Surgical treatment
For
Atrial Fibrillation

Magued Zikri, M.D.
Professor of Cardiothoracic surgery
Cairo University
2012
Atrial Fibrillation: How common?

- General population = 0.4% - 1% (Age related)
- Mitral valve surgery candidates = 60%
- Ischaemic Cardiomyopathy = 30%
- In patients with ASD:
  - Incidence relates to age at time of surgery
  - Up to 60% in patients older than 40 y
AF surgery

Risk of Thromboembolism

- 1% per year in general population & Lone AF.
- More frequent in elderly, DM, CHF, RHD.
- Farmingham Study embolic stroke data:
  - 5 folds increase risk of Stroke in non Rheumatic AF
  - 17 folds increase risk in Rheumatic AF
- Adequate anticoagulation reduces rate of thromboembolism by only 50%.
AF surgery

Types of atrial fibrillation:

- **Paroxysmal:**
  - Pulmonary veins trigger.

- **Non paroxysmal:**
  - Multiple sustained rotor drivers
    - Persistent
    - Long standing persistent
    - Permanent.
AF surgery

Non Pharmacologic Therapeutic options:

- **Catheter based:**
  - His b. ablation + VVI (Scheinman et al.; 1982).

- **Surgery:**
  - Left atrial isolation (Williams et al.; 1980).
  - Corridor operation (Guiraudon et al.; 1985).
  - Maze like operations (variety of lesions)
  - Pulmonary vein isolation
  - Ganglionic plexus ablation
**AF surgery**

Difference in Non Pharmacologic options.

<table>
<thead>
<tr>
<th></th>
<th>Control HR</th>
<th>A. Quick</th>
<th>Prevent TE</th>
</tr>
</thead>
<tbody>
<tr>
<td>His Ablat.</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Lt A. Isol.</td>
<td>YES</td>
<td>Rt Side</td>
<td>NO</td>
</tr>
<tr>
<td>Corridor</td>
<td>YES</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Maze OP.</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
AF surgery

Estimated AF cases for US population at a 1% incidence: 3 million patients.

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>Lone AF</th>
<th>Concomitant AF patients N= 60 k</th>
<th>Relative incidence 98/2%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paroxysmal</td>
<td>Cath based PVI, Surgical PVI at time of surgery. N= 36 K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non Paroxysmal</td>
<td>Cath based PVI, Hybrid, Surgical PVI at time of surgery. N= 24K</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Relative incidence 3:2
Indications for surgery for AF

- Previous thromboembolic event.
- Adjunct to mitral valve surgery if AF > 1 y
- AF rate uncontrolled by medications.
- Failure to control AF related symptoms.
- Intolerance to efficient medications.
AF surgery

The case for addressing AF surgery in setting of concomitant surgery:

- No increase in surgical risk,
- Less post operative morbidity,
- Fewer thromboembolic events,
- Decreased valve related events,
- Decreased tricuspid regurge,
- Better quality of life,
- Increase long term survival.
Aim of atrial lesions in MAZE

- Prevent impulse from propagating except in one direction.
- Fractionate atrial mass to reach a size less than that needed for a reentrant circuit to get perpetuated.
AF surgery

Surgical Tools

- All aim towards trans mural lesion causing electric interruption of impulse propagation
- Ultimate goals include ease of application, rapidity & absence of collateral damage.

Cut and sew
Cryosurgery
Radiofrequency
Ultrasonic waves
Laser energy
AF surgery

Classic Maze III procedure.
AF surgery

Modified Biatrial Maze like operation
AF surgery

Rt atrial lesions using bipolar RF clamp.
AF surgery

left atrial lesions set.
AF surgery

Post left atrial wall lesion
Radiofrequency modified maze in patients with atrial fibrillation undergoing concomitant cardiac surgery

Hauw T. Sie, MDa, Willem P. Beukema, MDa, Anand R. Ramdat Misier, MDa, Arif Elvan, MDa, Jacob J. Ennema, MDa, Max M.P. Haalebos, MDa, Hein J.J. Wellens, MDb From the Departments of Cardiothoracic Surgery and Cardiology and Cardioanesthesiology, Isala Klinieken, Hospital De Weezenlanden, Zwolle,a and the Academic Hospital Maastricht, Maastricht,b The Netherlands.

