

Surgical/thoracoscopic ablation: past, present and future

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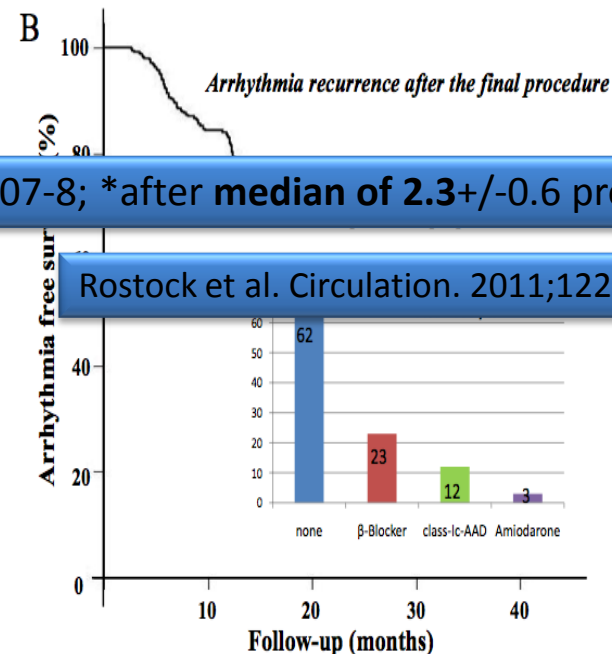
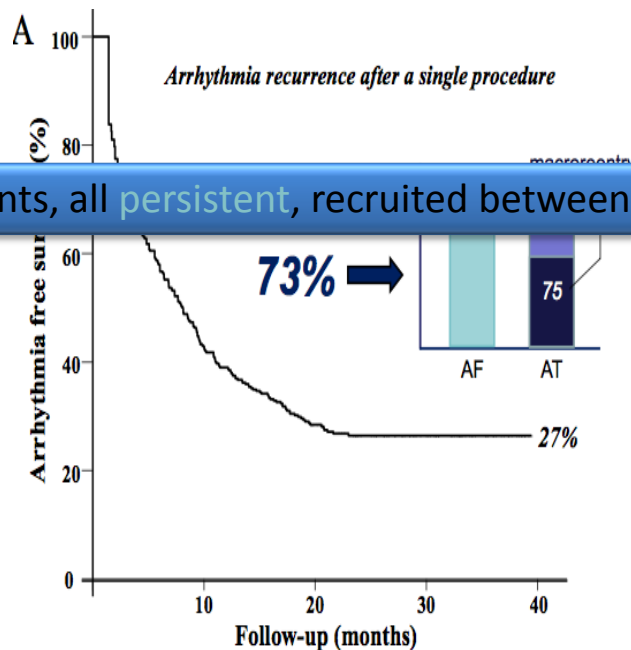


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Persistent AF – suboptimal long term success

**SINGLE PROCEDURE
SUCCESS RATE 27%**

**MULTIPLE
PROCEDURE SUCCESS
RATE* 79%**



395 patients, all persistent, recruited between 2007-8; *after median of 2.3+/-0.6 procedures

Rostock et al. Circulation. 2011;122:2368-2377.

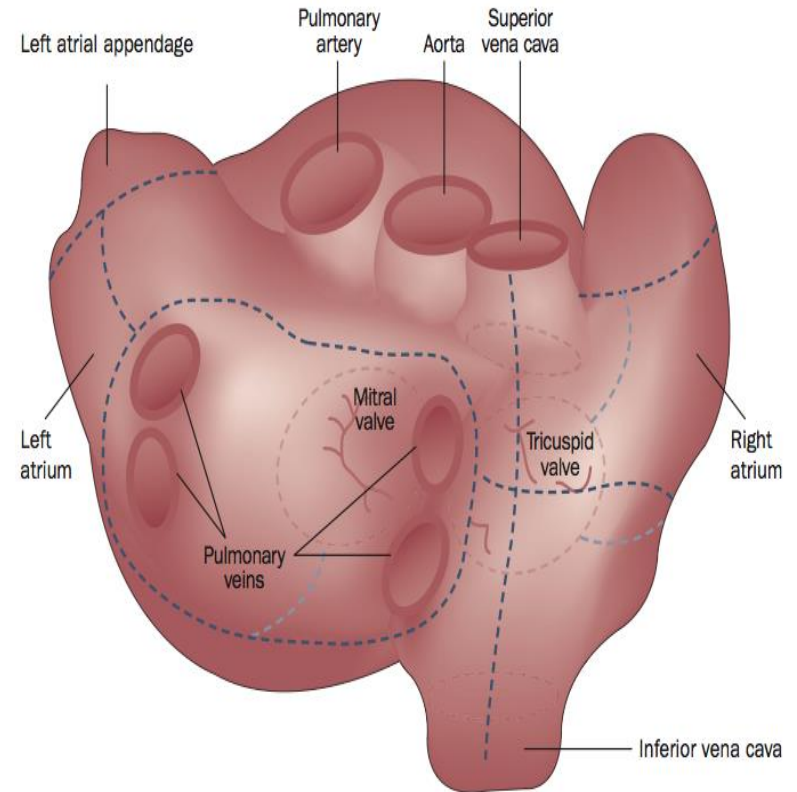


Surgical Maze Procedure

First described by James Cox (1987)

