Interventional Therapy for Cardiac Arrhythmias

Cardiovascular Boot Camp

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Cardioversion
Electrical Cardioversion

- Direct current cardioversion
- Involves delivery of an electrical shock synchronized with the intrinsic activity of the heart
- Usually is done by sensing R wave on the EKG.
- Done for quality of life rather than stroke prevention

Electrical Cardioversion

- Assures no electrical stimulation from 60–80 ms before to 20–30 ms after the apex of the T wave
  - vulnerable phase of cardiac cycle
- Used to normalize all abnormal cardiac rhythms except for ventricular fibrillation or pulseless VT
- Rhythms due to re-entry are more suitable for cardioversion
- Rhythms due to automaticity do not respond to cardioversion
Electrical Cardioversion

- Often performed electively
- Need for anesthesia
- Immediate need for hemodynamically unstable rhythms
- Anticoagulation prophylaxis (same with pharmacological cardioversion)
- Full anticoagulation versus TEE / Heparin strategy
- Anticoagulation post: Stunning
- Risk for thromboembolism greatest when atrial fibrillation present greater than 48 hours
Electrical Cardioversion

- **Technical Issues**
  - Need for good R wave and good P wave visualization
  - AP placement preferred (short axis)
  - Initial energy delivered (monophasic) for atrial flutter may be as low as 50 J
  - Higher energy is needed for atrial fibrillation starting at least 200 J
Electrical Cardioversion

- **Technical Issues (continued)**
  - Initial higher energy produces more immediate success and may reduce total energy delivered
  - Maximum J is 400
  - Biphasic waveforms use less energy
  - Time between shocks not less than one minute
  - 2 defibrillators may be used

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Electrical Cardioversion

- Success rates vary from 70% to 90%
- The relapse rate is high without continuation of antiarrhythmic drug therapy

- **Facilitated cardioversion**
  - Ibutilide pretreatment
    - Not will other Class III agents with exception of amiodarone
Treatment: Electrical Cardioversion

Factors Predicting Success:
- Short duration of atrial fibrillation
- Atrial flutter
- Young Age

Factors Predicting Failure:
- Left atrial enlargement
- Underlying heart disease
- Cardiomegaly

Energy Levels for Cardioversion

<table>
<thead>
<tr>
<th>Rhythm</th>
<th>Initial Energy Level (monophasic)</th>
<th>Subsequent Energy Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial Flutter</td>
<td>50 J</td>
<td>100, 200, 300, 360 J</td>
</tr>
<tr>
<td>SVT</td>
<td>50 J</td>
<td>100, 200, 300, 360 J</td>
</tr>
<tr>
<td>Atrial Fibrillation</td>
<td>100 – 200 J</td>
<td>300, 360 J</td>
</tr>
<tr>
<td>Monomorphic VT</td>
<td>100 J</td>
<td>200, 300, 360 J</td>
</tr>
</tbody>
</table>
Treatment: Electrical Cardioversion

- **New Therapies**
  - Biphasic waveform
  - Transvenous cardioversion
    - Superior to external in obese patients and those with COPD
    - Frequency of reoccurrence not superior to external
    - Biphasic waveform will decrease the need for internal cardioversion
    - Future indications might include implantable pacemakers or defibrillators or drug infusion pumps

Electrical Cardioversion

- Cardioversion with Implantable Pacemakers and ICDs can be safe when appropriate precautions are taken
- Generators are designed to protect themselves but programmed data can still be altered
- Device should be interrogated before and after procedure
Electrical Cardioversion

- Electricity conducted along an implanted lead can cause myocardial damage leading to exit block and failure of ventricular capture
- Paddle should be positioned away from implanted devices
- Internal cardioversion does not interfere with pacemaker function

Nursing Considerations in Cardioversion

- Emergency cart
  - Intubation supplies / ambu bag
  - Emergency drugs (lidocaine, epinephrine, amiodarone, atropine)
- Sedation reversal agent
- O2 delivery equipment
- Suction equipment
- O2 saturation monitor, and non-invasive BP monitoring equipment
Electrical Cardioversion

- Complications
  - Embolism (1%-7% without prophylactic anticoagulation)
  - Benign arrhythmias
  - Ventricular arrhythmias with hypokalemia and digitalis toxicity
  - Myocardial damage has not been confirmed
  - Reoccurrence of atrial fibrillation
    - Prophylactic antiarrhythmic drug therapy before cardioversion for patients at risk

Electrophysiology Studies
EPS

- Hands free external defibrillator (biphasic)