Thorac Cardiovasc Surg 2001;122:249-256
AF surgery

Methods:
N= 122
AF of one year or more
Concomitant structural heart disease requiring surgery
RF energy used to create modified MAZE III lesions

Results:
Mitral valve surgery (89%)
Additional crossclamp time 14 ± 3 min.
Mortality rate 4.1%
Survival at 39-month 90%
No atrial flutter or AF 78.5% ± 5.1%
Doppler echocardiography in pts with sinus, atrial rhythm, AVpacemaker,
RA transport function in 83%
LA transport function in 77%
Superiority of cut-and-sew technique for the Cox maze procedure: Comparison with radiofrequency ablation

John M. Stulak, MD1, Joseph A. Dearani, MD, Thoralf M. Sundt, III, MD, Richard C. Daly, MD, Christopher G.A. McGregor, MD, Kenton J. Zehr, MD, Hartzell V. Schaff, MD1,* Division of Cardiovascular Surgery, Mayo Clinic and Foundation, Rochester, Minn.

J Thorac Cardiovasc Surg 2007;133:1022-1027
AF surgery

Methods:

January 2002 and February 2005;
N=112

Divided into TWO equal matched groups
gender (33 male, 23 female, both),
age (67.5 vs 67.2 years),
New York Heart Association class (mean 2.28 vs 1.96),
atrial fibrillation type (37 paroxysmal, 19 continuous, both),
and concomitant mitral valve surgery (37 in both).

To receive either RF or classic MAZE
AF surgery

Results:

Fewer patients undergoing RF ablation were free from AF at dismissal (63% vs 88%; \( P = .0039 \)) at last follow-up (62% vs 92%; \( P = .016 \)).

Patients undergoing RF ablation were:

4.5 times more likely to be in AF at dismissal (95% CI, 1.8, 10.9)
5 times more likely to be in AF at follow-up (95% CI, 1.4, 17.3).
Video-assisted bilateral pulmonary vein isolation and left atrial appendage exclusion for atrial fibrillation

Randall K. Wolf, MD a , * , E. William Schneeberger, MD a , Robert Osterday, PA a , Doug Miller, MED a , Walter Merrill, MD a , John B. Flege, Jr, MD a , A. Marc Gillinov, MD b a
Section of Cardiothoracic Surgery at The University of Cincinnati College of Medicine, Cincinnati, Ohio
b Department of Thoracic and Cardiovascular Surgery at The Cleveland Clinic Foundation, Cleveland, Ohio.

Thorac Cardiovasc Surg 2005;130:797-802
AF surgery

OBJECTIVE:
Assess feasibility & safety (midterm results) of video-assisted thoracoscopic epicardial PV isolation.

METHODS:
N = 27
Age = 57
Male = 22
AF type: 18 paroxysmal, 4 persistent, and 5 permanent.
Approach via two thoracoscopic 10-mm ports & one 5-cm working port (non-rib spreading) bilaterally.
Pulmonary vein isolation by using a bipolar radiofrequency device.
LA appendage excised with a surgical stapler.
AF surgery

RESULTS:

Bilateral PV isolation & Lt appendage excision was performed successfully in all.
No conversions to sternotomy or thoracotomy.
All patients were extubated in the OR.
Follow up > 3 months  N = 23
Freedom of AF  91.3%
MRA at 3-6 month  N=12
Incidence of pulmonary vein stenosis nil.

CONCLUSION:

Bilateral thoracoscopic PV isolation with excision of Lt appendage is feasible, safe, offers a promising, new, minimally invasive, beating-heart approach for AF
Conclusion:

- **AF** is a very prevalent entity. It is a silent killer that is under diagnosed and hence under treated.

