Potential Complications and Management during EP Procedures

Keimyung University Dongsan Hospital
Park Hyoung-Seob
The EP Study

1. Consent
2. Sterile draping
3. Sedation
4. Vascular access
5. Catheter placement and manipulation
6. Ablation
7. Hemostasis
Complications

1. Vascular complications
2. Cardiac perforation
3. Atrioventricular block
4. Valvular damage
5. Pulmonary vein stenosis
6. Phrenic nerve injury
7. Atrioesophageal fistula
8. Radiation exposure
9. …
Vascular Complications
Vascular Access
Local Vascular Complications

- 2-6% of procedures
- Bleeding: most common vascular complication
- Hematoma
- Atriovenous fistulas
- Pseudoaneurysm
- Retroperitoneal hematoma
Cardiac Perforation
Incidence

- 0.1 – 0.2% for EP studies
- 0.2% for SVT ablation
- 0.4-2.7% for VT ablation
- 0.5-4.0% for LA ablation

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Major complications from catheter ablation procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of major complication</td>
<td>Total n = 1,676</td>
</tr>
<tr>
<td>Death</td>
<td>2 (0.1)</td>
</tr>
<tr>
<td>Perforation</td>
<td>21 (1.3)</td>
</tr>
<tr>
<td>Tamponade</td>
<td>12 (0.7)</td>
</tr>
<tr>
<td>Pericardial effusion</td>
<td>9 (0.5)</td>
</tr>
</tbody>
</table>

Bohnen M, et al., Heart Rhythm 2011;8:1661-1666


Signs of Perforation

- Unexpectedly high pacing threshold
- RBBB complex during “RV pacing”
- Static left heart border in LAO view
- Diaphoresis, chest pain, neck fullness
- Hypotension, narrowed pulse pressure
RBBB pattern with RV pacing

Detection

- Assessment of the cardiac silhouette fluoroscopically
  - Decreased excursion of lateral heart border on fluoroscopy in the LAO projection

- Thoracic echocardiography: most definitive method
Management

- Minimal pericardial effusions
  - Continuous monitoring
  - Do not warrant termination of the procedure

- Large amount of effusions
  - Procedure should be terminated
  - Protamine, Fresh frozen plasma, Vitamin K
  - Intravenous fluids, vasopressors, blood transfusion
  - Pericardiocentesis
  - Thoracic surgery in the event of persistence or rapid reaccumulation of the effusion
Thromboembolism
Incidence

- Cerebral thromboembolism is most common
- 0.4 – 2.1% for AF ablation
- Up to 2.8% for LV VT ablation
- Incidence increases in a step-wise fashion with an increasing CHADS\textsubscript{2} score

### Table 2  Major complications from catheter ablation procedures

<table>
<thead>
<tr>
<th>Type of major complication</th>
<th>Total n = 1,676</th>
<th>SVT n = 524</th>
<th>AF n = 784</th>
<th>VT with SHD n = 249</th>
<th>Idiopathic VT n = 119</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thromboembolic event</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke/TIA</td>
<td>11 (0.7)</td>
<td>0</td>
<td>8 (1.0)</td>
<td>2 (0.8)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Systemic embolus</td>
<td>10 (0.6)</td>
<td>0</td>
<td>7 (0.9)</td>
<td>2 (0.8)</td>
<td>1 (0.8)</td>
</tr>
</tbody>
</table>

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Mechanism

- Thrombus formation on wires, catheters and sheaths
- Char formation at the tip of the ablation catheter
- Thrombi or air passing through a PFO or transseptal puncture
- Dislodgement of preexistent LA or LV thrombus
- New LA appendage thrombi formation
- Aortic atheroembolism during transaortic approach
Prevention

- Continuation of warfarin at therapeutic level at the time of AF ablation
- Pre-procedural echocardiography
- Intra-procedural heparin: ACT over 300-350 seconds
- Meticulous attention to sheath management
- Minimizing char formation during ablation by regulating power delivery to prevent abrupt impedance rise
- Open-irrigation RF ablation can potentially decrease the formation of char and thrombus at the tip.
Atrioventricular Block
Atrioventricular block

- **Mechanical trauma from catheter**
  - transient bundle branch block or AV block

- **AVNRT ablation**
  - 0.2-0.8% of slow pathway ablation using post. approach
  - During RF delivery or within the first 24 hours
  - Almost always preceded by junctional ectopy with VA block
  - Level of block is usually in the AVN
Predictors of AV block

