Objectives

- Know the typical venous access routes and typical sites for atrial and ventricular lead placement
- Understand typical implantation techniques and consider alternatives
- Be knowledgeable about lead positions on X-ray and possible patient complications
Implantation of a Pacemaker System

Pacemaker Implantation

- **Environment**
  - Operating room (cardiac/thoracic surgeon)
  - Catherization laboratory (cardiologist/EP physician)

- **Personnel**
  - 1 or 2 physicians (operator, assistant)
  - 2 nurses (scrub/circulating)
Pacemaker Implantation

Preoperative preparation
- Informed consent by the patient
- Stop of food intake for 6 hours
- Peripheral venous line
- Sedative medication
- Antibiotic prophylaxis

Pacemaker Implantation Procedure

Principal Approach
- Disinfection and local anesthesia
- Skin cut
- Preparation for venous access
- Lead insertion and positioning
- Intra-operative measurements
- Connection of lead(s) to pacemaker
- Implantation of the pacemaker
- Wound closure
- Postoperative care
PM Implantation Equipment

- ECG-Monitor, 3-channel-ECG recorder
- X-ray/fluoroscopy with foot switch
- Pacemaker programming system
- External defibrillator incl. transthoracic pacing
- External pacemaker for temporary pacing

Transvenous Access Routes
Transvenous Access Routes

**Permanent**
- V. cephhalica
- V. subclavia

**Temporary**
- V. jugularis
- V. femoralis
Venous Access for Lead Insertion

Anatomical Orientation
Anatomical Orientation

- Subclavian vein
- Cephalic vein

Local Anesthesia
Incision

Further Local Anesthesia
Electrocautery for Hemostasis

Subclavian Puncture
Subclavian Vein Access

**Seldinger Technique**

- Venous puncture
- Guide wire passed through the needle
- Needle withdrawn
- Sheath with dilator introduced over the wire

Introducer Set
Venous puncture

Guidewire Insertion
Guidewire Insertion

Tip advanced to the middle right atrium

Insertion of Sheath and Dilator
Sheath with Dilator in Place

Lead Insertion via Sheath
Ventricular Lead Positioning

A Lead approaching the tricuspid valve (TV)

B Lead pushed against TV

C Lead snapping across TV into right ventricle (RV)

D Lead passed to the pulmonary artery, stylet withdrawn, RV

Curved Stylet Technique
Ventricular Lead Positioning

Alternative

Lead bends to the lateral wall of the right atrium

Lead rotation or partial withdrawal can help to pass the tricuspic valve

X-Ray Projection for Lead Placement

AP  RAO
Measurements Ventricular Lead

- Analysis of intra-cardiac signals (sensing test)
- Measurement of the stimulation threshold (pacing test)

Ventricular Lead Position in RV Apex

Anterior-Posterior

Left-Lateral

Right Left Anterior Posterior
Retained Guide Wire Technique

Pacing lead

Peel-away sheath

Retained wire

Retained wire

Pacing lead

Retained wire
Retained Guidewire Technique

Inroducer sheath for second lead via retained wire

Atrial Lead Positioning

Preformed atrial J lead withdrawal of the stylet
Atrial Lead Positioning

Windscreen wiper motion of atrial lead in AP projection

Measurements Atrial Lead

- Analysis of intra-cardiac signals (sensing test)
- Measurement of the stimulation threshold (pacing test)
Atrial Lead Position in RA Appendage

Final Lead and Device Positions
Venous Access for Lead Insertion

- Puncture of the subclavian vein
- Cut-down of the cephalic vein

Cut-down of the Cephalic Vein
Cephalic Vein Lead Insertion

- Venotomy with scissors
- Held open with vein pick

Cephalic Vein Guidewire Technique

- Sacrificed vein
- Retained guidewire
- 2nd introducer
- 1st lead
- 1st introducer
Anchoring Lead with Suture Sleeve

Preparation of the Pacemaker Pocket

- blunt preparation with finger
- sharp preparation with scalpel (higher bleeding risk)
Lead Connection

- Torque wrench through silicon cap (no air compression)
- Insertion of lead connector pin until the very end
- Screw fixation with torque wrench
- Fixation check by pulling at the connector

Insertion of the Device

- Pocket inspection for hemostasis
- Flush pocket with saline or antibiotic solution
- Coil up excess lead loosely behind the device
- Pocket insertion of generator with label up
- Optional ligature for fixation within the pocket
Wound Closure

Layer-by-layer with inner and outer sutures using absorbable and non-absorbable threads

Wound Closure

- Suturing and dressing of the wound, plaster
- Verification of pacemaker function if needed
Risks and Complications

Complication Rate: 4-6%

Types of complications
- Arrhythmia
- Haematoma
- Pneumothorax
- Lead dislodgement
- Infection
- Perforation/Tamponade

Post-operative care

- Documentation of final lead position(s) by AP and left-lateral X-ray
- Prophylactic antibiotics for 1-2 days (optional)
- 12-lead ECG recording: intrinsic rhythm, with magnet application
- Predischarge follow-up
  - sensing and pacing tests
  - optional programming
- Activation of Home Monitoring
- Patient education (e.g. avoid arm raising above shoulder height for up to 14 days)
- Final Report to referring physician
- Date for first in-office FU-visit