- Patients with non-Paroxysmal AF and a concomitant pathology are candidates for Maze or Maze-like biatrial set of lesions with a variety of ablative methods though with a clear superiority of cut & sew technique.

- Patients with Paroxysmal AF and a concomitant pathology are candidates for PVI supplemented by GP identification and ablation.

- Lone AF, whether paroxysmal or non-paroxysmal, are candidates for PVI, preferably minimally invasive, at failure of second trial of catheter based procedures.
MAZE III/Mitral Valve

In rheumatic heart disease.
Background.

- Rh.H.D. is best described as pancarditis culminating in myocardial, valvular and endothelial scarring.
- High incidence of AF is multi factorial:
  - At the macro level → Bi-atrial enlargement,
  - At the micro level → Myocardial rheumatic scarring causes fragmentation of wave front within thickened atrial wall tissue.
- Non paroxysmal AF, ultimately of the chronic type, is the end result.
Mitral Valve surgery/MAZE III

Clinical impact of AF & rheumatic mitral valve.

- Rate control within the setting of often impaired hemodynamic.
- Highly thrombogenic situation:
  - Endothelial injury within left atrial cavity,
  - Stasis within left atrium:
    - Impaired atrial emptying in mitral stenosis,
    - Lack of synchronous atrial contraction,
    - Enlarged left atrial appendage.
Mitral Valve surgery/MAZE III

Conventional management.

- Correct mitral valve, eliminating stasis/turbulence:
  - Mitral valvuloplasty,
  - Mitral valve replacement.
- Obliteration of left atrial appendage.
- Post operative pharmacologic tuning:
  - Optimize post op anticoagulation regimen,
  - Optimize AF rate control.
The impact of mitral valve surgery combined with maze procedure

Akinobu Itoh, Junjiro Kobayashi *, Ko Bando, Kazuo Niwaya, Osamu Tagusari, Hiroyuki Nakajima, Shigeru Komori, Soichiro Kitamura Department of Cardiovascular Surgery, National Cardiovascular Center, 5-7-1 Fujishirodai, Suita, Osaka 565-8565, Japan

Eur J Cardiothorac Surg 2006;29:1030-1035
Mitral Valve surgery/MAZE III

Methods:

- 521 consecutive patients underwent combined maze procedures with MVR or valvuloplasties.
- Three kinds of maze techniques were primarily used: Cox–maze III, Kosakai maze, and cryo-maze procedure.
- At 3 months post op, 394 pts were in NSR (Group S) while the remaining 116 patients were in continuous or intermittent AF (Group F), excluding 11 early deaths.
- Risk factors for Group F were determined by the analysis of all patient demographics. Survival, freedom from stroke, cardiac events, and AF recurrence were analyzed.
Mitral Valve surgery/MAZE III

Results:

- The proportion of pts without any other simultaneous procedures was greater in Group S (41% vs 29%, \( P = 0.02 \)).

- Risk factors for unsuccessful maze procedures:
  - left atrium > 70 mm (HR = 2.6)
  - preop AF > 10 yrs (HR = 8.2, \( P < 0.001 \))
  - f-wave voltage in V1 < 0.1 mV (HR = 6.2, \( P < 0.001 \)).

- Actuarial survival rates (HR = 2.7, \( P = 0.035 \)), freedoms from stroke (HR = 3.0, \( P = 0.003 \)) and cardiac events (HR = 4.3, \( P < 0.001 \)) by Cox proportional hazards models showed superiority in Group S.

- Freedom from AF n Group S was 98.4% at 5 yrs and 81.0% at 12 yrs, and in overall pts was 73.0% and 60.1%.
Conclusions:

- Patients with successful maze procedures resulted in higher survival rate, greater freedom from stroke and cardiac events.

