Complications of AF ablation

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Ablative therapy for AF is associated with significant risk!!

- Cardiac Tamponade
- Thromboembolic Events
- PV Stenosis
- Phrenic Nerve Injury
- Atrio-Esophageal Fistula
- Periesophageal Vagal Injury
- Vascular Complications
- Acute Coronary Artery Occlusion
- Air Emboli
- Catheter Entrapment in the Mitral Valve
- Organized Left Atrial Tachyarrhythmias after AF Ablation
- Adverse Impact on Atrial Contractility
- Radiation Exposure During Catheter Ablation of AF
Cardiac Tamponade

► **Incidence:** Among 8,754 patients from the worldwide survey who underwent catheter ablation of AF between 1995 and 2002, peri-procedural cardiac tamponade occurred in 107 patients (1.2%).

► **Etiology:**

1. Transseptal puncture and catheter manipulations.
2. High RF power > 42 W. In creating bidirectional block in LA linear ablation and Cavotricuspid isthmus ablation.

► **Precautions:**

1. Imaging tools, such as ICE or TEE
2. Direct echocardiographic imaging
   - Careful titration of RF power delivery seems to be very effective in reducing tissue boiling and endocardial rupture.

► **Management:**
Thromboembolic Events
All efforts should be made to minimize a thromboembolic event prior to ablation

**Incidence:** Symptomatic thromboembolic events from 0-5%.

**Precautions:**

1- **Preablation:**
   - CHADS2 score of 1 or more Warfarin 3 weeks INR 2-3 with bridging prior to ablation by Heparin.
   - CHADS2 score 0 with persistent AF.
   - TEE.

2- **during ablation:**
   - **Causes:**
     - Thrombus can form on long intravascular sheaths.
     - RF lesions can induce endothelial disruption and char.
   - **Anticoagulation:**
     - Time: after LA access.
     - Dose: UFH 100-140IU/kg, 15-18IU/Kg/hr.
     - Adjustment: ACT 250-400 seconds.

3- **Post ablation:**
   - Anticoagulation therapy with warfarin restarted in all patients either the same evening of the ablation procedure or the next morning with bridging by Heparin started 3-4 hours after sheath removal. whereas warfarin is continued for at least three months "blanking period."
The decisive factor in avoiding PV stenosis seems to be a fundamental understanding of the anatomy of the LA, coupled with the ability to define further the anatomy and identify the location of lesion deployment. Avoidance of lesion placement within venous structure is critical.
► Incidence: 0.5-2%

► Symptoms: 1- asymptomatic. (single PV stenosis)
   
   2- 2-6 months after procedure: cough, dyspnea, hemoptysis, or recurrent and drug-resistant pneumonia

► Precautions: Angiography of the PVs, ICE, 3-D mapping systems with integration of MR or CT imaging anatomic information, and impedance measurements using the ablation catheter Doppler assessment of PV flow targeting a maximum flow of 100 mL/sec.

► Diagnosis: TEE including Doppler measurements, V/Q, MR or CT
Management:

a-symptomatic patients:

- Angioplasty (restenosis rate 45%) and/or stenting.
- Surgery should be discouraged (disappointing results in congenital cases).

b-Asymptomatic patients with two or more stenosed PVs, invasive therapy might be considered to prevent pulmonary hypertension during exercise.

Whether patients with one stenosed PV and no or minimal clinical symptoms should be treated is not yet known.

Regression, as well as progression of PV stenosis to complete occlusion, has been observed during follow-up.

Anticoagulation is typically maintained if severe stenosis is present to prevent acute thrombosis.
Phrenic Nerve Injury
**Etiology:** The right PN as it runs along the lateral and postero-lateral wall of the right atrium is vulnerable to collateral injury during endocardial RF delivery.

**Incidence:** 0.1%

**Course:** 1- Clinically silent in the majority of cases
2- Symptoms: dyspnea, cough, and weakness.
3- Pneumonia, atelectasis, pleural effusion, and respiratory failure requiring mechanical support.

**Precautions:** Identification of PN location with high-output pacing and avoiding energy application in these regions.
Atrio-Esophageal Fistula
Apparently rare, nearly universally fatal !!!

- Close proximity, often less than 0.5 cm, of the esophagus to the left atrial wall, + documented movement of the esophagus during an ablation procedure.
3-D mapping systems, including Ensite and Carto, the ingestion of radio-opaque contrast, and online ICE have all been used to image the esophagus before, during, and following ablation.
**Precautions:** Injury is thermal in nature. Monitoring of esophageal location and/or temperature and avoidance of overheating the endocardial surface (microbubble formation) and/or low energy delivery for short duration.

**Symptoms:** Fever, malaise, leukocytosis, dysphagia, hematemesis, and neurological symptoms (air emboli).

**Diagnosis:** - CT, MRI chest or head, Endoscopy should be avoided (massive air emboli).

**Management:** - Rapid surgical correction, Stenting of the esophagus has also been reported to be effective.
Periesophageal Vagal Injury

► **Incidence:** 1%.

► **Symptoms:** abdominal bloating and discomfort few hours to 2 days following ablation.

► **Etiology:** LA RF energy delivery affecting the periesophageal vagal plexus. Upper gastro-intestinal investigation showed a pyloric spasm, gastric hypomotility, and a markedly prolonged gastric emptying time.