Access
- Right femoral vein
- Subclavian, IJ, brachial vein
- Right femoral artery (left sided ablations)
  - Transseptal puncture may also be used

Catheters
- Multi polar
- Recording / pacing

Catheter Placement: Typical SVT Study

[Diagram showing cardiac anatomy with labels for high right atrium, coronary sinus, His bundle, right ventricle]
EPS

- Specialized catheters: 30 or more poles
- Surface and intracardiac recordings
  - Up to 120 ECGs
- Recorded intervals
  - AH interval
  - HV interval

Programmed Electrical Stimulation (PES)

- Pacing according to pre-established protocols in the atria and ventricles, and sometimes from the His bundle or CS catheters.
- Evaluates conduction system function; determine refractory period of the atria, AV node, and ventricle; and to induce supraventricular or ventricular arrhythmias.

Mapping

- Precise placement and movement of a catheter to find a focus or electrical pathway responsible for an arrhythmia
- Locate the area for ablation
Radiofrequency Catheter Ablation

- Electrical energy produced by high frequency alternating current
- Thermal energy and local tissue destruction: fibrotic scar
  - Grounding pad
  - 30-60 seconds (up to 2 minutes)
  - Temperatures 60 to 70 degrees (90 degrees – local coagulation)
- Indications:
  - AVNRT (60% of PSVTs)
  - AVRT (30% of PSVTs)
  - AV Node Ablation
  - Atrial Flutter
  - Atrial Fibrillation
  - VT
    - Focal origin (idiopathic)
    - Ischemic
    - BBB reentrant

There is still risk of damaging coronary arteries during RF ablation.
Cryoablation

- Removes heat from tissue
- Cryoadhesion (catheter stability)
- Some cells freeze [-70 degrees C] (others are hypothermic but will recover)
- Cells are left electrically inactive but architecturally intact
- Smaller volume of tissue destruction than with RF ablation
- Significantly less frequent and smaller thrombi
- Using warmer temperatures and/or shorter times causes reversible alterations in cardiac conduction
  - Referred to as “cryomapping” or “ice mapping”
  - Used when working in close proximity to the AV conduction system

Ablation for Atrial Fibrillation

- Ablation of AV Junction with permanent pacemaker insertion to control ventricular rate
- Ablation of ectopic foci
- Surgical / catheter ablation of reentrant mechanisms
Focal Ablation for Atrial Fibrillation

- > 90% of foci responsible for paroxysmal atrial fibrillation come from area around 4 pulmonary veins.

Treatment: Catheter Ablation (Focal to Eliminate Trigger)

- Sites of ablation:
  - Pulmonary veins (or isolation of pulmonary vein from left atrium)
  - Superior vena cava
  - Right and left atria
  - Coronary Sinus
- Circumferential Mapping Technique
- Success rate
- Reoccurrence rate
Treatment for Reentrant Mechanism
Catheter Ablation

- AF can be triggered from premature atrial contraction originating from the pulmonary veins
  - Risk of pulmonary vein stenosis and pulmonary hypertension
  - Newest techniques involve circumferential isolation of the pulmonary vein from the atrial tissue in combination with substrate ablation
- Eliminates or reduces recurrence but many patients still on antiarrhythmics
- Active research as first line and in patients with permanent atrial fibrillation

Note: AV nodal ablation can be used for rate control

Special Considerations

- CABG
  - Oral beta blockers
  - Preoperative administration of amiodarone reduces incidence of post op AF
  - Restore SR with cardioversion or ibutilide
  - Anticoagulant
- AMI
  - Cardiovert
  - Amiodarone to slow RVR
  - IV BB and Nondihydropyridine Calcium Channel blockers to slow rate
  - Anticoagulant
MAZE Procedure

- For patients with symptomatic AF undergoing open heart surgery
- Series of “incisions” in the atria using radio frequency ablation or other forms of energy
- Incisions create barriers blocking ectopic foci / reentrant circuits
- May also amputate left atrial appendage
- May need permanent pacemaker

Treatment: Surgical Ablation

- Modified Maze / Cox operation
  - Controls atrial fibrillation in 90% of select patients
  - Barriers to conduction are created by surgical incisions (or other methods of isolation by: radiofrequency, microwave and cryothermy energy.)
  - This limits the amount of myocardium available for reentrant wave fronts
  - Incisions circling the pulmonary veins may isolate arrhythmogenic foci from the remainder of the atria
  - Focus is now on pulmonary veins and left atria
Alternative Sources Used During Modified Maze /Cox Procedure

- **Radiofrequency ablation** uses radiofrequency energy to heat the tissue and produce lesions on the heart, eliminating the incisions necessary in the Maze procedure. Radiofrequency surgical ablation has proved to be successful in 80% of cases. The greatest risk of this procedure is damage to surrounding structures, such as the esophagus.