Numerous modifications

Cox-Maze III procedure
the past surgical 'gold' standard



Cox-Maze III – Long term results

- Long-term results are excellent
- Freedom from symptomatic AF > 90% at 10 years
- Phone call follow-up to assess rhythm status
- Midline sternotomy, multiple atrial incisions and CPB
- Technically complex
- Risk of morbidity
 - PPM 3..2%
 - Mortality (1.4%)
- Effective but invasive
- Reserved for those undergoing concomitant cardiac surgery.

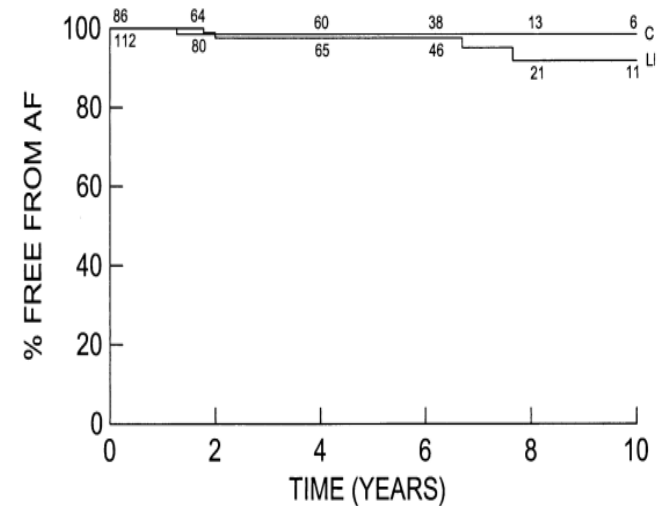


Figure 1. Kaplan-Meier survival analysis of freedom from recurrent AF. The numbers on each line indicate the number of patients at risk. There was no difference in the long-term estimate of freedom from AF between the lone maze group (L) and the concomitant group (C; $P = .64$).

1st Description of Video-assisted Thoracoscopic (VATS) ablation - Wolf 2005

Evolving Technology

Video-assisted bilateral pulmonary vein isolation and left atrial appendage exclusion for atrial fibrillation

Randall K. Wolf, MD,¹ E. William Schneeberger, MD,² Robert Osterday, PA,³ Doug Miller, MD,⁴ Walter Merrill, MD,⁴ John B. Flege, Jr, MD,⁴ and A. Marc Gillinov, MD⁵



Schneeberger, Flege, Wolf, Merrill, Osterday, Miller (left to right)

Objective: Pulmonary vein isolation is curative in selected patients with atrial fibrillation. The objective of this study was to assess the feasibility and safety (midterm results) of video-assisted thoracoscopic epicardial pulmonary vein isolation.

Methods: Twenty-seven patients (22 male patients) with atrial fibrillation (18 paroxysmal, 4 persistent, and 5 permanent; average age, 57 years) underwent bilateral video-assisted thoracoscopic off-pump epicardial pulmonary vein isolation and exclusion of the left atrial appendage. All patients had had unsuccessful drug therapy or were intolerant to antiarrhythmic drug therapy or were intolerant to warfarin. The approach included two 10-mm ports and one 5-cm working port (non-rib spreading) bilaterally. Pulmonary vein isolation was achieved bilaterally by using a bipolar radiofrequency device. The left atrial appendage was excised with a surgical stapler.

Results: Bilateral pulmonary vein isolation and left atrial appendage excision was performed successfully in all patients. There were no conversions to sternotomy or thoracotomy. All patients were extubated in the operating room. Postoperative complications in 3 patients were minor and resolved within 48 hours. One morbidly obese patient had more serious complications related to comorbid conditions. Average postoperative follow-up is approximately 6 months (173.6 days). Twenty-three patients have been followed up for greater than 3 months, and 21 of these patients are free of atrial fibrillation (91.3%). The results of magnetic resonance angiography were normal (no pulmonary vein stenosis) in 12 of 12 patients evaluated 3 to 6 months postoperatively.

Conclusions: Bilateral video-assisted thoracoscopic pulmonary vein isolation with excision of the left atrial appendage is feasible and safe and offers a promising, new, minimally invasive, beating-heart approach for curative surgical treatment of atrial fibrillation.

Atrial fibrillation (AF) affects more than 2 million patients in the United States.¹ AF is associated with increased mortality, increased risk of stroke, and exacerbation of heart failure.²⁻⁴ Antiarrhythmic medications have limited efficacy in maintaining sinus rhythm and might have serious adverse effects.⁵⁻⁷ The Cox maze III open surgical ablation has a success rate of more than 95%.

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Address for reprints: Randall K. Wolf, MD, The University of Cincinnati College of Medicine, Medical Sciences Building, 231 Albert B. Sabin Way, PO Box 670558, Cincinnati, OH 45267 (E-mail: wolf@ucmail.uc.edu).