- The large left atrium, small f-wave, and long AF duration were significant risk factors for failed maze procedures, suggesting that earlier surgical interventions would result in superior results in mitral valve surgery combined with maze procedure.
Successful Cox Maze Procedure During Mitral Valve Surgery Restores Patient Survival Without Increasing Operative Risk

Inova Heart and Vascular Institute, Falls Church, VA, USA

6th Biennial meeting, the Society of Heart Valve Disease, Barcelona, June 25th – June 28th, 2011.
Mitral Valve surgery/MAZE III

Methods:

- N=410 had an isolated MV surgery.
- NSR n=311 and AF n=99.
- Pts with AF had additionally a Cox Maze procedure.
- Rhythm was verified by EKG/24-hour holter.
- Kaplan-Meier analysis compared cumulative survival between the two surgery groups, plus a third group with isolated MV and untreated AF (n=34).
Results:

- Isolated MV group was younger, \( p = 0.002 \) and at lower risk, \( p = 0.005 \) compared to MV plus CM group.
- Length of stay was longer for MV plus CM patients (8.5 [7.4] vs 5.5 [7.1] days, \( p < 0.001 \)),
- BOTH were comparable on perioperative complications and operative mortality (1%).
- MV plus CM patients had similar survival as isolated MV patients (Log Rank=0.01, \( p = 0.91 \)).
- Cumulative survival in isolated MV with untreated AF patients was lower than in MV plus CM.
Mitral Valve surgery/MAZE III
Mitral Valve surgery/MAZE III

Kasr el eini University H. experience:

- Initial case for AF surgery started in 2000.
- Sporadic cases to 2005.
- Approved for a Doctorate thesis in 2006.
- Departmental policy since 2010.
Mitral Valve surgery/MAZE III

Inclusion criteria

- Chronic atrial fibrillation > 1 year duration
- Rh H.D. with significant stenosis and/or regurgitation dictating surgery.
- +/- Previous thromboembolic event.
- +/- AF rate uncontrolled by ttt.
- +/- AF controlled by ttt causing side effects.
- Lately, all new comers with non paroxysmal AF and undergoing mitral valve surgery.
Exclusion Criteria

- Redo op (closed mitral commissurotomy).
- Combined surgical aortic valve disease.
- Ejection fraction < 45%.
- Pulmonary hypertension > 70 mmHg.
- Hepatic dysfunction 2 ry to tricuspid disease.
- Rare blood groups.
- Lately , left atrial size above 6 cm.
Patient population

N = 38
Female gender = 30
Age mean = 32.6 y
Mitral Valve surgery/MAZE III

Presenting Complaint

• NYFC III = 35/38
• Palpitations = 36/18
• Throbo embolism = 18/38
  ➢ Cerebral Stroke = 13 /18
  ➢ Peripheral art. Embolism = 5 /18
Mitral Valve surgery/MAZE III

Echocardiographic findings

- Mitral Stenosis: 22/38
- Mitral Regurge: 10/38
- Combined stenosis/regurge: 6/38
- Tricuspid valve disease, TR > 2+: 20/38
- Aortic regurge, moderate: 5/38
- P A pressure: 35-80 mean 62mmhg
- Left atrial size: 5.5-8.0 mean 6.1 cm
- Left atrial thrombus: 14/38
Operative technique

- Complete set of biatrial maze,
- Start with right atrial incision after going on bypass while maintaining normothermia,
- Finish left side incisions before addressing mitral valve,
- Tricuspid repair and closure of right atrial incision while rewarming.
Mitral Valve surgery/MAZE III

Operative technique

- **First 15 cases:**
  - Extensive mobilization along roof of left atrium,
  - Amputation of right atrial appendage,
  - Vertical atrial septal incision,
  - Cryothermy, vaporized liquid N2O:
    - On tricuspid annulus in two points,
    - Mitral annulus at P2-P3 junction,
    - Two points on base of amputated left atrial appendage which is closed independently.
  - One stay stitch in mid of post left atrial incision.
Mitral Valve surgery/MAZE III

Operative technique

- Current technique:
  - Omit left atrial roof pre-bypass exposure.
  - Vertical incision along crest of right RA appendage,
  - Omit atrial septal incision and cryothermy,
  - Low intensity diathermy coagulation on tricuspid and mitral annuli,
  - Single, transplant like, encircling left atrial incision guided by three stay stitches, two at the base of amputated LA appendage.
Mitral Valve surgery/MAZE III

Operative Data

- **Myocardial protection.**
  - Ante / Retrograde Cold blood cardioplegia.
  - Systemic cooling (28 degrees centigrade).
  - Terminal hot shot (autologous blood)

- **Mitral valve replacement 29/38 cases:**
  - Cross clamp time: 108 min. Bypass time: 139 min.

