Procedural Electrophysiology & Anesthesia in the EP Lab

PETER JESSEL, MD
ASSISTANT PROFESSOR
Outline

- The Clinical Electrophysiology Lab
- Common Arrhythmias and Management
- Atrial Fibrillation Ablation
- Complications
- Device Implantation
- Approach to Sedation and Anesthesia
Introduction

- Initially EP labs were developed for diagnostic procedures
- EP studies were done for diagnosing bradyarrhythmias
- Focus is now primarily therapeutic for tachyarrhythmias and device implantation
- Electrophysiology procedures are becoming more complex and occurring in a sicker population
- Anesthesia is increasingly used as long procedures become more frequent
- The EP lab is an isolated environment with distinct challenges for the anesthesiology team
The Clinical Electrophysiology Lab
The Clinical Electrophysiology Lab

- **Equipment:**
  - Programmed stimulator
  - Recording system
  - Biplane Fluoroscopy
  - 3D mapping system
  - RF generator
  - Display boom
  - Cryoablation system
  - Intracardiac echo
  - 2 biphasic defibrillators
  - Magnetic navigation system (stereotaxis)
EP Procedure Fundamentals

- Intracardiac electrograms
  - EP catheters record the electrical activity of the heart
  - Providing information on timing, position, voltage
Most arrhythmias have a reentrant mechanism

Typically a critical isthmus (slow conduction) that can be ablated to terminate the rhythm and render the local tissue electrically silent
Standard EP Study Catheter Locations

- Standard 4 catheter diagnostic study
  - High right atrium – approximates sinus node location
  - His bundle – approximates AV nodal conduction
  - Coronary Sinus – records LA/LV along mitral annulus
  - RV apex
Standard EP Study Catheter Locations

RAO

LAO
SVT EP Study

- Usually pace in the ventricle first
- Then pace in the atrium
- If non-inducible – isoproterenol 1-10ug/min
- Prefer lightest sedation possible to increase chance of eliciting SVT
- Goal is to induce SVT and perform pacing maneuvers to define mechanism and location
- After a diagnosis made, a mapping/ablation catheter will be inserted
Common Arrhythmias

- Paroxysmal Supraventricular Tachycardia (PSVT)
  1. AV Nodal Reentrant Tachycardia (AVNRT)
  2. AV Reciprocating Tachycardia (AVRT)
  3. Atrial Tachycardia (AT)

- Atrial flutter (AFL)

- Atrial fibrillation (AF)

- Premature Ventricular Contractions (PVCs)/Ventricular Tachycardia (VT)
PSVT

- PSVT - General term applied to intermittent SVT other than AF, AFL, multifocal AT
- SVT is a narrow complex tachycardia rate >100 bpm and QRS <120ms
- Usually associated with a structurally normal heart
- SVT relatively common – 2.25/1,000 normal population
AVNRT

- SVT involving the AV node and adjacent tissue
- Because circuit is near both atrium and ventricle, these chambers are activated in parallel rather than series
AVNRT

- RAO view of Triangle of Koch; anatomic and fluoroscopic views
AVRT

- Congenital presence of an accessory pathway between atrium and ventricle

- Wolff-Parkinson-White pattern (~0.25% general population) – ventricular preexcitation (delta wave) on ECG, no symptoms or documented SVT

- WPW syndrome – ventricular preexcitation + symptoms/PSVT

- Many accessory pathways are concealed – no antegrade conduction, but capable of retrograde
AVRT – WPW Pattern
AVRT
Atrial Tachycardia

- Ectopic atrial focus
  - Reentrant, triggered or automatic mechanisms
  - Often has warm up phase
  - Most right atrial and along the crista terminalis
  - P wave morphology can be used to localize

- Frequent in patients with prior cardiac surgery or congenital heart disease
Atrial Tachycardia

Kistler, et al. JACC. 2006; 48: 1010
PSVT Chronic Management

- PSVT is very rarely life threatening
- Decision for medical therapy
  - Frequency of arrhythmia
  - Severity of symptoms
  - Side effects
  - Patient preference
- Medications; beta blocker or calcium channel blockers, rarely use antiarrhythmics
- Indications for EPS and ablation
  - Poorly tolerated PSVT (near syncope/syncope, falls)
  - Failure of medical therapy
  - Patient preference for ablation
- Ablation success rate generally >90%
Typical Atrial Flutter

- Frequently coexists/precedes AF
- Macroreentrant circuit
  - “Typical” cavotricuspid isthmus atrial flutter
  - Flutter waves
- Regular atrial and ventricular rate
  - Atrial rate 250-350 bpm
  - Ventricular rate variable often rapid
Typical Atrial Flutter
Typical Atrial Flutter Management

- Rate control is often difficult to achieve with medications
- Antiarrhythmics are 3rd line therapy
- Most patients are offered DC cardioversion or atrial flutter ablation
- Depends on clinical circumstances and patient preference
- Requires anticoagulation for >3 weeks prior to conversion to sinus rhythm
Typical Atrial Flutter – 3D Activation Map
Typical Atrial Flutter
Atrial Fibrillation

