UNDERSTANDING PACEMAKERS

• 2 PARTS: PULSE GENERATOR & LEAD (S)

PULSE GENERATOR – A METAL CASE WITH A BATTERY AND CIRCUITRY

LEAD OR LEADS: INSULATED AND FLEXIBLE
TYPES OF PACEMAKERS

- **SINGLE-CHAMBER**
  - 1 LEAD IN RA OR RV
  - LEAD PLACED DEPENDING ON ARRHYTHMIA
    - EX: CHRONIC AT FIB - RV LEAD, TIMED BEAT

- **DUAL-CHAMBER**
  - 2 LEADS, 1 IN RA AND 1 IN RV
  - SYNCRONIZED HEART CHAMBER BEATING, MORE EFFICIENT
  - MOST PPM ARE THIS
DEFIBRILLATORS
**IMPLANTABLE CARDIAC DEFIBRILLATORS**

**INDICATIONS:**

1. **NYHA CLASS III OR IV HEART FAILURE WITH EITHER IDIOPATHIC DILATED OR ISCHEMIC CMO, WITH A QRS > 130 MS, WITH LVED DIAMETER OF > 55 MM, WITH LVEF < 35 %**

2. **SCD DUE TO VT OR VF, SUSTAINED VT**
   NUMBER 1 CAUSE OF DEATH IN USA, 1 DEATH / MINUTE

3. **EF <35 % AT LEAST 1 MONTH POST MI AND 3 MONTHS POST CARDIAC ARREST REVASCULARIZATION (STENTS)**

4. **LONG QT SYNDROME, BRUGADA SYNDROME, HYPERTROPHIC CMO**

5. **CARDIAC TRANSPLANT PT AWAITING HEART TRANSPLANT**
Reduced left ventricular ejection fraction (LVEF) remains the single most important risk factor for overall mortality and sudden cardiac death.
WHEN NOT TO USE AN ICD

1. INCESSANT VT OR VF (REPEAT SHOCKS)
2. VT OR VF RESULTING FROM ARRHYTHMIAS AMENABLE TO SURGERY OR CATHETER ABLATIONS (WPW SYNDROME WITH AT FIB)
3. TERMINAL ILLNESS WITH LIFE EXPECTANCY < 6 MOS
4. NYHA CLASS IV DRUG REFRACTORY CHF PATIENTS WHO ARE NOT CANDIDATES FOR HEART TRANSPLANT
5. SIGNIFICANT PSYCHIATRIC ILLNESS THAT MAY BE AGGRAVATED BY DEVICE IMPLANT OR MAY PRECLUDE SYSTEMATIC FOLLOW-UP CARE
3 TYPES OF ICD’S

- **SINGLE CHAMBER**
  - 1 LEAD IN RV
  - DELIVERS PACING AND ELECTRICAL SHOCKS TO THE VENTRICLE

- **DUAL CHAMBER**
  - 2 LEADS
    - 1 LEAD IN RA & 1 LEAD IN RV
  - THIS TYPE MONITORS & DELIVERS PACING IMPULSES TO THE RA TO KEEP THE HEART CHAMBERS BEATING IN SYNC
3\textsuperscript{rd} Type of ICD is the Biventricular ICD

- **Has 3 Leads:**
  - **1 Lead in RA** (Junction of SVC and the RA)
  - **1 Lead in RV Apex** (Distal Apex Portion close to the Interventricular Septum) - Provides best possible defibrillation performance
  - **1 Lead in LV Lateral Wall** via the CS (Strategically placed in one of the cardiac veins) - Lateral wall of left ventricle is desired location for this lead
BIVENTRICULAR PACING IS ALSO CALLED CRT CARDIAC RESYNCHRONIZATION THERAPY

Biventricular pacing is pacing of the ventricles 100% of the time to correct ventricular dyssynchrony
TESTING OF DEVICE AFTER IMPLANTATION

• **GOAL** - TO ENSURE THAT THE ENERGY REQUIRED FOR DEFIBRILLATION IS ALWAYS < THE ENERGY THAT THE DEVICE IS ABLE TO DELIVER