- **Cryothermy** (also called cryoablation) uses very cold temperatures through a probe (called a cryoprobe) to create lesions. This technique is used commonly during arrhythmia surgery to replace the incisions made during the Cox-Maze procedure. This technique cures atrial fibrillation in close to 80% of people.

- **Microwave technology** uses a special catheter (the Flex-4 catheter) to direct microwave energy to create several lesions on the heart. The benefit of microwave radiation in comparison to other surgical ablation techniques, is that the depth and volume of heated tissue is more controlled and precise lesions are created, and less charring of the heart's surface occurs, decreasing the risk of blood clots that may travel to the brain or other organs. Microwave energy cures atrial fibrillation in about 80% of people.

Treatment: Surgical Ablation

- Complications are those common with median sternotomy and CABG
  - Also – short term fluid retention due to decreased release of atrial natriuretic peptide
  - Disruption of blood supply to sinus node made require permanent pacemaker insertion
  - May take several weeks for scar tissue to form and become effective

- Can be done with surgery for structural cardiac conditions
  - Mortality rate is higher when combined with other cardiac surgery than when done alone
Catheter Ablation for Reentrant Mechanism

- Designed based on success of surgical ablation
- Ablation limited to the right atrium produces marginal success
- Linear ablation in the LA has been more successful in controlling atrial fibrillation
  - Improvement in 70%-80% of selected patients with medically refractory atrial fibrillation

Treatment: Pacing

- Role of atrial pacing in RA or from several atrial site to prevent recurrent paroxysmal atrial fibrillation??
- In patients with standard indications for pacing there is a lower incidence of atrial fibrillation and stroke with atrial than ventricular pacing
- The use of atrial pacing in patients not meeting standard pacemaker criteria has not been proven
Treatment: Internal Atrial Defibrillators

- Reduce the energy requirement for cardioversion so the shock could be tolerated by awake patients
- Limitation: Discharged energy > 1 J is uncomfortable; average Much research was done to find shock waveforms that would required energy for cardioversion 3 J

Atrial Flutter

- Macroreentrant circuit- **Isthmus** (formed by the tricuspid valve annulus and the inferior vena cava) Dependent (up the septum and down the right atrial free wall – *typical*)
- Treated with ablation
Catheter Ablation for Atrial Flutter

- Catheter Ablation for Atrial Flutter:
  - Atrial flutter can be distinct arrhythmia or develop during antiarrhythmic therapy for atrial fibrillation (especially with class IC agents)
  - Catheter ablation is more effective than drugs for the treatment of atrial flutter
  - Reduces the reoccurrence rate by 93% to 95% when used as a first line strategy

Catheter Ablation of Atrial Flutter

- First line therapy for recurrent, typical flutter
  - Excellent efficacy, low risk
- Subsequent atrial fibrillation occurs in >20-30% of patients
- Non-isthmus dependent flutter is occasionally encountered, particularly in patients with prior atrial surgery
  - Efficacy is less predictable
Ablation for Reentrant SVTs

- **AVNRT**
  - Ablate the slow pathway to prevent heart block

- **AVRT with WPW Syndrome**
  - Orthodromic
  - Antidromic
  - Ablate the accessory pathway

AV Nodal Re-entrant Tachycardia
Ablation for VT

- Radiofrequency ablation (RFA) is the treatment of choice in the management of symptomatic patients with ventricular tachycardia (VT) in the absence of structural heart disease. Idiopathic VT which usually originates from the RV outflow tract.
- In-patients with ischemic heart disease VT (reentrant circuits from LV) RFA has developed predominantly an adjunctive role (ICD and drug therapy) in patients with incessant or highly symptomatic, drug refractory VT.

Ablation

- Patients at low risk for SCD with sustained VT that cannot be treated with drugs
- Patients with BBB reentrant tachycardia
- Adjunct to ICD when patient receiving multiple shocks
- Patients with WPW resuscitated from SCD
Ablation

- **Radiofrequency Ablation**
  - Ischemic heart disease: PREFER STABLE SCAR
    - Scar Tissue: Monomorphic
    - Ischemia: Polymorphic
  - Cardiomyopathy
  - BBB reentry
  - Idiopathic VT
    - Single morphology of PVCs

- **Direct Surgical Ablation or Resection of Arrhythmogenic Focus**
  - VT refractory to drugs, ICD, ablation
  - Pre-op or intraoperative mapping / scar based approach