- Paroxysmal AF – spontaneously converts to sinus rhythm, or with intervention <7 days
- Persistent AF – Continuous AF >7 days
- Long standing Persistent AF – Continuous AF > 1 year
- Permanent AF – patient and physician have decided to leave patient in AF

No significant difference in stroke risk between paroxysmal and persistent groups when corrected for risk factors

Reasons We Treat AF

- **Symptoms**
  - wide spectrum from completely asymptomatic to exquisitely sensitive

- **Risk of stroke**
  - Virchow’s Triad
    - Endothelial injury – myocyte hypertrophy, fibrotic changes
    - Stasis - No organized mechanical function, LA dilation
    - Hypercoaguable state – platelet activation, prothrombin

- **Rate**
  - Chronically elevated heart rate may cause tachycardia cardiomyopathy
AF Guidelines 2014

Figure 2. Strategies for Rhythm Control in Patients with Paroxysmal* and Persistent AF†

No Structural Heart Disease

- Dofetilide
- Dronedarone
- Flecainide
- Propafenone
- Sotalol
- Catheter ablation
- Amiodarone

Structural Heart Disease

- CAD
- HF

- Dofetilide
- Dronedarone
- Sotalol
- Catheter ablation
- Amiodarone
- Dofetilide
- Amiodarone
AF Ablation Indications

- Symptomatic AF refractory or intolerant to at least 1 class I or III antiarrhythmic medication
- Ablation may be considered prior to antiarrhythmics, but this situation is rare
- Left atrial appendage thrombus or inability to take anticoagulation are contraindications
## AF Ablation Patient Selection

<table>
<thead>
<tr>
<th>Variable</th>
<th>More Optimal Patient</th>
<th>Less Optimal Patient</th>
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</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td>Highly symptomatic</td>
<td>Minimally symptomatic</td>
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<tr>
<td>Class I and III drugs failed</td>
<td>1</td>
<td>0</td>
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<tr>
<td>AF type</td>
<td>Paroxysmal</td>
<td>Long-standing persistent</td>
</tr>
<tr>
<td>Age</td>
<td>Younger (&lt;70 years)</td>
<td>Older (≥70 years)</td>
</tr>
<tr>
<td>LA size</td>
<td>Smaller (&lt;5.0 cm)</td>
<td>Larger (≥5.0 cm)</td>
</tr>
<tr>
<td>Ejection fraction</td>
<td>Normal</td>
<td>Reduced</td>
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<tr>
<td>Congestive heart failure</td>
<td>No</td>
<td>Yes</td>
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<tr>
<td>Other cardiac disease</td>
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<td>Yes</td>
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<tr>
<td>Pulmonary disease</td>
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<td>Yes</td>
</tr>
<tr>
<td>Sleep apnea</td>
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<td>Yes</td>
</tr>
<tr>
<td>Obesity</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Prior stroke/TIA</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Success:</td>
<td>Single Procedure</td>
<td>Multiple Procedure</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Optimal patient:</td>
<td>70% - 80%</td>
<td>80% - 90%</td>
</tr>
<tr>
<td>Less optimal patient:</td>
<td>50% - 70%</td>
<td>70% - 80%</td>
</tr>
<tr>
<td>Poor candidate:</td>
<td>&lt; 40%</td>
<td>40% - 60%</td>
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Pulmonary Vein Isolation (PVI) is the Cornerstone of AF Ablation

2012 HRS Consensus Statement
“Ablation strategies which target the PVs and/or PV antrum are the cornerstone for most AF ablation procedures.”

Complete electrical isolation should be the goal for targeted PVs and entrance and/or exit block should be demonstrated.
Pulmonary Vein Isolation

Pre

Post
Common Lesion Sets in AF Ablation
3D Mapping AF Ablation
Radiofrequency AF ablation

- Focal RF ablation was not specifically designed for AF ablation
- Technically challenging for operator
- More versatile than dedicated PVI technologies
Cryoballoon AF ablation

- Ablates at the point of contact – ice formation
- Balloon deflation in left sided veins often induces transient hypotension
- Pace right phrenic nerve to monitor loss of diaphragmatic capture
Transseptal Puncture

- Electrophysiologists perform routinely for left sided access
  - AF Ablation
  - LA Atrial tachycardia or accessory pathway ablation
  - PVC/VT ablation
- Echocardiography (intracardiac vs. TEE) used in nearly all EP labs to improve safety
- Immediately after successful transseptal an IV heparin bolus is given
Transseptal Puncture

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Anticoagulation Strategies

- Multiple studies have shown AF ablation is safer on therapeutic warfarin vs. holding warfarin with LMWH bridging\(^1,2\)
  - Fewer bleeds and strokes
- Device implantation in patients at higher risk for thrombotic events also with fewer bleeding events on therapeutic warfarin\(^3\)
  - 81% reduction in pocket hematomas
- Management strategy on NOACs still evolving, but generally held prior to procedures

Periprocedural INR Goal

Annualized Incidence vs. INR

- Stroke
- Intracranial Hemorrhage

Ischemic Stroke

<table>
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<th>INR</th>
<th>OR</th>
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<tr>
<td>2.0</td>
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<tr>
<td>1.7</td>
<td>2.0</td>
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<tr>
<td>1.5</td>
<td>3.3</td>
</tr>
<tr>
<td>1.3</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Recommended Target INR Range: 2.6-3.0