► **Precautions:** esophageal temperature monitoring and avoiding LA endocardium overlying the esophagus.
Vascular Complications

- complications include large hematoma at the groin or neck sites of catheter insertion, pseudoaneurysm, arteriovenous fistula, retroperitoneal bleeding

**Management:**
1. Conservative +/- transfusion.
3. Percutaneous intervention.
4. Surgical.

**Precautions:** careful vascular access, avoidance of large sheaths, and adequate vascular compression during states of persistent anticoagulation.
Acute Coronary Artery Occlusion

- Incidence: very rare 0.002
- LCx occlusion in mitral isthmus ablation. RF energy was delivered in the coronary sinus
Air Emboli

**Causes:** Air emboli may enter the arterial system during sheath/catheter exchanges, aspiration, irrigation, or continuous infusion of sheaths.

**Complications:** Air embolus - right coronary artery - acute inferior myocardial wall ischemia, chest pain, ST elevation in the inferior ECG leads. Air emboli may also travel to cerebral circulation and may lead to neurologic manifestations.

**Precautions:**

**Management:** 1. Resolves spontaneously, although aggressive supportive measures may be required.
2. If the signs suggestive of an embolus persist, coronary angiography and, if necessary, aspiration of the air from within the coronary artery should be considered.
Catheter Entrapment in the MV

- **Incidence:** 0.01%

- **Precautions and management:**
  1. Always position the circular part of the mapping catheter in the posterior LA.
  2. Torque the catheter in a clockwise direction when leaving the transseptal sheath.
  3. Advance the catheter and/or the sheath over the catheter when such entrapment is observed.
  4. Early surgical extraction, in order to avoid mitral valve injury and preserve the mitral valve apparatus.
Organized Left Atrial Tachyarrhythmias after AF Ablation

- Organized left atrial tachycardias and flutter are common in patients who have undergone left AF ablation with a reported incidence of 3% to 50%.

- The variability in the frequency of occurrence post-ablation and the mechanism of the tachycardia appears to be clearly dependent upon the type of ablation procedure used.

- Circumferential PV ablation combined with additional linear lesions in the LA report a higher prevalence that is three times that observed with only PV isolation procedures. This is especially true if no attempt is made to establish a line of bidirectional block.

- PV isolation alone: predominantly focal LA tachycardias originating from reconnected PVs
Presentation and diagnosis:

- Early postablation with symptoms due to rapid 2:1 conduction.
- Resistant to drug therapy and recurrent after DC.
- 50% resolves spontaneously after the post ablation healing period.
- Because many tachycardias will persist after the two- to three-month blanking period and/or are recurrent and very symptomatic, repeat ablation procedures are appropriate.

Surface ECG: 1-P wave morphology: A superior and posterior location for the PVs creates inferiorly directed P waves with a positive precordial activation pattern. Importantly, right atrial flutter after extensive LA ablation can create atypical surface ECG patterns.

- 2- isoelectric interval.
- Activation map for focal atrial tachycardia.
- Entrainment for macroreentrant tachycardia.
Management:

- 1- Isolation of the reconnected PV segment (for focal tachycardias of PV origin), focal ablation.
- 2- Targeting the zone of slow conduction or a well defined anatomic isthmus for macrore-entrant flutter, linear ablation.
- Success rates > 80%.
- LA linear lesions strategy should only be used when felt to be clinically necessary. In addition, documentation of bidirectional block using the appropriate stimulation techniques should be performed routinely to prevent this common complication.
Figure 5. Patient #12: Large figure of eight circuits with two reentrant loops around ipsilateral isolated PV ostia (isochronal activation map in center with anteroposterior, superior and posteroanterior views of LA). Left: ECG shows the absence of isoelectric intervals (most evident in leads II, III, and avF). RF was delivered on LA roof beginning from near LSPV os (red circles on 3D map) to transect common pathway. Right: tachycardia termination during RF delivery #7 close to RSPV ostium.
**Figure 3.** Patient #11. Another small reentry circuit dependent on a narrow isthmus at RSPV ostium. Left, 3D map and cartoon of circuit and isthmus. Right, 12-lead ECG with a 144 msec isoelectric interval and P waves suggestive of RSPV origin. Inset, ablation site. Bottom, tachycardia termination four seconds after RF delivery at*. 

*ECG, mapping and ablation*
Adverse Impact on Atrial Contractility

- Proximal and antral PV isolation showed improvement in LAEF at both long and short terms.
- However, circumferential PV ablation showed no increase in LAEF compared to patients in chronic AF which was less than those in control group.
- LA function are clearly dependent on the extent of LA ablation.
- ??relationship to thromboembolic risk.
Radiation Exposure During Catheter Ablation of AF

- Increased exposure:
  1. CT scan prior to the procedure
  2. Long fluoroscopy time.
  3. Obese patient.

- How to avoid:
  1. Very low frame rate pulsed fluoroscopy
  2. Limiting cine and magnification.
  3. Changing the angulation of equipment.
  4. Electroanatomic and remote navigation.
Why should we ablate AF??!!

► Catheter Ablation Versus Antiarrhythmic Drugs for Atrial Fibrillation
The A4 Study
Catheter Ablation Versus Antiarrhythmic Drugs for Atrial Fibrillation
The A4 Study

112 Pts (16% women), Alter 51 ± 11 Jahre

PV-Ablation
n=53

Antiarrhythmic drugs
n=59

Crossover from Abl. → AAD =63%

No Recurrence of AF at 1 year FU
Atrial Fibrillation

We Have Learned a lot –
But Many Issues and Questions Remain.

The Gift That Keeps on Giving!
Thank you