- **Ischemic:**
  - Endocardial Ablation
- **Non Ischemic:**
  - Can do Epicardial Ablation
Ablation for Ischemic VT

- Endocardial and epicardial mapping to identify scarred areas
  - Challenges of epicardial mapping
    - Epicardial fat
    - Coronary arteries
- Non invasive imaging (MR) pre ablation to help locate area of scar
- Two strategies for ablation:
  - The first strategy involves induction of ventricular tachycardia, mapping and targeted ablation. *In those patients who have stable VT, it is possible to map the heart during stable VT, identify the critical circuit, and eliminate it; but only about 10% of patients actually have hemodynamically stable VT.*
  - The second strategy involves substrate mapping in sinus rhythm and linear ablation to eradicate regions of abnormal myocardium with the potential to facilitate reentry
  - Most centers now use a combination of these two approaches.
Ablation for Ischemic VT

"As mapping and ablation techniques develop and the accuracy of predicting the long-term outcome improves, the role of RFA may expand, making it the therapy of first choice in a growing proportion of patients. Perhaps with time ICDs may be reserved as the treatment for failed ablation procedures or for prophylactic indications, particularly in parts of the world where widespread implantation of ICDs is financially impractical. Even if ICDs remain justified on the basis of residual uncertainty, the quality of life is likely to be improved by the reduction in discharges resulting from catheter ablation."

Complications of Ablation

- Perforation
- Tamponade
- Venous thrombosis
- Pulmonary embolism
- Pneumothorax
- Infection – sepsis
- Bleeding
- Damage to coronary arteries
ICD Therapy

- Reduction in mortality compared to drug therapy
  - 25-55% reduction in mortality compared to drugs

- Primary prevention
- Secondary prevention
  - Dynamite trial: Not indicated acute period post MI

Assumed Criteria for ICD

- Receiving optimal medical therapy
- Expectation of survival with good functional status for > 1 year
- Meets specific criteria for disease state

- Note: Acute reversible cause is indication if not completely reversible
  - Life vest as bridge
ICD Function – Rhythm Detection

**Heart Rate**
- Monitors ventricular rate and delivers therapy when rate exceeds programmed tachycardia detection rate
- Defined rate boundaries
  - Tachycardia zones

**Interval stability**
- Looks for variability in cycle lengths
- Differentiates regular from irregular rhythms

**Morphology**
- Measures width of electogram
- Only treats if width is greater than programmed value

**Sudden Onset**
- Detects sudden

ICD Termination Therapies

**ATP-Antitachycardia Pacing**
- Painless
- “Slow” VT’s
- **Burst:** delivery of a programmable number of pacing stimuli at a constant cycle length into the tachycardia (usually around 7-8 paced beats).
- **Ramp:** a burst with progressively decreasing cycle length between paced beats.
- **Decremental Scanning:** allows successive bursts to be delivered at shorter cycle lengths (faster rates).

**Cardioversion Shock**

**Defibrillating Shock**
ICD Function
ATP-Antitachycardia Pacing

Tiered Antiarrhythmia

- **Cardioversion Shock**
  - Delivers shocks from 0.1 to 30 joules synchronized on the R wave
ICD Function

- **Defibrillating Shock**
  - Delivers high energy (20-34 joules)
  - Unsynchronized shock for VF

Management Options for VT Storm

- Shock may beget shock
  - Spontaneous calcium release
  - Reprogram ICD (stop pacing)
- IV Beta Blockers
  - Amiodarone / Lidocaine
- Revascularization
- IABP
- Deep sedation / general anesthesia
- Sympathectomy
  - Thoracic epidural anesthesia (T1-T2)
  - Other approach
- Catheter ablation
Complications Related to Pacemaker / ICD

◆ Complication of Subclavian Vein Stick
  • Pneumothorax
  • Hemothorax
  • Subclavian artery puncture
  • Air embolism
  • Bleeding
  • Brachial plexus injury
    ◆ Pain or paresthesias in arm, hand, finger

Complications Related to Pacemaker / ICD

◆ Complications related to pulse generator
  • Pocket erosion
  • Pocket hematoma
  • Infection
  • Generator migration
  • Generator malfunction
  • Premature battery depletion
Complications Related to Pacemaker / ICD

- Complications Related to Leads
  - Perforation of RV, subclavian veins
  - Lead dislodgement
    - Twiddlers Syndrome
  - Insulation breaks, lead fracture
  - Diaphragmatic stimulation
  - Venous thrombus
  - Pulmonary embolus

QUESTIONS??

Thanks for Attending
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You may contact us at
www.cardionursing.com