Update on Surgical treatment of Atrial Fibrillation

Ali Khoyneshad MD, PhD, FHRS
Director of Cardiovascular Surgery
MemorialCare Long Beach Medical Center
Professor of Surgery
David Geffen School of Medicine at UCLA
Los Angeles, CA

Financial Disclosure

- Vasctek: Research support
- Medtronic: National PI, research support
- Endologix, Gore, SJM, Atricure, Sorin, Bard (not relevant)
AF is not a Benign Disease!

- AF is second leading cause of stroke
- 2x the mortality rate of matched population
- 23% of Medicare patients are likely to incur a stroke within the first year of AF diagnosis
- AF related stroke has 50% worse prognosis than non-AF stroke
- A growing problem


AF Stat

5-Year Survival By Primary (Invasive) Cancer Site in U.S. 2003-2009

AFib: a growing problem!

- From 1985 to 1999, hospitalizations for Afib increased 2-3 fold
- Annual healthcare cost of Afib within a hospital setting is now estimated at $6.65 billion
- Prevalence:
  - over 5mil, 2030: 18mil

Aims of AF treatment

- Improve symptoms
- Improve quality of life
- Reduce stroke
- Reduce heart failure
- Reduce bleeding
- Reduce cardiomyopathy
- Reduce mortality
- Reduce dementia?!
Options for afib patients:

- Catheter-based ablation
- Surgical ablation (Maze)
- Rate control and anticoagulation (permanent AF):
  - less heart function
  - less quality of life
  - more bleeding
  - more heart failure and death

Coumadin

- it reduces embolic stroke
- bleeding risk is major risk
- Major bleeding risk between 0.1 and 3.4% \(^{2-3}\)
- Pt’s age and level of anticoagulation are most powerful predictors of major bleeding.

### Catheter-guided ablation

- Well-established
- Most effective in early stages of AF
- Preferred approach in paroxysmal AF
- Typically our first approach
- Contraindication: clot in atrium
- Less effective: elderly with large atrium and persistent AF


### Maze and guidelines

**HRS 2014**

5.7. Surgery Maze Procedures: Recommendations

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Ia</td>
<td>An AF surgical ablation procedure is reasonable for selected patients with AF undergoing cardiac surgery for other indications. <em>(Level of Evidence: C)</em></td>
</tr>
<tr>
<td>Class Ib</td>
<td>A stand-alone AF surgical ablation procedure may be reasonable for selected patients with highly symptomatic AF not well managed with other approaches (168). <em>(Level of Evidence: B)</em></td>
</tr>
</tbody>
</table>

**STS 2017**

**CLASS OF RECOMMENDATION – IIA**

- Surgical ablation for symptomatic AF in the absence of structural heart disease that is refractory to class I/III antiarrhythmic drugs or catheter-based therapy or both is **REASONABLE** as a primary stand-alone procedure, to restore sinus rhythm. (Class IIa, Level B randomized)
- Surgical ablation for symptomatic persistent or longstanding persistent AF in the absence of structural heart disease is **REASONABLE**, as a stand-alone procedure using the Cox-Maze III/IV lesion set compared with pulmonary vein isolation alone. (Class IIa, Level B nonrandomized)
The "Gold Standard": Cox-Maze III

- Low mortality
- NSR or paced supraventricular rhythm in 75-98%
- Cumulative risk of stroke: 1% @ 10 years
- Cox-Maze III success rates:
  - Cox 98%
  - Washington U 97%
  - Mayo Clinic 75%
  - U of Toronto 75%

Damiano et al. The long-term outcome of patients with coronary disease and atrial fibrillation undergoing the Cox maze procedure. J Thorac Cardiovasc Surg 2003;126: 2016-21

T-Maze

- bilateral VATS
- beating heart procedure
- bi-atrial lesion set
- Roof line and isthmus lesion
- bilateral ganglion-plexus ablation
- LAA exclusion
- confirm exit/entrance blocks & confirm lack of ablation gaps
Minimally Invasive Access

Device utilization via thoracoscopic approach
T-Maze procedure

Intraoperative EP study

✦ Pre-ablation:
  Sense (baseline PV potentials)
  Pace (find threshold for capture)
  HFS (GP activity: increase RR interval)

✦ Post-ablation:
  Sense (inactive EKG)
  Pace (pace @ threshold for capture)
  HFS (no GP activity)
Benefits of collaboration: the Surgeon and the Cardiologist

EP-guided ABLATION Anatomy guided

Benefits of collaboration: the Surgeon and the Cardiologist

Max

INVASIVE

Min

Cardiologist

Surgeon
Hybrid Thoracoscopic Surgical and Transvenous Catheter Ablation of Atrial Fibrillation

Laurent Pison, MD,* Mark La Meir, MD,† Jurren van Opstal, MD, PhD,* Yuri Blaauw, MD, PhD,* Jos Maessen, MD, PhD,† Harry J. Crijns, MD, PhD*
Maastricht, the Netherlands

Objectives
The purpose of this study was to evaluate the feasibility, safety, and clinical outcomes up to 1 year in patients undergoing combined simultaneous thoracoscopic surgical and transvenous catheter atrial fibrillation (AF) ablation.