- **Mitral valve repair 9 cases:**
  - Cross clamp time: 93 min, bypass time: 132 min.

- **Tricuspid annuloplasty:** 12 cases.
Mitral Valve surgery/MAZE III

Results

- Mean mediastinal blood shed 459 cc.
- Mean use of blood transfusion 600 cc,
- No blood products 22/38 pts.
- Mean Ventillation time 15 h.
- In 18 pts = Adrenaline 100 Ng/kg/min x 36 h.
- In seven pts = Isuprel x 24 h.
- Mean ICU stay 2.5 days, hospital stay 11.5 days.
Mitral Valve surgery/MAZE III

Results

Echocardiography findings

- Well functioning Mitral Prosthesis: 28/29
  1 Pt., in NSR, prosthetic thrombosis 9 months post op.

- Mitral valve repair: 8/9
  Mean gradient 6 mmHg.

- Regression of left atrial size to a mean of 5.6 cm.

- Documented atrial contraction:
  MVR: A-wave in tricuspid Doppler flow.
  MV repair: A-wave in mitral Doppler flow.
AF surgery

Atrial Transport function after Maze III
Mitral Valve surgery/MAZE III

Results

Abnormal impulse generation or conduction

- Sinus node dysfunction: 6/38
- AV block, 1rst degree, transient postop: 22/38
- AF during hospital stay:
  - Reversible, cordarone/electric cardioversion: 6/38
  - On Discharge post op day 5 for 12 h.: 2/18
Mitral Valve surgery/MAZE III

Results

- **Morbidity:**
  - **Reopening for bleeding:** 4/38:
    - Origin of bleed:
      » Two cases unidentified,
      » One case right atrial incision,
      » One case base of left atrial appendage.
  - **Complete AV block:** 1/38:
    » post op day 5, resuscitated, resolved in 4 days discharged home in controlled A flutter.
  - **Lower limb edema:** 3/38:
    » All from amputated right atrial appendage grp.
Mitral Valve surgery/MAZE III

Results

- Follow up duration: 2-115, mean 38 months.
- Completion of follow up: 24/38 = 63%.
- Follow up protocol:
  - Quarterly first year, than biannually,
  - History for dizziness/palpitations,
  - ECG, for rhythm & chronotropic response,
  - Holter when required.
- Rhythms on follow up:
  - NSR: 33/38 = 86.8%,
  - two NSR + AV block 1rst degree: 2/38,
  - AF, first year: 3/38, 36 month: 5/38.
Conclusion

• Combined Mitral valve surgery / Maze III operation is both safe and reproducible.
• Fact:
  Adequate anticoagulation reduces by 50% thromboembolic risk of AF.
• Recommendation:
  Maze op is warranted even if anticoagulant ttt is dictated by use of a prosthetic valve.
MAZE III / Mitral Valve

In young females.
Rheumatic mitral valve disease in young females

- Therapeutic options:
  - Mitral valve surgery, frequently valve replacement, in view of pathology.
  - Choice of valve in young patient presently restricted to mechanical prosthesis
  - Large Lt atria, AF, mechanical valve is a triad necessitating very accurate INR Control.
  - Warfarin based anticoagulation regimen.
Rheumatic mitral valve disease in young females

- Pregnancy and anticoagulation:
  - The physiologic hypercoagulable of pregnancy dictates increasing warfarin.
  - The regimen of anticoagulation divided into three phases:
    » First trimester: stop warfarin because of teratogenicity and use heparin,
    » Second trimester: safer with warfarin, though dose related > 5 mg still hazardous,
    » Third trimester: back to heparin in anticipation of caesarian section and placental bleeding.
Rheumatic mitral valve disease in young females