• DEEP SEDATION - HURTS

• INDUCE V FIB, ALLOW DEVICE TO RESPOND (TAKES 15-30 SECONDS), DEFIB OCCURS AND EVALUATE RHYTHM, DEVICE MAY REDELIVER IN ITS PRESCRIBED TIMING RESPONSE, IF FAILS EXTERNALLY DEFIB
ANESTHETIC CONSIDERATIONS WITH ICD TESTING

1 TEST - INDUCE V FIB & BE READY TO RESCUE

IF REPEAT TEST: MAY STUN THE SICK HEART AND CAUSE CARDIOGENIC SHOCK

- MAY NEED INOTROPIC SUPPORT (EPI, DOPAMINE, DOBUTAMINE, MILRINONE, OR AMRINONE)
- MAY NEED INTUBATED
- MAY NEED ICU / VENT MANAGEMENT FOR 24 – 72 HOURS TO ALLOW HEART TO RECOVER
## DIFFERENCES BETWEEN PACEMAKERS AND ICDs

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ALL ICD’S ARE PACEMAKERS
BUT NOT ALL PACEMAKERS ARE ICD’S
COMPLICATIONS OF DEVICES

- INFECTION, <1% (GIVE PROPHYLACTIC ANTIBIOTICS)
- DAMAGE TO HEART OR CENTRAL VEINS FROM WIRES (PERFORATION WITH TAMPONADE)
- BLOOD CLOTS AND OR POCKET HEMATOMA
- PNEUMOTHORAX (GREATEST WITH SUBCLAVIAN APPROACH)
- DEVICE MALFUNCTIONS
- LEAD FRACTURES OR INSULATION FAILURES
- LEAD DISLODGE-MENT-USA LLY OCCURS IN FIRST FEW HOURS OR DAYS
- POCKET EROSION <1%
- TWIDDLER’S SYNDROME-TWISTING & FRACTURE OF LEADS DUE TO MANIPULATION OF GENERATOR
COMPLICATION OF MAJOR CONCERN

• LATE INFECTION AT SITE OR ON A LEAD UP TO 1 YEAR AFTER DEVICE IMPLANTATION
• STILL CONSIDERED A POST-OP PROCEDURAL COMPLICATION
• MAY REQUIRE EXTRACTION, TEMPORARY PACEMAKER, EXTERNAL DEFIB PADS, AND PROLONGED HOSPITALIZATION
BE CAREFUL

• KEEP PATIENTS ARM AT THEIR SIDE AND DO NOT LIFT THEIR ARM ABOVE THEIR SHOULDER HEIGHT

• RESTRICT WEIGHT LIFTING FROM THAT AFFECTED SIDE IMMEDIATELY POST-OP-DON’T LET THEM LIFT THEMSELVES WITH THIS ARM

**THese can cause immediate lead dislodgement**
"I don't trust those new-fangled defibrillators"
CARDIOVERSIONS

CHEMICAL
(PHARMACOLOGICAL)
& OR ELECTRICAL
ATRIAL FIB & ATRIAL FLUTTER
ELECTRICAL CARDIOVERSIONS

• **ELECTIVE (NON-EMERGENCY) CONSIDERATIONS**
  
  • RECENT (LESS THAN 48 HRS) KNOWN ONSET
    
    – AT FLUTTER  SYNC  50-100 JOULES
    – AT FIB  SYNC  BEGIN WITH 100 JOULES
    – *TAKES 48 HOURS FOR CLOT FORMATION TO BECOME ORGANIZED ENOUGH TO CREATE A PROBLEM
    – CONCERN IS THAT MANY PATIENTS DON’T KNOW WHEN THEY WENT INTO THIS RHYTHM
    – **A TEE MAY BE INDICATED** FOR SAFETY REASONS- OBSERVE FOR CLOT FORMATION-AVOID CLOT DISLODGEMENT AND POTENTIAL STROKE
TECHNIQUE

• GENERAL ANESTHESIA OR HEAVY SEDATION-PAINFUL TETANIC CONTRACTION

• SYNCHRONIZATION OF ELECTRICAL DISCHARGE ON THE R WAVE OF THE QRS COMPLEX-IF SHOCK FALLS ANYWHERE ELSE MAY CAUSE V FIB
DIGITALIS TOXIC RHYTHMS