Background
The combination of the transvenous endocardial approach with the thoracoscopic epicardial approach in a single AF ablation procedure overcomes the limitations of both techniques and should result in better outcomes.

Methods
A cohort of 26 consecutive patients with AF who underwent hybrid thoracoscopic surgical and transvenous catheter ablation were followed, with follow-up of up to 1 year.

Results
Twenty-six patients (42% with persistent AF) underwent successful hybrid procedures. There were no complications. The mean follow-up period was 470 ± 154 days. In 23% of the patients, the epicardial lesions were not transmural, and endocardial touch-up was necessary. One-year success, defined according to the Heart Rhythm Society, European Heart Rhythm Association, and European Cardic Arrhythmia Society consensus statement for the catheter and surgical ablation of AF, was 93% for patients with paroxysmal AF and 90% for patients with persistent AF. Two patients underwent catheter ablation for recurrent AF or left atrial flutter after the hybrid procedure.

Conclusions
A combined transvenous endocardial and thoracoscopic epicardial ablation procedure for AF is feasible and safe, with a single-procedure success rate of 83% at 1 year. (J Am Coll Cardiol 2012;60:54-61) © 2012 by the American College of Cardiology Foundation

Hybrid Atrial Fibrillation Ablation: Current Status and a Look Ahead

Ali Khoynezhad1 MD, PhD, James R. Edgerton2 MD, Talal Al-Atassi3 MD, MPH, Kenneth A. Ellenbogen1 MD, Xinzhong Wang4 MD, Paul Wang5 MD, Vigneswar Kasinjan1 MD

1. Cedars-Sinai Heart Institute, Los Angeles, CA.
2. Heart Hospital, Plano, TX.
3. Virginia Commonwealth University School of Medicine and Pauley Heart Center, Richmond, VA.
4. Stanford University, Palo Alto, CA
### Literature on Hybrid TT-Maze

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>Patients (n)</th>
<th>P-LSP</th>
<th>Access</th>
<th>Timing</th>
<th>Mortality</th>
<th>Complication(s)</th>
<th>Follow-Up</th>
<th>AF Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mahapatra</td>
<td>2011</td>
<td>15</td>
<td>100%</td>
<td>B-Thor</td>
<td>Staged</td>
<td>0</td>
<td>0</td>
<td>20 months</td>
<td>87%</td>
</tr>
<tr>
<td>Lee</td>
<td>2011</td>
<td>25</td>
<td>35%</td>
<td>B-Thor</td>
<td>Staged</td>
<td>0</td>
<td>4%</td>
<td>14 months</td>
<td>79%</td>
</tr>
<tr>
<td>La Meir</td>
<td>2013</td>
<td>28</td>
<td>54%</td>
<td>B-Thor</td>
<td>Concomitant</td>
<td>0</td>
<td>0</td>
<td>12 months</td>
<td>91%</td>
</tr>
<tr>
<td>Pison</td>
<td>2012</td>
<td>26</td>
<td>42%</td>
<td>B-Thor</td>
<td>Concomitant</td>
<td>0</td>
<td>0</td>
<td>12 months</td>
<td>92%</td>
</tr>
<tr>
<td>Pison</td>
<td>2014</td>
<td>78</td>
<td>63%</td>
<td>B-Thor</td>
<td>Concomitant</td>
<td>0</td>
<td>8%</td>
<td>24 months</td>
<td>87%</td>
</tr>
<tr>
<td>Kurfurst</td>
<td>2014</td>
<td>30</td>
<td>100%</td>
<td>B-Thor</td>
<td>Staged</td>
<td>0</td>
<td>24%</td>
<td>0</td>
<td>90%*</td>
</tr>
<tr>
<td>Bulava</td>
<td>2015</td>
<td>50</td>
<td>100%</td>
<td>B-Thor</td>
<td>Staged</td>
<td>0</td>
<td>24%</td>
<td>12 months</td>
<td>94%</td>
</tr>
</tbody>
</table>

