Surgical MAZE for AF

Michael Bates MD, FACS
Conflicts & Acknowledgements

• No conflicts
• Bias: I am a surgeon and I like to work with the Atricure system
• Thanks to Peter Troup for slides and Gan Dunnington for pictures
The Amazing Maze

- Jim Cox pioneered Afib surgery in the 1980’s
- Mapping and clinical work developed the current Cox-Maze IV lesion set
- Cutting, freezing or burning to create lines of scar
- Removal of the LAA
2007 Consensus Statement on Surgical AF:

- **Paroxysmal**: recurrent AF that terminates spontaneously in 7 days
- **Persistent**: >7 days or <7 days requiring pharmacological or electrical cardioversion
- **Longstanding Persistent**: continuous > 1 year

Heart Rhythm Society
American College of Cardiology
American Heart Association
Society of Thoracic Surgeons
European Heart Rhythm Association
European Cardiac Arrhythmia Society
Indications for Surgical Ablation

• All symptomatic patients undergoing other cardiac procedures

• Asymptomatic patients undergoing other procedures in which ablation is safe

• Stand-alone procedures when patients choose or those who have failed catheter ablation or are not candidates for catheter ablation
Relative indications

• AF patients with contraindication to long-term anticoagulation and CHADS score >2 (eliminate LAA and post op stroke rate Low)

• Previous stroke in longstanding AF on anticoagulation are high risk for another event

• AF patients with clot in the LAA
Development of the Cox-MAZE

- Introduced 1987 after extensive investigation
- Designed to block macroreentrant circuits
- Surgical incisions in R and L atria to allow propagation of sinoatrial node impulse
- Preserve atrial synchrony and transport
- CMP III “cut and sew”
- 198 consecutive patients 97% free symptomatic Afib at 5 years

Cox-Maze IV

- Right and Left atrial lesion sets
- Cryo ablation of the MV and TV annulus
- LA “box” most closely approximates Cox III and is the most effective
- MUST perform an epicardial ablation of the coronary sinus and connect to endocardial LA line
- Remove LAA
- Shorter operation and lower complications while maintaining efficacy and success of Cox III
Cox-Maze IV results at 2 years

• 100 stand alone patients for lone AF (31 paroxysmal and 69 persistent or longstanding persistent)

• 90% free from AF

• 84% free from AF off drugs

• No strokes no mortality

• Over 2/3 prolonged monitoring

Damiano, J Thorac Cardiovasc Surg 2011
Energy sources

• Kinetic: cutting

• Heat: RFA (unipolar and bipolar) HIFU

• Cryo: nitrous oxide or argon

• All techniques and energy sources must produce a complete transmural lesion to be effective
Surgical ablation as treatment for the elimination of atrial fibrillation: a meta-analysis

RESULTS: Sixty-nine studies were included in this analysis. Five thousand eight hundred eighty-five total patients were involved. Patients undergoing surgical ablation demonstrated significantly greater rates of freedom from atrial fibrillation compared with those seen in control patients. Survival rates were similar. However, patients undergoing biatrial ablation demonstrated superior freedom from atrial fibrillation at all time points (1 and 3 years).

CONCLUSION: Biatrial ablation surgical procedures were more effective in controlling atrial fibrillation than procedures confined to the left atrium.

Barnett SD, Ad N. Journal of Thoracic and Cardiovascular Surgery, 2006 May;131(5):1029-35
Surgical ablation as treatment for the elimination of atrial fibrillation: a meta-analysis

Barnett SD, Ad N. *Journal of Thoracic and Cardiovascular Surgery*, 2006 May;131(5):1029-35
Under Treatment by Procedure

Coronary Artery Bypass with AF Diagnosis
- 55,000 (93%)
- 4,000 (7%)

MV/Aortic Valve Procedures with AF Diagnosis
- 27,000 (61%)
- 17,000 (39%)

Source: Agency for Health Care Quality and Research (AHRQ) Cost and Utilization Project Nationwide Inpatient Sample 2009
Potential Macro-Reentrant Circuits in N-PAF
Why PV Isolation is not enough for N-PAF
Objective of the Maze Lesions
Pulmonary Vein Isolation

- Persistent AF
- Long-Standing Persistent AF

PAF N-PAF

Least Effective

Most Effective
Pulmonary Vein Isolation

No Difference

Most Effective
Completed Left Atrial Lesions
Completed Right Atrial Lesions

On-Pump during Reperfusion / Re-warming
It is advisable that all patients with documented AF referred for other cardiac surgeries undergo a left or biatrial procedure for AF at an experienced center, unless it will add significant RISK...”

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Decrease in *All* Complications

Fewer Long-Term Thromboembolic and Valve-Related Complications

Treated AF

Untreated AF

Freedom from Long-Term Strokes

Halts Progression of Tricuspid Insufficiency

Restoration of Normal Sinus Rhythm

Do we increase the operative risk by adding the Cox Maze III procedure to aortic valve replacement and coronary artery bypass surgery?

“The addition of the Cox Maze III procedure to AVR or CABG did not convey an increase in major morbidity and perioperative risk .... The Cox Maze III may significantly improve their outcome.”

