demand

Senses spontaneous cardiac activity; can be converted to fixed rate mode if magnet held over it

- Inhibited: pulse generator inhibited by spontaneous cardiac activity
- Triggered: pacemaker detects cardiac activity, discharges during absolute refractory period

1	2	3	4	5
Chamber paced	Chamber sensed	Response to sensing	Programmability	Anti-arrhythmic functions
0 none A atrium V ventricle D both S single chamber	0 A V D S	0 none T triggered I inhibited D dual	0 none P simple M multi C communicating (telem) R rate modulation	0 none P pacing S shock D both

Indications

AVN dysfunction, SAN dysfunction, hypersensitive carotid sinus syndrome, neurogenic syncope, long QT, prevention of tachycardia, HTCM

AAI: paces A, senses A, if A activity sensed, pacing inhibited; if no atrial activity sensed generates atrial pacing stimulus; *atrial demand mode pacing* prevents atrial rate too low; used in AVN dysfunction

VVI: paces V, senses V, if V activity sensed, pacing inhibited; if no V activity sensed, generates V pacing stimulus; used in chronic AF and flutter

DDD: paces both, senses both, as above for both chambers; senses A and provides impulse if no native one - AV interval where pacer is inactive - at end of interval if no V impulse has occurred, provides one; if tachycardia occurs, DDD will switch to VVI until tachycardia over, so that V aren't inappropriately paced too fast
Placing magnet over pacemaker will initiate AOO, VOO, DOO – which allows treatment tachycardia

Pacemaker Problems

Pocket - infection, haematoma

Leads - separation: failure to capture, dislodgement - thrombosis/myocardial rupture/arrhythmia

Failure to pace, capture or sense

Malfunction (overpacing; electromagnetic interference, physiological electrical activity)

Pacemaker-mediated tachycardia (re-entrant loop with pacemaker sensing retrograde P wave as native stimulus, and pacing ventricle)

Sensor-induced tachycardia



Problems with Sensing

- Undersensing -

- pacemaker fails to sense native cardiac activity
- results in asynchronous pacing
- causes: incr stimulation threshold at electrode (exit block), poor lead contact, new BBB, program problem
- ECG findings: may be minimal; suggested by pacing spikes within QRS complexes

- Oversensing -

- electrical signals are inappropriately recognised as native cardiac activity and pacing is inhibited (large P or T waves, skeletal muscle activity, lead contact problems)
- abnormal signals may not be evident on ECG
- reduced pacemaker output/output failure may be seen on ECG if patient stimulates pectoral muscles

Output Failure

- a paced stimulus is not generated in a situation where expected
- results to decr or absent pacemaker function
- causes: oversensing, wire fracture, lead displacement, interference

Failure to Capture

- paced stimulus does not result in myocardial depolarisation
- causes: electrode displacement, wire fracture, electrolyte disturbance, MI, exit block

(If patients native HR is greater than pacemaker threshold then no pacemaker activity expected, so output failure and capture failure cannot be seen on ECG)

Pacemaker Associated Dysrhythmias

- Pacemaker-mediated tachycardia (PMT) -

- aka endless-loop tachycardia or pacemaker circus movement tachycardia
- a re-entry tachycardia where pacemaker forms antegrade pathway with retrograde conduction via AVN
- caused by retrograde p waves being sensed as native
- the paced ventricular complex results in further retrograde conduction with retrograde p wave generation, forming a continuous cycle
- results in paced tachycardia with max rate limited by pacemaker programming
- can be terminated by slowing AVN conduction (adenosine or activation of magnet mode)
- newer pacemakers have programme to terminate PMT
- may cause rate-related ischaemia if IHD

- Sensor-induced tachycardia -

- modern pacemakers allow incr HR in response to physiological stimuli (exercise, acidaemia etc)
- sensor may misfire if distracting stimuli: vibrations, loud noises, fever, limb movement, electrocautery
- leads to pacing at inappropriately fast rate - rate cannot exceed pacemakers upper limit (160-180)
- will usually terminate with magnet

- Runaway pacemaker -

- potentially life-threatening malfunction, usually older pacemakers with low battery
- pacemaker delivers paroxysms of pacing spikes at 2000bpm - can cause VF
- may be failure to capture causing bradycardia
- magnet may halt problem, but pacemaker battery needs replacing

- Lead displacement dysrhythmia -

- dislodged lead may float in RV, intermittently 'tickling' myocardium, causing ectopics or runs of VT
- if QRS morphology changes from LBBB to RBBB, suggests electrode eroded through IV septum