• DON’T CARDIOVERT
  – THE ENHANCED AUTOMATICITY OF THESE RHYTHMS COMBINED WITH SHOCK CAN RESULT IN V FIB ARREST OR V TACH (SLOW OR FAST)
THERAPEUTICALLY DELAYED CV

- IF PAROXYSMAL AT FLUTTER OR AT FIBRILLATION FOR > 24-48 HOURS
  - TAKE ANTICOAGULATES FOR APPROX 4-6 WEEKS BEFORE A CARDIOVERSION
  - OTHER ANTIARRHYTHMICS MAY BE ORDERED
  - PT WILL BE RESCHEDULED IF NOT THERAPEUTIC
  - BE AWARE OF ONGOING INR’S (2-3 RANGE IS INDICATED FOR THERAPEUTIC SAFETY)

- COUMADIN & ASA ARE COMMONLY USED, LOVENOX IS ALSO USED SHORT TERM IN THE 48 HOUR PERIOD IF UNSURE OF TIME OF RHYTHM CHANGE
IF ELECTRICAL CV DOES NOT WORK

• MAY NEED TO ADD PHARMACOLOGICAL INTERVENTION

• ONE COMMONLY USED DRUG IS IBUTILIDE (CORVERT) IN 1 MG DOSE OVER 10 MINUTES—WATCH FOR TORSADES, HAVE MAGNESIUM SULFATE AVAILABLE FOR TREATMENT, MUST BE MONITORED FOR MINIMUM OF 4 HOURS AFTER ADMIN
CARDIAC ABLATIONS

EMPLOYED SINCE THE LATE 1980’S
CARDIAC ABLATIONS

• DONE FOR:

  – ATRIAL TACHYCARDIAS (75% IN RA-MOST COMMON SITES ARE CRISTA TERMINALIS, TA & CS)
  – AVNRT & AVRT (AV NODE THRU HIS BUNDLE CONDUCTION LESIONS)
  – ATRIAL FIB (PULMONARY VEINS, MITRAL ANNULUS)
  – ATRIAL FLUTTER (RA, LA, CS LOCATIONS)
  – BYPASS TRACTS (ANYWHERE BETWEEN RA & RV, LA & LV) EX: WPW
  – V TACHS / PVC’S (RVOT, RV, LV, LVOT)
  – CHRONIC AF WITH HIGH VENT RATES (AV JUNCTION ABLATION, T PACER TO PPM)
GOAL OF ABLATION

• TO POSITION A CATHETER IN A CRITICAL AREA OF THE HEART
• TO APPLY DAMAGING ENERGY THROUGH THE CATHETER TO CREATE A SCAR BY DESTROYING MYOCARDIAL TISSUE
• THUS PERMANENTLY DISRUPTING DYSRHYTHMIA PATHWAY BY MAKING IT ELECTRICALLY INERT
TYPES OF ABLATION
EQUIPMENT

- ELECTRICAL
- THERMAL (HOT- RF ABLATION OR COLD-CRYOENERGY BY FREEZING)
- LIGHT (LASER)
- MECHANICAL (ULTRASOUND)
- CHEMICAL
RADIOFREQUENCY ABLATION

- MOST COMMONLY USED TECHNIQUE OVER THE LAST DECADE
  - GREATER EFFICACY; ABILITY TO CONTROL VERY FOCAL AREA OF INJURY
  - GREATER SAFETY; LOW ENERGY FREQUENCIES PREVENT BAROTRAUMA
  - REQUIRES PRECISE EPICARDIAL MAPPING OF ABLATION AREA
  - ELECTICAL ENERGY IS CONVERTED TO THERMAL ENERGY
  - MONITORING OF IMPEDEENCE AND TISSUE CONTACT TIME IS CRITICAL TO ENSURE ADEQUATE TISSUE CONTACT
  - HEATING MYOCARDIAL TISSUE AT 50 DEGREES CELCIUS RESULTS IN COAGULATION NECROSIS AND COMPLETE DESTRUCTION OF TISSUE:
    - Boiling of Blood
    - Steam pop
ANESTHESIA CONSIDERATIONS FOR ABLATION PROCEDURES