Ad N, Henry L, Hunt S, Holmes SD
Inova Heart and Vascular Institute, Cardiac Surgery Research, Falls Church, VA
The LAA and Strokes

All Strokes (100%)

- 90% Ischemic
- 10% Hemorrhagic

20% are Associated with AF

95% have LAA Thrombi

= 130,000 Strokes / yr
1. Stroke in AF patients 5-7 times more likely than non-AF patients. Risk estimated at 12% per year at any age for AF patients with a history of thromboembolic disease. (European AF Trial Study, Lancet)

2. Thrombus is most frequently located in left atrial appendage in AF patients (Blackshear)

3. Evidence for stroke rate reduction associated with LAA exclusion (Garcia-Fernandez, Blackshear, Watchman, Bando, Nademanee)

4. Successful LAA exclusion demonstrated a reduction in stroke of 26% over Warfarin (Watchman FDA panel, Protect AF Trial)

5. AF related strokes are associated with 2 x greater mortality than non-AF strokes (Marini, 49.5% mortality at 1 year)
Minimally Invasive Surgery

- Sternal Sparing: thoracotomy, thorascopic, robotic, subxyphoid

- Thorascopic Bilateral epicardial ablation

- Recapitulates or approximates the MAZE lesion set

- Must use cpb and open atrium to make the annular ablation left or right side
Dr. Mark LaMeir- 5mm ports x 3, using 5mm scope
Excluding the LAA
AtriClip™ Gillinov-Cosgrove
LAA exclusion system

The first surgical device designed specifically for left atrial appendage exclusion

- Applied epicardially not in the circulating blood
- Tissue is compressed and not cut or pierced
- Closure is linear and not circular so forces are applied in same orientation as the LAA anatomy
- AtriClip addresses both mechanical and electrophysiological aspects of LAA
Reliability Proven in Clinical Trials Via CT Scans

3 month CT Scan Cross-sectional view
Dr Bates 1/12/2016.
intraoperative TEE
The Hybrid Approach

• Combines aspects of all minimally invasive approaches
• Epicardial Ablation
• Endocardial Ablation
• LAA closure
• Can be performed in one setting or staged
• TEAM approach
• Can mirror current valve and revascularization multidisciplinary approached to cardiovascular disease
Thorascopic

Manage the LAA
Address ligament of Marshall
Isolate PVs
Catheter Ablation

• R and L atrial isthmus
• Coronary sinus
• Test PV isolation
• Mapping gaps and testing surgical lines
• Demonstrate conduction block
Hybrid Thoracoscopic Surgical and Transvenous Catheter

- 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 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.
- 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.

Ablation of Atrial Fibrillation, *J Am Coll Cardiol* 2012;60:54–61
La Meir M. New Technologies and Hybrid Surgery for Atrial Fibrillation

“New technologies have simplified creation of transmural lesions on the beating heart through a less-invasive, thoracoscopic procedure. This allows for pulmonary vein isolation, isolation of the posterior wall, and left atrial appendage exclusion—usually combined with ganglionic plexi evaluation and destruction.”

Rambam Maimonides Med J 2013;4(3)
“In an attempt to limit the shortcomings of an endo- or an epicardial technique, a hybrid approach has recently been introduced. This approach is based on a close collaboration between the surgeon and the electrophysiologist, employing a patient-tailored procedure which is adapted to the origin of the patient’s atrial fibrillation and takes into consideration triggers and substrate. Using a mono- or bilateral energy source, a thoracoscopic epicardial approach is combined with a percutaneous endocardial ablation in a single-step or in a sequential-step procedure.”
Initial Experience of Sequential Surgical Epicardial-Catheter Endocardial Ablation for Persistent and Long-Standing Persistent Atrial Fibrillation With Long-Term Follow-Up

Results: All patients underwent uncomplicated surgical ablation and electrophysiology procedure. Five Sequential patients had seven inducible flutters that were mapped and ablated. After a mean follow-up of 20.7 ± 4.5 months, 13/15 (86.7%) Sequential patients, but only 16/30 (53.3%) catheter-alone patients, were free of any atrial arrhythmia and off of AAD (p = 0.04). On AAD, 14/15 (93.3%) Sequential patients were free of any atrial arrhythmia recurrence, compared to 17/30 (56.7%) catheter-alone patients (p = 0.01).

Conclusions: For patients with atrial fibrillation who have failed catheter ablation, Sequential minimally invasive epicardial surgical ablation, followed by endocardial catheter-based ablation, has a higher early success rate than repeat catheter ablation alone.
Hybrid Procedures Are Complimentary

**Epicardial:**
- Fast, anatomical, continuous lines
- LAA
- Avoid CPB
- Decrease: tamponade, flouro time, stroke risk, esophageal perforation and phrenic injury

**Endocardial:**
- Mapping
- Testing quality of the lesion set
- Complete Lines that need touch up
- Left and right Isthmus lines
- Flutter lines
Looking Forward

• Development of Hybrid approach
• DEEP trial results
• Combined teams of surgeons and EP
• Similar to approach of the Valve Team and advancement of TAVR
• Results improve and patients benefit