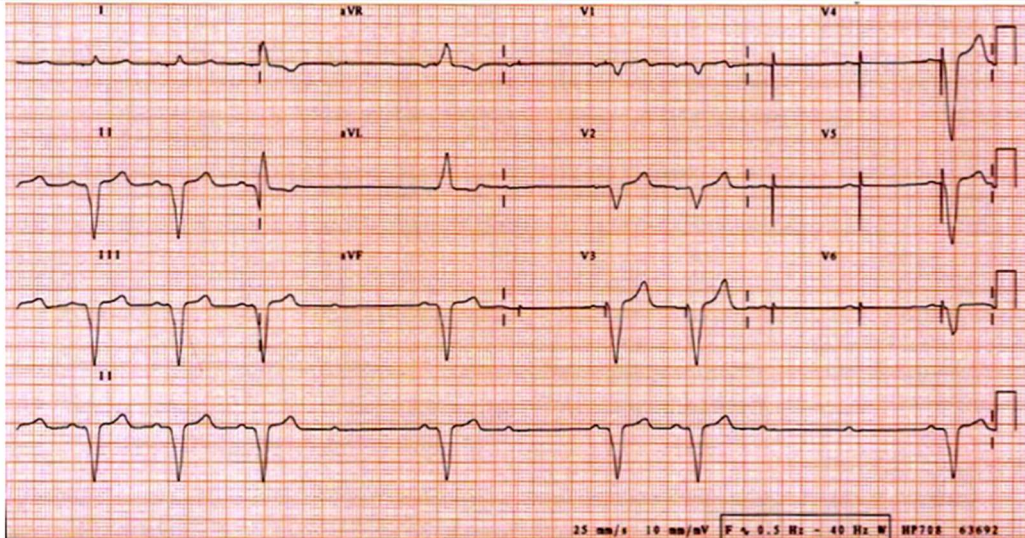
Pacemaker Syndrome

- caused by improper timing of atrial and ventricular contractions, results in AV dyssynchrony and loss of atrial kick
- symptoms: fatigue, dizziness, palpitations, pre-syncope
- BP may decr >20mmHg when changing from native to paced rhythm

Twiddler's Syndrome

- accidental or deliberate manipulation or pulse generator - rotates on long axis - dislodges leads
- can cause diaphragmatic or brachial plexus pacing (arm twitching) depending on where leads are

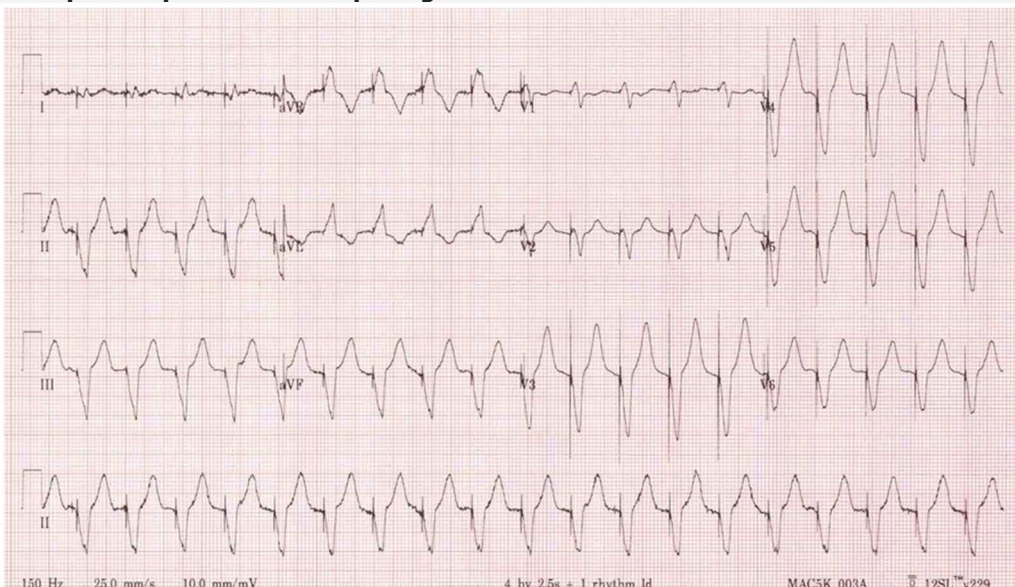
Example – Pacing failure



Ventricular paced rhythm with intermittent failure to capture

This ECG shows a ventricular paced rhythm with intermittent failure to capture.