### Literature on Hybrid non-TT-Maze

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>Patients (n)</th>
<th>P-LSP</th>
<th>Access</th>
<th>Timing</th>
<th>Mortality</th>
<th>Complication(s)</th>
<th>Follow-Up</th>
<th>AF Freedom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richardson</td>
<td>2016</td>
<td>83</td>
<td>99%</td>
<td>B-Thor</td>
<td>Both</td>
<td>1.2%</td>
<td>11%</td>
<td>12 months</td>
<td>71%</td>
</tr>
<tr>
<td>Binerli</td>
<td>2013</td>
<td>45</td>
<td>100%</td>
<td>R-Thor</td>
<td>Staged</td>
<td>0</td>
<td>0</td>
<td>28 months</td>
<td>89%</td>
</tr>
<tr>
<td>Gehi</td>
<td>2014</td>
<td>29</td>
<td>94%</td>
<td>R-Thor</td>
<td>Concomitant</td>
<td>0</td>
<td>10%</td>
<td>12 months</td>
<td>55%</td>
</tr>
<tr>
<td>Kaefer</td>
<td>2010</td>
<td>28</td>
<td>100%</td>
<td>SubX</td>
<td>Concomitant</td>
<td>0</td>
<td>11%</td>
<td>6 months</td>
<td>76%</td>
</tr>
<tr>
<td>Gehi</td>
<td>2013</td>
<td>101</td>
<td>84%</td>
<td>SubX</td>
<td>Concomitant</td>
<td>0</td>
<td>6%</td>
<td>12 months</td>
<td>73%</td>
</tr>
<tr>
<td>Gersak</td>
<td>2014</td>
<td>73</td>
<td>100%</td>
<td>SubX</td>
<td>Concomitant</td>
<td>0</td>
<td>9%</td>
<td>12 months</td>
<td>73%</td>
</tr>
<tr>
<td>Zembala</td>
<td>2012</td>
<td>27</td>
<td>100%</td>
<td>SubX</td>
<td>Staged</td>
<td>3.7%</td>
<td>9%</td>
<td>12 months</td>
<td>80%</td>
</tr>
<tr>
<td>Edgerton</td>
<td>2016</td>
<td>24</td>
<td>100%</td>
<td>SubX</td>
<td>Concomitant</td>
<td>14%</td>
<td>10%</td>
<td>24 months</td>
<td>19%</td>
</tr>
</tbody>
</table>
Follow-up is important!

- Afib is now fixed! Still need follow-up!
- EKG f/u can overestimated success by 20%
- Zio patch at 3, 6-12 months and yearly thereafter
- Importance of integrated patient-centric afib center

Patient-centric care at LB

- Collaborative (integrated) approach to patient care is critical to optimize success
- See patients together in Clinic (One-stop-Shop)
- Perform cases together (Hybrid)
- Discuss complex advanced-afib patients
- Endocardial Ablation for Right Side Flutter
- Follow-up after afib procedure
- Manage postoperative medications
Our hybrid experience

- 132 patients (82% long-standing persistent afib)
- No procedural stroke, MI or death
- Pump-assisted in 3 pts, no sternotomy
- Average hospital stay 3.4 days
- One pt died at six weeks of unrelated cause
- Ten pts required atrial flutter/fibrillation ablation
- Three pts have 45% & 10% afib burden at 1-year
- 94% pts in NSR or paced sinus
- 85% off anti-arrhythmic
- midterm f/u up to 21 months on 7/14-day Holter

Midterm outcomes of Thoracoscopic Ablation of Atrial Fibrillation using Dallas Lesion set

Ali Khoynezhad MD, PhD, FACS
Professor of Cardiovascular Surgery
Director of Aortic Surgery
Co-Director, Atrial Fibrillation Program
Cedars-Sinai Heart Institute
Los Angeles, CA, USA

OBJECTIVE:
- Atrial fibrillation (AF) is the most common sustained arrhythmia and is associated with a nearly five-fold increased risk for stroke as well as near triple-fold increased risk of death.
- For symptomatic drug-refractory AF, percutaneous ablation has been used with varying success and possible incomplete ablation lines.
- AF is often combined with structural heart disease, but patients with lone AF are optimal candidates for the endoscopic ablation treatment.
- While Cox Maze IV is the gold standard for concomitant Maze, optimal approach for stand alone operations is not established. Thoracoscopic Maze.
- We analyzed our data in endoscopically performed ablation of atrial fibrillation using Dallas Lesion set.

