Surgical management of supraventricular tachycardia associated with congenital cardiac anomalies

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Background of arrhythmia surgery

First stage

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Duke university

Successful Surgical Interruption of the Bundle of Kent in a Patient with Wolff-Parkinson-White Syndrome

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and Andrew G. Wallace, M.D.
Second stage

Transcatheter radiofrequency (RF) ablation

- map of offending arrhythmia
- deliver RF energy to precise intracardiac location
- success of catheter ablation technique for accessory connection-mediated tachycardia and AV nodal reentry tachycardia
- expansion to atrial ectopic foci, atrial flutter, atrial reentry tachycardia following repair of congenital heart disease
Development of Cox-Maze operations for atrial fibrillation (1991)

- Restore a regular ventricular rhythm
- Restore normal cardiac hemodynamics
- Alleviate the patient’s vulnerability to thromboembolism

Cryosurgical ablation of His bundle (1973)
LA isolation procedure (1980)
Catheter ablation of His Bundle (1985)
Corridor procedure (1985)
Third stage

- Patients with arrhythmia and coexisting acquired or congenital heart disease (Patients who could undergo concomitant reparative and arrhythmia surgery)

- Patients who have failed catheter ablation and/or have a wide arrhythmogenic focus not suitable for ablation
# Indications for surgical ablation

| Accessory pathway mediated tachycardia (WPW syndrome) | Ebstein’s anomaly  
|                                                     | Congenitally corrected TGA  
|                                                     | Complex congenital heart disease  
| Atrial reentry tachycardia                          | Fontan procedure with residual hemodynamic abnormalities  
|                                                     | Senning or Mustard repair undergoing baffle revision  
|                                                     | Tetralogy of Fallot undergoing revision  
|                                                     | Atrial septal defect for surgical closure  
| Atrioventricular nodal reentry tachycardia           | Senning or Mustard repair undergoing surgery  
|                                                     | Complex congenital heart disease  
| Atrial fibrillation                                 | Mitral valve surgery  
|                                                     | Fontan surgery  

Accessory pathway mediated tachycardia: Wolff-Parkinson-White syndrome

10 - 29 % in Ebstein’s anomaly

Location

Left free-wall
Right free-wall
Septal
Transcatheter ablation

Acute success rate
- 89-99%
- Highest left-sided pathways
- *Lower septal and right-sided pathways*

*Posteroseptal pathways*;
- may have *epicardial course*
- limiting the success of ablation using an endocardial catheter approach.

*Right - sided pathways*;
- tend to be *multiple, broad, difficult to localize* in the patients with *Ebstein’s anomaly*
- recurrence risks for preexcitation are significantly higher
Surgical division

Posterior septal accessory conduction pathway
Lateral right free wall accessory pathways
Atrial reentry tachycardia

Incidence

- Most common form of SVT after operation for CHD
- 20-50% of postoperative Senning or Mustard patients
- 40-50% of Fontan patients
- 34% of Tetralogy of Fallot patients
Transcatheter ablation

- Acute success rates of 30-80%
- Short-term recurrence rates for certain types of heart disease greater than 50%
- Require many hours for completion

Contributing factors

• Chronic atrial hypertension and dilatation
• Distorted anatomy
• Multiple reentrant circuits
• Restricted catheter access following lateral tunnel type repairs
• Inability to deliver radiofrequency lesions of sufficient depth to create a line of block
Fontan conversion and Maze procedure

*Drs Mavroudis, Deal, and Backer*
*Children’s Memorial Hospital, Chicago*
Reduction atrioplasty
Elimination of high pressure atrium
Perioperative atrial antitachycardia pacemaker placement

Animal study by Gandhi, 1996
Preexisting Fontan atrial suture lines are critical to the pathogenesis of IART

Modified Right-sided Maze for atrial reentry tachycardia
3 major tachycardia circuits

1. Inferomedial right atrium
   Between TV annulus and CS os
   Between CS os and IVC

2. Horizontal lesion from the superior rim of the ASD patch

3. Vertical lesion from the SVC os to the IVC os
Modified right atrial Maze procedure

- Resection of large section of anterior right atrial wall
- Incision from SVC to IVC (along the crista terminalis)
- Cryoablation
Double outlet right ventricle with mitral atresia
Tricuspid atresia
Single ventricle with unbalanced AVSD
Recurrence rate of arrhythmia

- Fontan conversion without arrhythmia surgery
- Fontan conversion with arrhythmia surgery

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<tr>
<th>Study</th>
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<th>Recurrence Rate</th>
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<td>Kreutzer</td>
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<td>Mavroudis</td>
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<td>Kim</td>
<td>2005</td>
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Atrial fibrillation

Cox – Maze III

Memorial Hospital

Mavroudis et al.
Right-sided Maze procedure for right atrial arrhythmia in CHD

*Theodoro et al. Mayo clinic (1998)*
From 1993-2003, **99 patients** with CHD and AFI/F

Median age, 43 years

Primary diagnosis - Ebstein’s anomaly (n=47)
- other congenital TR (n=19)
- univentricular heart (n=11)
- isolated ASD (n=8)
- TOF (n=8)
- others (n=6)

Free of AFI/F - Mean F/U period, 2.7 years (up to 8 years)
- 77 of 83 early survivors (77%)
- no difference between paroxysmal vs chronic
Supraventricular tachyarrhythmias in Ebstein anomaly: Management and outcome

From 1990-2001, 130 patients with CHD and AFI/F
Median age, 25 years
EP study in 109 pts

Free of APMT or AVNRT - mean F/U period, 57 months
- 6 of 6 survivors (100%)

Free of AFI/F - Mean F/U period, 34 months
- 41 of 44 late survivors (93%)
- no difference between RA maze vs isthmus abl.
**Advantages**

- Minimizing dissection of adhesions
- Shorter cardiopulmonary bypass time
- Limited total number of suture lines
- Minimizing the risk of bleeding behind the heart
- Preventing a possible postoperative non-contractile left atrium and the subsequent risk of systemic embolization

**Disadvantages**

- Possibility of the left atrium also being a substrate for atrial fibrillation
- Not removing the left atrial appendage as a potential source of thromboembolism
AV nodal reentrant tachycardia
Intraoperative interruption

**Indications**

In patients with prior Mustard or Senning procedures undergoing reoperation

**Cryolesions**

- Anterior to the coronary sinus & adjacent to the tricuspid annulus
- Along the superior (atrial side) of AV node
Success of surgical ablation for SVT

- through understanding of the anatomic features referable to the specific congenital anomaly
- resection of excess atrial tissue including previous atrial incisions
- establishing lines of block in areas that have been previously shown to be critical parts of a re-entrant circuit
- establish atrial pacing, especially when sinus node dysfunction exists
Less successful in surgical ablation

- Abnormal accessory connection(s) location(s), such as between the aortic and mitral valve, is possible (as in the case of DORV with aorto-mitral discontinuity due to subaortic conus

- Concern over the location of the AV node may also be a limiting factor, especially in cases of heterotaxy syndrome and tricuspid atresia with a tricuspid dimple, unbalanced AVSD
In the future

- More detailed electrophysiologic mapping in complex forms of single ventricle

- Comparison of long-term results between right sided Maze procedure vs bi-atrial Maze procedure in the patients with congenital heart disease and atrial fibrillation