Example - Rapid ventricular pacing

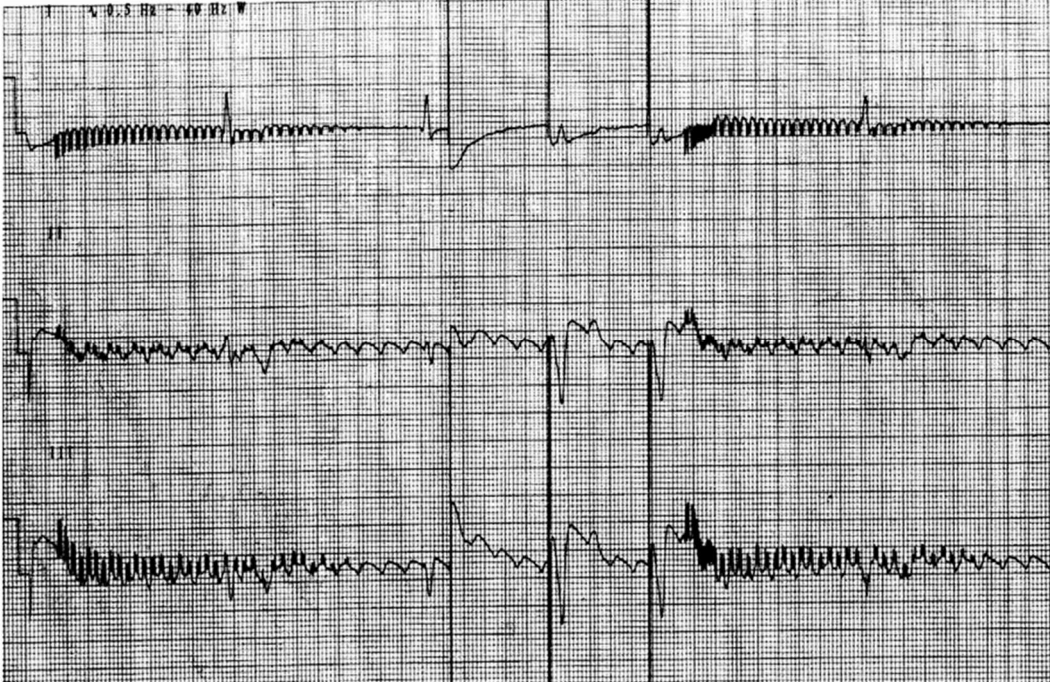


Rapid ventricular-paced rhythm (120bpm), no evidence of preceding atrial activity.

DDx: pacemaker-mediated tachycardia (retrograde P waves buried in QRS); sensor-induced tachycardia

- could be normal in presence of appropriate stimulus (eg exercise)

Example – Runaway pacemaker



Indications for Temporary Pacing

Transcutaneous:

Unresponsive, symptomatic bradycardia
 Mobitz II or higher AV block
 New LBBB + bifascicular block
 1st deg AV block + RBBB or LBBB

Transvenous:

Asystole
 Alternating BBB
 Consider: RBBB + LAHB/LPHB
 Overdrive pacing in unresponsive VT
 Unresponsive recurrent sinus pauses

AICD (automatic implantable cardiac defibrillation)

Lifespan = 8 years
 Most common cause of death of ICD pts = CCF
 RX of CCF (+ICD) = same as usual CCF Rx
 ED attendance: usually for assessment - post shock ?appropriate

History

No. shocks, Prodromal sx, Post-shock trauma, Recent changes in medication

Examination

Vitals/CVS exam, Generator pocket, Incidental trauma, Monitoring

Investigations

ECG - ST/T changes secondary to shock - should resolve <15mins
 CXR: lead migration/fracture
 Electrolytes, Drug levels
 ICD/pacemaker check = mandatory



Causes of inappropriate shocks

1. SVT
2. muscle activity (shivering, diaphragm contractions); extraneous source - vibration
3. sensing "T" as "QRS" = double counting
4. sensory lead fracture/migration
5. unsustained tachyarrhythmia
6. ICD - PPM interaction
7. component fracture

If ICD + cardiac arrest - normal ACLS - do not put pads over ICD

If ongoing appropriate shocks - donut magnet

Indications for cardioversion

Unstable Tachyarrhythmia

Failed Medical Management of Tachyarrhythmia

Best 1st line Rx: Atrial Flutter, WPW & AF

Contraindications

Relative: non-fasted

Absolute: operator danger (hyperbaric, in water), bradyarrhythmias, SSS, digoxin toxicity, AF >48hr

Complications

Local - aspiration, burns, damage to pacemakers

Systemic - emboli

Electrical - more malignant rhythm, post-shock myocardial depression, failure of synchronisation

Transcutaneous Pacing

Indications

Bradycardia unresponsive to drug therapy

3rd degree heart block

Mobitz type II second-degree heart block + haemodynamically unstable

Overdrive pacing

Asystole

Method

place pads in AP position (black anterior, red posterior)

connect ECG leads

set pacemaker to demand

turn pacing rate to > 30bpm above patients intrinsic rhythm

set mA to 70

start pacing and increase mA until pacing rate captured on monitor

if pacing rate not captured at a current of 120-130mA -> resite electrodes and repeat

once pacing captured, set current at 5-10mA above threshold

Complications

failure to pace and failure to capture

discomfort



Overdrive Pacing

Overdrive pacing = pacing the heart at a higher rate than the native heart rate
VT or VF can result - always have DC cardioversion available

Indications

failure of drug therapy
recurrent arrhythmia
contraindication to cardioversion (digoxin toxicity)
aid to differentiate VT from SVT

Rhythms that can be controlled

AV junctional tachycardia
paroxysmal re-entrant SVT
atrial flutter (rate 320-340)
SVT with rapid ventricular response that fails to revert
VT (may precipitate VF)

Overdrive pacing vs cardioversion

may assist with rhythm diagnosis
can use in digoxin toxicity
doesn't require GA
avoids complications of DC shock (myocardial depression)
pacing available post electrical version (in case of bradycardia or asystole)

Overdrive pacing vs drugs

may aid in rhythm diagnosis
avoid drug induced cardiac depression and other side effects
can be used when drug therapy fails
termination of the tachycardia with pacing often immediate
standby pacing immediately available