METHODS:
- From January 2012 through January 2014, a total of 48 symptomatic and drug-refractory patients with lone atrial fibrillation underwent a thoracoscopic epicardial ablation using the bipolar radiofrequency clamp (AtriCure Inc.).
- 27 of these patients were performed using Dallas lesion sets on the beating heart.
- All of them had persistent long-standing AF.
- Epicardial ablation was performed on 15 men (70%) and 8 women (30%), with a mean age of 64 years (range 47 to 82).
- Entrance and exit block were confirmed in all patients after Maze, and the left atrial appendage was excluded.

RESULTS:
- There were no hospital stroke, myocardial infarction or operative mortality.
- No patients (pts) needed cardiopulmonary bypass used to fix a laceration of the left atrial appendage and left atrium. No sternotomy or cardioplegic arrest was necessary.
- The follow-up was completed in 91% with a mean length of 13 months with a freedom of AF in 90%.
- The heart rhythm was documented in all of them besides 7 patients with a holder ECG with duration of at least of 7 days.
- In 2 patients the postoperatively persistent AF or flutter was treated with radiofrequency ablation.
- Percutaneous implantation was done in 3 patients (10%) due to bradycardia (n=2) and sick sinus syndrome (n=1).
- There were 2 late deaths (7%) one due to pulmonary embolism (PE) and non-AF related stroke.

CONCLUSIONS:
- Thoracoscopic radiofrequency ablation using Dallas lesion set on the beating heart for treatment of lone atrial fibrillation is technically feasible, and achieves high success rates with low procedure-related morbidity.
- Mid-term follow-up is encouraging with acceptable rates of EP re-intervention and pacemaker implantation.
- Collaboration with electrophysiology colleagues is critical for optimal patient care.
- Long-term follow-up is needed.
DEEP AF Trial

- up to 20 centers internationally
- non-paroxysmal patients with or without previous EP ablations
- Hybrid approach:
  - Bi-atrial thoracoscopic Maze (debulking)
  - Right (and left isthmus lesion) along with EP testing at 3 months
- PIs: Ellenbogen, Wang, Kasirajan, Khoynezhad

Conclusions

- Team approach improves care of patients with advanced AF
- Surgical AF (T-Maze) is the most effective remedy for persistent AF
- Hybrid Maze is an attractive and less-invasive alternative for advanced AF
- Hybrid Maze is undergoing multi-center trial
- LAA occlusion is a must!
Thank you!

Hot topics in treatment of Aortic Diseases

Ali Khoynezhad MD, PhD, FHRS
Director of Cardiovascular Surgery
MemorialCare Long Beach Medical Center
Professor of Surgery
David Geffen School of Medicine at UCLA
Los Angeles, CA
The “Hot” Topics

- TEVAR for all type B dissections?
- Aortic valve repair is now the new standard of care!
- Branched stent graft for the aortic arch is here!
- TEVAR will be come an attractive option for high-risk pts with type A aortic dissection.
- Arch debranching and moderate hypothermia for the aortic arch!
## Aortic Valve Repair

<table>
<thead>
<tr>
<th>AI Class</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal cusp motion with PAA dilatation or cusp perforation</td>
<td>Cusp Prolapse</td>
<td>Cusp Restriction</td>
</tr>
<tr>
<td>a</td>
<td>lb</td>
<td>lc</td>
<td>ld</td>
</tr>
</tbody>
</table>

### Mechanism

- **Type I**: Normal cusp motion with PAA dilatation or cusp perforation
- **Type II**: Cusp Prolapse
- **Type III**: Cusp Restriction

### Repair Techniques

<table>
<thead>
<tr>
<th>Repair Techniques (Primary)</th>
<th>STJ remodeling Ascending Aortic Graft</th>
<th>Aortic Valve sparing: Reimplantation or Remodeling with SCA</th>
<th>STJ Annuloplasty</th>
<th>SCA</th>
<th>Patch Repair</th>
<th>Prolapse Repair</th>
<th>Leaflet Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STJ</td>
<td>SCA</td>
<td>SCA</td>
<td>SCA</td>
<td>Autogeous or bovine pericardium</td>
<td>Free Margin Plication</td>
<td>Snaing Decalcification Patch</td>
</tr>
</tbody>
</table>

**El-Khoury Classification**

### David operation – valve-preserving aortic root replacement
Surgical management strategy for AI repair

An example: patient information

- 37 yo F with bicuspid aortic valve (Sievers Type 1) and normal aortic root dimensions.
  - Has been serially followed, and now has increased dyspnea with exertion (>4 flights of stairs).