NEJM.2003; 349:1910-26
AF Ablation Complications

- Mortality after AF ablation is 0.05% according to a large world wide survey in 2005\(^1\)
- Overall complication rate of 6%
- Vascular access complications – 0.5%
  - Hematoma
  - Pseudoaneurysm
  - AV fistula
- Tamponade – 1.2%
- Stroke/TIA – 1%
- Symptomatic PV stenosis – 0.6%
- Atrioesophageal fistula – 0.01%
- Phrenic nerve injury 0.1% (Cryoballoon ablation 11%\(^2\))

1. Cappato R Circulation 2005; 111:1100
2. Packer DL JACC 2013. 16:1713
Pericardial Tamponade

- ↑Pericardial fluid → ↓Ventricular filling → ↓SV
- As little as 60-100cc of pericardial fluid can cause tamponade
- Diagnosis with LAO fluoroscopy or echocardiography
- Pericardiocentesis and drainage usually resolves the effusion
  - Protamine if heparin, Kcentra (prothrombin complex concentrate) if warfarin
  - Rare for active novel oral anticoagulant during procedure
Atrioesophageal Fistula

- Monitoring of esophageal temperature
- Limiting power and duration of lesions
- PPI is prescribed for 30 days after ablation
Pacemaker/Defibrillator Implantation

- Prefer implantation at left shoulder
  - Easier to place leads
  - Better vector for defibrillation
  - Exception is left handed pacemaker patient

- Standard EP practice is for IV antibiotics finished before incision
  - Cefazolin 1-2gm IV
  - Vancomycin 1gm IV if PCN allergic

- Standard access at OHSU axillary stick, but cephalic cut down may be chosen

- DFT Testing – VF induction to confirm device ability to terminate
  - falling out of favor
  - SIMPLE Trial – DFTs did not improve outcome
Subcutaneous ICD

- Only limited post shock pacing
- Requires DFT testing
Biventricular Pacemaker/Defibrillator

- Indicated for HF patients with EF≤35%, LBBB QRS>120ms
- Placement of a coronary sinus lead can be challenging
- Undesired phrenic nerve capture is more common in CS lead placement
Device Complications

- Complications rise as systems get more complex
  - VVI pacemaker -> dual chamber ICD -> CRT-D
- 2006-2008 NCDR ICD Registry 339, 076
- Overall implantation risk 3.36%
- Pneumothorax - 0.57%
  - Usually is managed conservatively
- Pocket hematoma – 0.97%
  - Avoid heparin
  - Do not aspirate or evacuate pocket
- Perforation 0.08%
- Lead dislodgement – 1.07%
- Death (in lab) – 0.02%

Hammill SC. Heart Rhythm. 2009; 9: 1397
Approach to Sedation and Anesthesia in the EP Lab

- EP lab not designed with anesthesia in mind
- Patients are not typical elective OR patients
- Retrospective analysis of incident reports shows communication and teamwork issues most frequent contributors\(^1\)
  - Closed loop verbal orders
- Communication with the EP attending or fellow regarding level of sedation

Approach to Sedation and Anesthesia in the EP Lab

- EP Expectations
  - VT and AF ablation typically done with general anesthesia for patient comfort
  - Most other procedures can be done with moderate sedation
  - Generally, prefer minimal sedation when trying to induce SVT or for PVC mapping

- What is MAC?
  - Anesthesia personnel present during a procedure and does not implicitly indicate the level of anesthesia needed
Little data to guide decisions regarding the best approach in the EP lab

Dexmedetomidine – a2 blocker, sympatholytic

Most SVTs remained inducible in a pediatric population with propofol (except AT)\(^1\)

Volatile agent affect on accessory pathways;\(^2\)
  - Enflurane > isoflurane > halothane

Anesthesia in AF Ablation

- Best studied population is AF ablation
  - 257 PAF pts RFA; GA higher success rate, reduced PV reconnection, shorter fluoroscopy time\(^1\)
  - GA higher rate of esophageal injury (48% vs. 4%)\(^2\)

1. Di Base. Heart Rhythm. 2011; 8: 368
Deep Sedation Without Assisted Ventilation in AF Ablation

- 1000 consecutive patients undergoing AF ablation
- 2% Propofol infusion and intermittent fentanyl directed by electrophysiologist
- Cessation of propofol occurred in 15.6%
  - 13.6% due to hypotension (fail maintain >90 SBP)
  - 1.9% respiratory depression (O2 sat <90%)
  - 0.1% hypersalivation
- 1 patient required bag mask ventilation 4min, no intubations required
Conclusions

- Procedural electrophysiology is a continuously evolving field highly dependent on technology.
- The clinical electrophysiology lab is a unique setting for the anesthesiology team.
- Optimal sedation and anesthesia strategies in the EP lab are actively being investigated.
- The EP team very much appreciates your excellent care of our patients.
The EP Control Room After Successful Fellow Femoral Access In July