- Real life implications:
  - Planned pregnancy and early detection of gestation.
  - Combined clinics for obstetrics and cardiology.
  - Accurate laboratory analysis for INR.
  - Availability of warfarin in all concentrations in a fresh preparation.
Dose-Dependent Fetal Complications of Warfarin in Pregnant Women With Mechanical Heart Valves

Nicola Vitale, MD,* Marisa De Feo, MD,* Luca Salvatore De Santo, MD,* Alessio Pollice, PhD,† Nicola Tedesco, PhD,† Maurizio Cotrufo, MD*

Naples and Bari, Italy
Rheumatic mitral valve disease in young females

Results:

- Gestations on warfarin 5 mg or less versus gestations on > 5 mg: 33 pregnancies versus 25.
- Gestation outcome, warfarin 5 mg as a cut off point:
  - Incidence of full term pregnancy = 28 vs 3,
  - Incidence of fetal complications = 5 vs 22,
  - Significant statistical difference (p > 0.0001).
- Correlation Analysis for linear relationship between probability of fetal complications and warfarin doses: $p = 0.7316$
- Maternal valve thrombosis one in each group.
Rheumatic mitral valve disease in young females

- Actual outcome of pregnancy:
  - Lost fetus secondarily to teratogenesis.
  - Complicated delivery, usually caesarian.
  - Valve related complications, mainly valve thrombosis requiring emergency reoperation.
  - Incidence of maternal and fetal loss perioperatively.
Why a tissue valve?

Valve thrombosis of a bileaflet prosthetic mitral valve
Rheumatic mitral valve disease in young females

- How to stop this vicious circle:
  - Identify the central culprit which is anticoagulation regimen.
  - Eliminate the two reasons for its use:

Atrial fibrillation

Metallic mitral prosthesis.
Criteria in favour of bioprosthesis:

- Desire of informed patient
- Limited life expectancy, severe comorbidity, or age > 65-70
- Patient for whom future redo valve surgery would be at low risk
- Unavailability of good quality anticoagulation
- Young woman contemplating pregnancy
- Re-operation for mechanical valve thrombosis in a patient with proven poor anticoagulation control
Composition of a bioprosthesis:

1. Stent = Flexible Acetal Copolymer
2. Cloth = Polyester
3. Cuff = Sewing Ring
4. Suture markers
5. Steel bar
6. Porcine Leaflets 3x
7. Pericardial shield
Rheumatic mitral valve disease in young females

Present status of biological valves

- Newer valves have longevity extended into the second decades with a predicted failure mode.
- The risk of planned reoperative valve surgery is only slightly more than in initial operation.
- Price gap between metallic and bioprosthesis has consistently decreased.
Valve Related Complications

Hammermeister et al. JACC 2000
Re-Operations

Hammermeister et al. JACC 2000
Myken's paper: excellent 17-year durability data in Aortic and Mitral positions

17-year Published Durability Data by Age Group¹
Actuarial Freedom (%) from Reoperation due to SVD

<table>
<thead>
<tr>
<th>Age at Implant Follow-up</th>
<th>≤50 yrs</th>
<th>51-60 yrs</th>
<th>61-70 yrs</th>
<th>71-80 yrs</th>
<th>≥80 yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic</td>
<td>43.8%</td>
<td>69.5%</td>
<td>82.1%</td>
<td>96.9%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Mitral</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤50 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>63.8%</td>
</tr>
<tr>
<td>16 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>78.6%</td>
</tr>
<tr>
<td>17 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>89.4%</td>
</tr>
<tr>
<td>14 yrs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Conclusion

- Young females anticipating childbirth are candidates for mitral repair or bioprosthesis combined with a cut and sew Maze procedure.

- The increased fetal and maternal safety due to anticoagulation free regimen justify calculated risk of a planned redo mitral valve surgery.
Rheumatic mitral valve disease in young females

Why not a tissue valve in younger patients combined with surgery to ablate atrial fibrillation?
Thank you for the privilege of sharing these information.