New Technologies and Approaches for AF Ablation:
Cardiac Imaging, Transseptal Access, Mapping and Ablation Catheters, Alcohol Ablation

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• Catheter ablation of atrial fibrillation require many steps of delicate technique and time
  – Vessel puncture
  – Catheter position
  – Trans septal puncture
  – 3 dimensional mapping system use
  – Interpretation of complex electrogram
  – Manipulation of ablation catheter
  – Patient sedation
  – Epicardial puncture
Evolving technique

- Imaging Technologies
- Ablation Technologies
- Ethanol ablation
- Transseptal puncture
Imaging

- Fluoroscopy
- CT and MRI
- Rotational Angiography
- Merge Technique (CT/MRI/3DATG fluoroscopy merge)
Fluroscopy

- Primary imaging modality in EP field
- Easy availability, simplicity and low cost
- Contrast use for anatomical definition
- Risk of radiation and contrast toxicity
CT and MRI

- 3D reconstruction of cardiac structure by CT or MRI
  - Easy understanding of anatomy of cardiac chamber and measuring the chamber volume

- Sizing and location information by 3D imaging may become more important with the advent of complex ablation tools such as cryoballoons.
CT and MRI

- Characterization of LA fibrosis by delayed enhanced MRI imaging

CT and MRI

- MRI can be used to guide catheter navigation while directly visualizing ablation lesions during RF (radiofrequency) energy delivery
CT and MRI

- Expensive
- Usually performed several days before procedure—some change of volume and anatomical status and esophagus position
- Radiation exposure and contrast toxicity by CT
One map technique in NavX system
Rotational Angiography

Recently introduced imaging modality that allows acquisition of volume images of cardiac chambers (or blood vessels) by rotating the X-ray C-arm around the area of interest while injecting contrast.
3D Atriography (3DATG)
Fusion of 3DATG and NavX

- overlay the 3D image of the chamber of interest on live fluoroscopy and register it using anatomic landmarks or catheter placement.
- 3DATG can be imported into the CARTO system or NavX and provide real-time anatomical information to supplement EAM.
NavX vs 3D Navigator
NavX vs 3D Navigator
Rotational Angiography

- real-time anatomical information of CT-like quality with less cost and radiation exposure
- Radiation and contrast toxicity
- no technical support during the procedure
Future directions in imaging for atrial fibrillation ablation

- Laser balloon ablation incorporates an optical fiber that generates 30° arcs of light projected onto regions of balloon and PV contact

Future directions in mapping for atrial fibrillation ablation

- novel computational imaging method to detect localized electrical rotors or repetitive focal impulses.
- Hilbert transform analysis on signals obtained from a 64-pole basket catheter
Ablation

- Balloon-based ablation system
- Multi-electrode ablation catheters
- Force-sensing technologies
- Alcohol ablation technique
• relatively simple alternative for point-by-point radiofrequency ablation because this technology theoretically allows for PV isolation with a single application.
Cryo Balloon

- not adequate for the treatment of persistent or permanent atrial fibrillation.
- Additional use conventional catheters to the balloons is necessary for adequate ablation.
- Right inferior pulmonary vein isolation is difficult.

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Cryo Balloon

- high efficacy rate of the procedure
- phrenic nerve palsy has been reported in up to 11.2% of cases and PV stenosis is also reported.
- “single big (28 mm) cryoballoon technique” to deploy cryothermal lesions proximal to the PV ostium at the antrum level, thereby reducing the risk of collateral damage
Multi Electrode Ablation Catheters

Pulmonary Vein Ablation Catheter (PVAC)
- Maps, ablates and confirms isolation of the pulmonary veins
- Over-the-wire design facilitates navigation and stability

Multi-Array Septal Catheter (MASC)
- Maps, paces and ablates arrhythmogenic tissue along the left atrial septum
- Unique electrode placement simplifies septal ablation

Multi-Array Ablation Catheter (MAAC)
- Maps, paces and ablates arrhythmogenic tissue in the left atrial body
- Bidirectional reach to allow access to the roof and mitral isthmus
Multi Electrode Ablation Catheters

- Controlled energy delivery
  - Unipolar energy for depth
  - Phasing provides bipolar energy for fill
  - Duty cycling facilitates electrode cooling
- Allows the user to select individual electrode pairs
- Accurately measures temperature and maintains power output at each electrode-tissue interface
- Graphical user interface provides visual confirmation of contact and power delivery
- Operate generator from within the sterile field using optional remote control
4:1 (Bipolar:Unipolar) RF Delivery Mode

- Power Ratio of Bipolar:Unipolar = **4 to 1**

- Current Flows Between Ablation Electrodes and to Return Electrode

- **80% of Power is Bipolar**
- **20% of Power is Unipolar**
**In-vitro** Lesion Characterization: PVAC

**SetTemp:** 60°C  **Duration:** 60s

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<th>Depth (mm)</th>
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<tr>
<td>bipolar</td>
<td>3.1</td>
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Multi Electrode Ablation Catheters

- Mapping / Pacing and Ablations from all electrodes
- Much easier procedure than current approaches
- Reduce procedure times to less than 3.0 hours for Permanent AF
- Reduce procedure times to less than 1.5 hours for PAF
- Tailored lesions (i.e., depths, lengths, configurations)
- Cover large area with a single catheter placement
Multi Electrode Ablation Catheters

- Require several applications for each vein
- Contact is important factor to achieve isolation
- Multiple catheter is required for procedure – high cost
- Lack of irrigation ablation system – concern of thrombogenicity
Force sensing technologies

- Too little force (poor contact)
  - smaller lesion formation in volume and depth
- Excess force (tight contact)
  - pressure and overheating related complication
Alcohol Ablation

- Vein of Marshall
Alcohol Ablation

- Vein of Marshall (Ligament of Marshall)
  - AF could originate from catecholamine-sensitive vein of Marshall (VOM) or its ligament
  - Ablation along the vein of Marshall could facilitate to make mitral isthmus block
  - Retrograde ethanol infusion in the vein of Marshall is feasible in human atrial fibrillation ablation
CS venogram

RAO 35°

LAO 35°
VOM cannulation
99% ethanol infusion
99% ethanol infusion
Voltage mapping (pre/post)
Voltage mapping (pre/post)
Ablation at PMI -> Perimitral block
Difficult Transseptal Puncture
Case 1
F/65, palpitation

- Onset: 2 years ago
- Dizziness, pre-syncope
- 2009년~(타병원)
  - AF with RVR, AFL
  - highly symptomatic paroxysmal AF
  - amiodarone & warfarin
- PHx> 1984년 secundum ASD: patch closure
- HTN, sleep apnea-CPAP
AFL termination during Ablation of Rt. PV
Case 2
F/41

- Symptomatic & drug-refractory AF
- 타병원 1992. ASD closure: GoreTex 4.5cm
Intracardiac echocardiography (ICE)
Case 3
F/38

- Drug resistant AF & AFL
- 타병원 ASD amplatzer 10 months ago
Before the procedure

5 days after double TSPs & RFCA

6 months after the procedure
Case 4
TGA s/p Senning op
LA angiography
Conclusion

- Catheter ablation of atrial fibrillation is now established therapy, but sometimes very challenging.

- Better understanding of disease characteristics, revolutionizing technique and technology is required to overcome the limitation.