• SEDATION-TAILOR TO PATIENTS AND EP PHYSICIAN’S NEEDS (GENERAL VS HEAVY SEDATION)
  – TOO HEAVY, MAY BE UNABLE TO REPRODUCE ARRHYTHM, MAY NEED TO AWAKEN PT TO ID ARRHYTHMIA THEN RESEDATE FOR ABLATION
  – MUST KEEP THEM MOTIONLESS DURING ABLATION TO AVOID INAPPROPRIATE TISSUE DESTRUCTION ESP: AROUND AV NODE (MAY END UP WITH PPM)
  – MAY NEED TO USE MEDS TO INDUCE ARRHYTHMIA
  – MAY NEED TO MONITOR ESOPHAGEAL TEMPS
OTHER ANESTHESIA CONSIDERATIONS

• FOLEY CATHETER-LONG PROCEDURES (4-6 HOURS IN LENGTH)
• PERIPHERAL LARGE BORE IV
• ALINE-USE FEMORAL BY EP DOCTOR, CAN SEE IMMEDIATE CHANGES, ESP: IF TAMPODADE
• SMOOTH VENTILATION-NOT CHOPPY, HELPS EP DOC WITH CATHETER STABILIZATION
• CONSIDER INTUBATION OR LMA-GENERAL TECHNIQUE, PROTECT AIRWAY, EASIER TO MONITOR ESOPHAGEAL TEMPS
• IF ABLATING IN THE PULMONARY VEIN ROOT THEIR ELECTROGRAM TRACING WILL BE ISOELECTRIC BECAUSE THERE IS NO ELECTRICAL AUTOMATICITY IN THIS AREA
• BE CONCERNED ABOUT PULM VEIN STENOSIS FROM EXTENSIVE BURNING OF TISSUE
• WARMED IV FLUIDS
• BODY BAIR HUGGER
CONSIDERATIONS DURING ATRIAL FIB ABLATION

• PULMONARY VEIN ISOLATION

• THERMACOOL OR RF ABLATION

• BE CAREFUL WITH LEFT SIDED CATHETER PLACEMENT DURING TRANSEPTAL APPROACH

• MAY DEVELOP PERICARDIAL EFFUSION WITH DECREASING SLOWLY OR RAPIDLY B/P, INCREASING HR, RESP CHANGES-AGONAL, TACHYPNEA

• IF SUSPECT, ULTRASOUND IMMEDIATELY AND TREAT APPROPRIATELY, INTUBATION AND PRESSOR SUPPORT MAY BE INDICATED, CARDIAC SURGEON CONSULT, BLOOD TRANSFUSION MAY BE NEEDED
Left Atrial Structures

Right Superior PV
Right Inferior PV
Left Superior PV
Left Inferior PV
TRANS-SEPTAL APPROACH

• NEEDLE DEVICE THROUGH PATENT FORAMEN OVALE OR INTRA-ATRIAL SEPTUM-ULTRASOUND GUIDED

• REQUIRES CONSISTENT HEPARIN ADMINISTRATION TO KEEP ACT’S 300 OR >
• IV BOLUS AT 100UNITS/KG HEPARIN FOLLOWED BY INFUSION STARTING AT 1,000UNITS/HR

• CHECK ACT’S EVERY 20 MIN AND ADJUST BOLUS AND CONTINUOUS INFUSION RATES AS INDICATED
• CONTINUE HEPARIN ADMINISTRATION AS LONG AS THEY ARE IN THE LEFT SIDE OF THE HEART

• REVERSE HEPARIN IF DESIRED OR ALLOW PATIENT TO NATURALLY RETURN TO NORMAL ACT LEVELS BEFORE REMOVING GROIN CATHETERS
ATRIAL FIB CONTINUED

• IF THERMA COOL IS USED BE CAREFUL OF FLUID ADMINISTRATION:
  – DEVICE RUNS INTRACARDIAC AT 2 ML/MIN MAINTENANCE
  – 17 ML/MIN WHEN RUNNING AT UP TO 35 WATTS
  – 30ML/MIN WHEN RUNNING AT > 35 WATTS

  – THIS TECHNIQUE IS NOT PAINFUL, FREEZING METHOD
  – PT NEED TO BE MOTIONLESS
  – SEDATED FOR ANXIETY REASONS AND PATIENT COMFORT
ESOPHAGEAL TEMP MONITORING