Physical Exam:
- HR 71, BP 148/61, BMI 22.4 kg/m²
- IV/VI diastolic murmur

Transthoracic echo:
- LVEF 55%, severe AI, LVEDd 5.9 cm, LVEDs 4.2 cm
BAV patient: preoperative TEE

AV gradients: peak 10 mm Hg; mean 5 mm Hg

Intraoperative TEE, pre-repair

Severe prolapse of nonfused cusp of the aortic valve
Severe, eccentric AI
**Aortic Root Dimensions**

- Annulus: 2.91 cm
- Sinus: 3.06 cm
- STJ: 2.74 cm
- Asc Ao: 3.13 cm

*Bosilwer M, J Thor & Cardiovasc Surg, 2009;137:286-93*

**Bicuspid Aortic Valve Repair**

- **Surgical Procedure**
  - Subcommissural annuloplasty
  - El-Khoury leaflet repair
  - Subcoronary external ring

- **Goals of Leaflet Repair:**
  - Free margin equalization (plication or resection)
  - Optimization of coaptation zone
  - Raphe release
  - Annular stabilization and reduction
  - Debridement of annular or leaflet calcification, if necessary for mobility
7-0 PTFE sutured over & over the free margin of the prolapsing cusp.

Tension applied to suture ends shortens free margin of prolapsing cusp.
Intraoperative TEE, Post-repair

Coaptation zone 0.8 cm
Annulus 22 mm, STJ 28 mm

Intraoperative TEE, Post-repair

Gradients: peak 16 mm Hg, mean 8 mm Hg
**Postoperative Course**

- Extubated and weaned off pressor support POD #0
- Transferred to stepdown unit POD #1
- Discharged to home POD #4

**Pre-discharge TTE:**
- Unchanged LV & RV function
- LVEDd 4.3 cm  
  - *Preop 5.9 cm*
- LVESd 3.5 cm  
  - *Preop 4.2 cm*
- No AI

**Aortic valve Repair Concepts**

- Even the free margin lengths: Plicate (or cut) the prolapsed cusp
- Annular Reduction (10-15%) and Stabilization with either Re-implantation (or Sub/Extra-Annular technique)
- Increase height (decrease length) of Free margin ….if leaflet belly below
- annular plane.
- Bottom line: “Any purely insufficient valve with enough leaflet surface area can be repaired”
Valve-sparing vs. non-valve-sparing operations: Contemporary single-center midterm outcomes

Ali Khoynezhad MD, PhD, FACS,
Alfredo Trento, MD
Cedars-Sinai Heart Institute

OBJECTIVE:
- Surgical approaches to aortic root aneurysms have evolved with improved results.
- The valve-preserving root replacement is increasingly challenging the non-valve-preserving techniques in many patients.
- We investigate the outcomes of both surgical approaches.

METHODS:
- 277 patients with elective root replacements between April 2010 and July 2014 underwent retrospective analysis.
- Follow-up was completed in 94% with a mean length of 25.2 months.

RESULTS (continued):
- 20 patients (29%) required valvular repair in addition to the valve-sparing root operation.
- One patient experienced a minor left occipital stroke with right lateral visual field defect.
- The survival was 100% up to midterm follow-up.
- Freedom from 2+ aortic regurgitation and reoperation was 100% in midterm follow-up.
- Among these patients, 7 had prooperative severe AR, 2 had bicuspid aortic valve with mild or moderate preoperative AR, and 4 were older (average of 60 years) than the mean age.
- Two patients (1%) with Bentall operation died early, one patient with endocarditis required reoperation, and two patients developed thromboembolic events in midterm follow-up.
- There was no valve degeneration and no other mortality in follow-up.

CONCLUSIONS:
- David operation is an attractive option with at least as good as outcomes compared to composite valve conduit. Risk factors for progression of AR include presence of a bicuspid aortic valve, preoperative severe AR, and age.
- However, none reached statistical difference due to the sample size. Patients amenable to aortic valve preservation should be considered for valve-sparing operations. Further long-term follow-up is necessary.

RESULTS:
- The mean age of the patients was 59 years (range 20 to 87 years).
- 91 patients (33%) had valve-sparing root operations, 174 patients had modified Bentall, and 12 had homograft/Prosthetic Root root replacement.
- Of the patients undergoing valve-sparing root replacement, 68 (75%) underwent David IV-VI operation.
- Bicuspid aortic valve was present in 27% (n=18), Marfan syndrome in 7% (n=5), and preoperative severe aortic regurgitation (AR) in 20% of patients (n=14).

Presented at ISMICS 2015