- Proximity of ablation site to the compact AVN
- Occurrence of fast junctional tachycardia (CL < 350ms) during RF application
- Occurrence of junctional rhythm with VA block
- The number of RF applications
- Worsening of anterograde AV conduction during ablation procedure
Valvular Damage
Aortic Valve Damage

- During retrograde crossing of the ablation catheter
- To prevent leaflet damage or perforation
  - Never cross aortic valve with straight catheter tip
  - A tight J curve should be formed with the catheter tip before passage to the aortic root
  - Limit RF Power output and duration while ablating at aortic cusp.
Mitral Valve Damage

- Result from entanglement of the ablation catheter within the mitral valve apparatus
- Serious damage is unlikely
- Higher risk following entrapment of catheters with circular mapping catheters
- In case of entrapment
  - Prior to pulling on the catheter, consider advancing the catheter toward the LV apex
  - Advance the sheath over the catheter and withdraw the catheter into the sheath followed by withdrawal of the whole assembly
  - Thoracic surgery maybe preferable: spare the valve
Pulmonary Vein Stenosis
Incidence

- Overall rate when moderate and mild lesions included: as high as 15.5%
- Severe PV stenosis: as low as 1.0 -1.4%
- More common in left-sided PVs
- Segmental PV isolation > Circumferential LA ablation
Clinical Presentation

- Frequently asymptomatic (mild or moderate stenosis)
- Onset of symptoms: usually several months later
- Dyspnea on exertion: most common initial symptom
- Pleuritic chest pain: late symptom
- Hemoptysis: rare
- Pleuritic pain & hemoptysis: complete branch occlusion
Prevention and Management

- Abandon in-vein ablation at the site of the AF focus
- Limit ablation to the extraostial portion of the PV or PV antrum
- Reduce target ablation temperature and energy output
- Increase operator experience
- PV stenting is recommended in symptomatic patients
Phrenic Nerve Injury
Phrenic Nerve Injury

- 0.48% during AF ablation (18 of 3755 patients)
- Complete recovery was noted in 66% of patients
- Partial recovery was noted in 17% of patients

Sacher F, et al., J Am Coll Cardiol 2006;47:2498-2503
Clinical presentation

- Asymptomatic in 1/3 of cases
- Dyspnea: most common symptom
- Cough, hiccup during ablation
- Post-ablation pneumonia or pleural effusion
- No active treatment known to aid phrenic nerve healing
Prevention

- High-output phrenic nerve mapping (10mA)
- High risk area
  RA free wall, posteroseptal part of the SVC, inferoanterior aspect of the RPV ostium, proximal LA appendage roof

*Sacher F, et al., J Am Coll Cardiol 2006;47:2498-2503*
Atrioesophageal Fistula
Incidence

- 0.03 – 0.2% (estimated)
- Devastating complication associated with high mortality (15.6% cases with fatal outcome)
- Esophageal mucosal change: up to 47%
- Esophageal ulceration: 14-18%

Clinical Presentation

- From 2 days to 4 weeks
- High fever or severe chest or epigastric pain
- Hematemesis, sepsis, air embolization and stroke
- Leukocytosis: earliest and most sensitive marker
- Thoracic CT or MR: Most valuable diagnostic exam
- Endoscopy should be avoided
Prevention

- Assessment of esophageal position (esophagography)
- Avoid ablation near esophagus
- Esophageal temperature monitoring
- Reduction of ablation power output and duration at sites close to the esophagus
Radiation Exposure
Injury to the patient

- Skin area of the back: receive greatest radiation dose
- Acute and chronic radiation-induced skin injury
- Increased risk of malignancy
  - Estimated lifetime risk of fatal malignancy after AF ablation: 0.15% for women, 0.21% for men
  - Higher in AF ablation as compared to SVT ablation
- Every 60 minutes of fluoroscopy: mean total lifetime excess risk of a fatal malignancy is 0.03% to 0.065%
Prevention

- 3D mapping system or Remote navigataion system
- Use as little fluoroscopy as possible
  - Only have fluoro when you are looking at screen
- Use low-frame pulsed fluoroscopy
- Keeping the image receptor close to the patient and the source away
- Don’t use magnification, Collimate the beam
- Rotate fluoroscope at different angles periodically
- Store fluoro loop instead of an angiographic(cine) run
Thanks for Your Attention!!