- CRITICAL FOR ATRIAL FIB ABLATION TECHNIQUES
- **NO TEMP RISE IS ACCEPTABLE**, IF RISES THERE MAY BE PERMANENT THERMAL INJURY TO THE ESOPHAGUS (ESOPHAGEAL NECROSIS)
- ESOPHAGUS LIES MM’S FROM THE LEFT SUPERIOR AND INFERIOR PULMONARY VEINS
REVIEW OF COMPLICATIONS OF ABLATIONS

• SAME AS EP STUDY
• ADDED RISKS:
  – CHB
  – CARDIAC PERFORATION & TAMPONADE
    • 1 – 2% INCIDENCE
  – PRODUCING MITRAL AND TRICUSPID REGURITATION
  – SYSTEMIC EMBOLIZATION
  – CREATION OF FIXED LESIONS WITHIN THE CORONARY ARTERIES
WAITING PERIOD
(APPROXIMATELY 30 MINUTES)

• TO CONFIRM THAT APPROPRIATE LESION DELIVERY WAS GIVEN TO PERMANENTLY STOP THE ARRHYTHMIA

• ABLATION CAN PRODUCE A LESION OR A LINE OF LESIONS WITH AN ESCAPE AREA THAT CAN ALLOW RE-ENTRY OF THE ARRHYTHMIA IF NOT COMPLETELY ABLATED

• ID OTHER SOURCES OF ARRHYTHMIAS THAT MAY BE PRESENT, REQUIRING ADDITIONAL ABLATION INTERVENTION
DRUGS COMMONLY USED IN THE EP LAB BY ANESTHESIA PERSONNEL

VERSED, FENTANYL, PROPOFOL, AND INHALATION AGENTS
VERSED

• MINIMAL HEMODYNAMIC EFFECTS EVEN WITH POOR VENTRICULAR FUNCTION

• REDUCES ANXIETY & MAY CAUSE TRANSIENT HYPOTENSION AND REDUCED HEART RATE IN LOW FLUID VOLUME STATE

• HAS BEEN PROVEN TO REDUCE OPIOID USE THUS PRESERVING HEMODYNAMIC STABILITY AND RELIABLE AMNESIA
• INCREASES CYCLE LENGTH THUS MINIMAL DECREASES IN HEART RATE
• DECREASES (SLOWS DOWN) AV NODE CONDUCTION
• MAY HELP ID & VISUALIZE AV NODE – HIS BUNDLE ABNORMALITIES
• PROFOUND ANALGESIC PROPERTIES, SMOOTH HEMODYNAMIC PROFILE, LACK OF NEGATIVE INOTROPY
• BLUNT RESPONSE TO CIRCULATING CATECHOLAMINES DURING MANIPULATION
PROPOFOL

- SLOWS ATRIAL RATE

- DEPRESSES AV NODAL CONDUCTION IN A DOSE-DEPENDENT MANNER

- PROLONGS CONDUCTION THRU HIS-PURKINJE SYSTEM

- NEGATIVE CHRONOTROPIC EFFECT AND IS MEDIATED BY M2-MUSCARINIC RECEPTORS THUS DECREASES SYMPATHETIC OUTFLOW, ATTENUATES VAGAL TONE, AND ALTERS BARORECEPTOR SENSITIVITY THUS EXACERBATING UNDERLYING AV BLOCK

- IMPARTS ANTIDYSRHYTHMIC PROTECTION TO PTS SUSCEPTIBLE TO SVT'S-MAY MAKE SVT EVALUATION MORE DIFFICULT THUS MAY NEED TO DECREASE DOSE
INHALATION AGENT

• SEVOFLURANE IS PREFERRED IN RANGES OF 1.5 TO 2.7 MAC

LEAST EFFECT ON HR WHEN CATECHOLAMINES ARE ADMINISTERED WITH IT

INCIDENCE OF ISCHEMIA, TACHYCARDIA, AND ADVERSE OUTCOMES ARE LESS

LESS MYOCARDIAL DEPRESSION IN LEFT VENTRICULAR DYSFUNCTION STATES