Follow up of intra-cardiac Devices

presented by

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Introduction

- Cardiac Pacing has been used for the treatment of cardiac bradyarrhythmias for more than 50 years.
- During that time both clinical practice and impressive body of research have proved its effectiveness in terms of quality of life, morbidity and mortality.
- Technology ➔ Software and hardware.

Historical Perspective

- 1905 – Einthoven
  - Published first two human AV block using string galvanometer
- 1958 – Senning and Elmqvist
  - Asynchronous (VVI) pacemaker implanted by thoracostomy and functioned for 3 hours
  - Arne Larsson
    - First pacemaker patient
    - Used 23 pulse generators and 5 electrode systems
    - Died 2001 at age 86 of cancer
Historical Perspective

- 1960 – First atrial triggered pacemaker
- 1964 – First on demand pacemaker (DVI)
- 1977 – First atrial and ventricular demand pacing (DDD)
- 1980 – Griffin published first successful pacemaker intervention for supraventricular tachycardias
- First ICD implanted in 1980

Historical Perspective

- 1981 – Rate responsive pacing by QT interval, respiration, and movement
- 1994 – Cardiac resynchronization pacing
- 1998 – Automatic capture detection
- Now
  - Approximately 3 million with pacemakers
  - Approximately 1 million with ICD device
Pacemaker Basics

- Provides electrical stimuli to cause cardiac contraction when intrinsic cardiac activity is inappropriately slow or absent
- Sense intrinsic cardiac electric potentials

ICD Basics

- Designed to treat a cardiac tachydysrhythmia
- Performs cardioversion/defibrillation
  - Ventricular rate exceeds programmed cut-off rate
- ATP (antitachycardia pacing)
  - Overdrive pacing in an attempt to terminate ventricular tachycardias
- They have pacemaker function (combo devices)
Intra-cardiac Devices

- Types:
  1. Cardiac pacemakers: VVI, VVIR, AAI, DDD, DDDR, VDD.
  2. Pacemaker for HF: CRT-P, CRT-D
  3. ICD: transvenous, subcutaneous.
  4. Loop recorder.
  5. VADs.

Follow up

- Time.
- Frequency
- Symptoms.
- Signs.
- Hardware
- Software
Time & frequency of follow up

1. After Implantation.
2. Routine follow up.
3. Emergent indication for follow up.

Pacer Malfunction SX

1. Vertigo/Syncope
   *Worsens with exercise
2. Unusual fatigue
3. Low B/P/ \(\downarrow\) peripheral pulses
4. Cyanosis
5. Jugular vein distention
6. Oliguria
7. Dyspnea/Orthopnea
8. Altered mental status
Pacemaker syndrome

- Refers to dizziness, near syncope, and fatigue even though there is no pacemaker malfunction. This syndrome is the result of unfavorable hemodynamic consequences of AV asynchrony.
- The incidence is higher in patients with VA conduction

Pacemaker Malfunction

- Failure to capture
- Failure to sense
- Over sensing:
  1. Pauses in paced rhythm
  2. Rapid triggered ventricular paced rates
- Rapid paced rates
- No output
CHEST X-RAY IN PACEMAKER PATIENTS

- Lead(s) position
- Lead configuration (bipolar, unipolar)
- Generator position
- Generator identification
- Connector block integrity
  - Faulty connection
  - Loose set screw
- Lead fracture
- Lead insulation defect
ECG

Well functioning VVI
Well functioning DDD

ECG before & after BiV Pacing
Well functioning CRT with bivent.

Capture

Pacemaker output (spike) is followed by ventricular polarization (wide QRS).
Malcapture

- Tissue is refractory (e.g., prior depolarization)
- Lead dislodgement
- Increase in myocardial stimulation threshold
- Lead insulation break
- Inappropriately low programmed output
- Generator end of life

Malfunctioning DDD
Sensing

Patient’s own beat is sensed by pacemaker so does not fire
Undersensing

Pacemaker doesn’t sense patient’s own beat and fires (second last beat)

Under Sensing

- Poor intracardiac signal
- Intracardiac signal occurs in pacemaker refractory period
- Lead dislodgement
- Insulation failure
- Conductor wire fracture
ABSENT PACING STIMULUS ARTIFACT

- Normal inhibition
- Electromagnetic inhibition
- Conductor wire fracture
- Loose lead-generator connections
- Lead insulation break
- Component failure
- Battery end of life

Oversensing

Oversensing

Pacemaker senses heart beat even though it isn’t beating. Note the long pauses.
Oversensing

- Physiologic intracardiac signals
  - T waves (VVI systems)
  - R waves (AAI systems, DDD(R) systems with mode switch)

- Physiologic extracardiac signals
  - Muscle potentials (diaphragm, pectoral, seizeur)

- EMI.
EMI

- Endogenous
  - Myopotentials
- Medical equipment
  - Electrocautery
  - MRI
  - Cardioversion, defibrillation
  - Transcutaneous pacing
- Electrotherapy
  - Transcutaneous nerve stimulation
  - Lithotripsy
Electromagnetic Interference

- Can interfere with function of pacemaker or ICD
- Device misinterprets the EMI causing
  - Rate alteration
  - Sensing abnormalities
  - Asynchronous pacing
  - Noise reversion
  - Reprogramming

Examples
- Metal detectors
- Cell phones
- High voltage power lines
- Some home appliances (microwave)
Electromagnetic Interference

- Intensity of electromagnetic field decreases inversely with the square of the distance from the source
- Newer pacemakers and ICDs are being built with increased internal shielding
RAPID PACED VENTRICULAR RATES

- DDD systems PMT
- Normal tracking of rapid atrial rates; Sinus tachycardia, Atrial fibrillation, Atrial flutter, Automatic atrial tachycardia
- Myopotential With subsequent PMT triggering or Without subsequent PMT
- Electromagnetic Cautery triggering
- Rate-adaptive systems: Rapid pacing should occur only if and when sensor is activated
Programming
Follow up by the programmer

1. Integrity of the hardware: Battery status, lead integrity.
3. CRT adjustment: Proper biventricular pacing, phrenic stimulation.
4. ICD: Interrogation of events.

ICD

ICD Shock of VT Converted to NSR