CT of the Left Atrium and Pulmonary Veins before Radio-Frequency Catheter Ablation for Atrial Fibrillation

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Agenda

- Our patient
- Atrial fibrillation and the role of the pulmonary veins
- Radiofrequency catheter ablation – technique, complications, challenges
- Pre-RFCA imaging with CT – epicardial and endocardial reconstructions, measurement of geometry
Our Patient

- 75 yo M w/ longstanding atrial arrhythmias
- Refractory to medical management – failed dofetilide, quinidine, amiodarone, sotalol
- Chronically anticoagulated and rate controlled, has pacemaker
- Recently suffering from increasingly severe shortness of breath associated with fatigue
- Noted to be in atrial tachycardia, pacemaker attempted to overdrive pace, but failed
- Echocardiogram showed reduced ejection fraction, consistent with worsening symptoms
Atrial Fibrillation

- Most common sustained cardiac arrhythmia
- Most common cardiac arrhythmia requiring hospitalization
- Occurs when ectopic electrical foci “fire” independently
- Major complications:
  - Hemodynamic compromise – rapid ventricular rate can cause hypotension, chronic poorly controlled tachycardia can cause ventricular dysfunction
  - Thrombi may form and embolize, resulting in significant morbidity/mortality from stroke
Pulmonary Veins and AF

- Ectopic foci are often found in the distal pulmonary veins*

- Thus, we can attempt to interrupt conduction pathways that lead to atrial fibrillation, electrically "disconnecting" the pulmonary vein from the atrium
  - Surgical management: modified maze procedure – series of atrial incisions
  - Non-surgical management: RFCA of distal pulmonary veins

RFCA for Atrial Fibrillation

- Under fluoroscopic guidance, a catheter with an ablation electrode is guided up the IVC, across the atrial septum, then to the pulmonary veins.
- The specific ectopic focus or the entire circumference of the vein is ablated.
- Frequently, to reduce need for a repeat procedure, all pulmonary vein ostia are empirically ablated.
Complications of RFCA

- Pulmonary vein dissection
- Atrial or pulmonary vein perforation
- Pulmonary vein stenosis*
- Lengthy fluoroscopic time poses radiation risk to patient and physicians
  - There has been at least one case of radiation dermatitis following fluoroscopy for RFCA**


Challenges of RFCA

- Pulmonary vein anatomy is quite variable
- The “normal” pulmonary vein anatomy is composed of four pulmonary veins
- However, common ostia or extra veins are common
- Radiofrequency energy is ideally applied very close to the venoatrial junction
  - Reduce risk of stenosis – the further the ablation is from the ostium, the greater the chance of stenosis
  - Reduce risk that portion of pulmonary vein that remains electrically attached to atrium may contain ectopic foci
Value of Pre-RFCA Imaging

- Imaging helps address these challenges, reducing complications
- Imaging tells us
  - Is the anatomy normal?
  - What is the ostial diameter of each vein and how far is it to the first branch?
  - Are there any extra pulmonary veins?
In the past, attempts were made to define the pulmonary vein ostia by injecting contrast into the L atrium and attempting to visualize contrast material that refluxed into the pulmonary veins (pulmonary venography).

This is difficult, as blood flows the opposite way.

Furthermore, the 2D nature of fluoroscopy doesn’t allow accurate 3D assessment.

Thus, we often use CT or MR – often CT as patients frequently have pacemakers and thus cannot receive MR imaging.
Multi-Detector Row CT

R ventricle
L ventricle
L atrium
**Epicardial (Extraatrial) VR Views**

- A 3D model of the left atrium and the pulmonary veins is created and can be manipulated to better understand the 3D structure.
- Note this patient has a R middle pulmonary vein!
Endocardial (Intraatrial) VR

- Endocardial reconstructions allow us to open up the atria and look from the inside.

3D reformation of C+ axial CT

L superior pulmonary vein
L inferior pulmonary vein
R superior pulmonary vein
R middle pulmonary vein
R inferior pulmonary vein

PACS, BIDMC
Endocardial VR (cont’d)

- We can actually “travel” through veins and imagine what the ablating catheter sees
Measurement of ostial diameters on endoluminal views

Endoluminal views can be used to measure geometry of the vessels, show vein orientation, show where veins branch, etc.

L superior pulmonary vein
L inferior pulmonary vein
R superior pulmonary vein
R middle pulmonary vein
R inferior pulmonary vein
Measurement of ostial diameters on multiplanar reformations

- Ostial diameters can also be measured by examining curved reformations, demonstrating the narrowing of the lumen of a vessel.

- Or on orthogonal cross sections.
Summary: CT mapping of LA and PV anatomy in RFCA for AF

- RFCA is increasingly used to treat atrial fibrillation
- CT provides the electrophysiologist with extra- and intra-atrial anatomic information prior to the procedure
- CT improves ease of visualizing number, position and location of pulmonary veins, reducing risk of complications
- Preprocedure mapping with CT diminishes fluoroscopic time
- CT can also be used to evaluate for pulmonary vein stenosis after the procedure
- MRI can be used similarly in patients who are able to receive MRI
References

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