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- 27 patients (18 PAF, 9 non-PAF)
- **Mini-thoracotomy** (50 mm working port)
- PVI & LAA exclusion using **bipolar RF clamp**
- 23 patients had > 3month F/U
- 91.3% were free of AF (including use of AAD)
- Rhythm assessed by 12 lead ECG + outpatient telemetry



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1st Description of Totally Thoracoscopic Surgical Ablation (SA) – Yilmaz 2008

Completely thoracoscopic bilateral pulmonary vein isolation and left atrial appendage exclusion for atrial fibrillation

A. Yilmaz, B. P. Van Putte, and W. J. Van Boven, Nieuwegein, The Netherlands

We describe a minimally invasive surgical technique involving completely thoracoscopic bilateral pulmonary vein isolation and left atrial appendage ex-



- Totally thoracoscopic surgical ablation (SA), using bipolar radiofrequency (RF) developed using video-assisted thoracoscopic (VATS) approach.
- 9 patients with PAF - PVI & LAA excision.
- Technique shown to be feasible and safe.
- 9 months follow-up, 78% of patients were in SR as per Holter monitoring.

clude the patient in a prone position with both arms snugly flexed along the body. A slight tilt of the operating table without repositioning of the patient was sufficient for adequate exposure on both sides. Furthermore, in case of an urgent sternotomy, repositioning of the patient was not necessary. Three thoracoports were introduced on each side, the first on the midaxillary line and a second 5 cm anteriorly through the fourth intercostal space. The third port was inserted caudally of the first port through the sixth intercostal space (Figure 1). Pulmonary vein isolation was accomplished with the Lumitip dissector and the bipolar Isolator Endo ablation clamp (AtriCure, Inc, West Chester, Ohio). Isolation was confirmed with high-frequency stim-



Figure 1. Three thoracoports were introduced on each side, the first on the midaxillary line and a second 5 cm anteriorly through the fourth intercostal space. The third port was inserted between the two ports through the sixth intercostal space.



Why Surgery?

- Transmural lesions on a beating heart
- Minimally invasive surgery
 - PVI, box lesion and other left sided lines
 - LAA exclusion/excision
 - Ganglionic plexi evaluation and destruction



A review of Minimally Invasive AF Ablation



Europace (2013) **15**, 170–182
doi:10.1093/europace/eus216



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REVIEW

Minimal invasive surgery for atrial fibrillation: an updated review

Mark La Meir^{1†}, Sandro Gelsomino^{1,2*†}, Fabiana Lucà^{1,2}, Laurent Pison¹, Andrea Colella², Roberto Lorusso³, Elena Crudeli², Gian Franco Gensini², Harry G. Crijns¹, and Jos Maessen¹

¹Department of Cardiothoracic Surgery and Cardiology, Academic Hospital Maastricht and Cardiovascular Research Institute Maastricht, Maastricht, The Netherlands; ²Department of Heart and Vessels, Careggi Hospital, Via Delle Oblate 1, 50134, Florence, Italy; and ³Civic Hospital, Brescia, Italy

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What does not work in MI AF surgery

- MW energy
 - 42% success with AAD at 12 months
- High Intensity Focused Ultrasound (HIFU)
 - 33% success without AAD at 6 months
- Unable to create transmural lesions on the beating heart



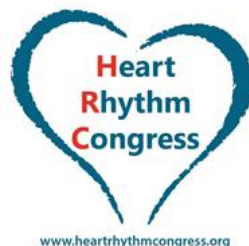
What works?

- Bipolar radiofrequency
 - Permanent transmural lesions on the beating heart
- Pulmonary vein isolation plus additional left sided lines
 - Freedom from AF-AAD
 - 65-92% PAF
 - 67-80% persistent AF
- Role of GP ablation and LAA exclusion/excision??



Surgical Complications 0-39%

- Conversion to sternotomy
- Bleeding
- CVA: Stroke/TIA
- Pulmonary Complications
- Renal insufficiency
- Phrenic nerve dysfunction
- Liver damage
- Brachial plexopathy
- PPM
- Pneumothorax
- Pleural effusion
- Pneumonia
- Pulmonary embolism
- Haemothorax
- Respiratory distress
- Prolonged ventilation
- Re-intubation



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The totally thorascopic maze procedure for the treatment of atrial fibrillation

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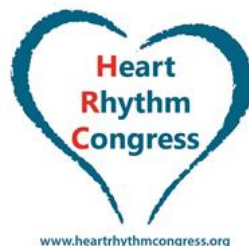
Received 2 May 2016; received in revised form 3 August 2016; accepted 8 August 2016

Abstract

The purpose of this study was to update the current evidence regarding the efficacy and safety of the totally thorascopic maze (TT-maze) procedure for the treatment of atrial fibrillation (AF). Fourteen studies published between 2011 and 2016 and comprising 1171 patients were included as follows: 545 (46%) patients had paroxysmal AF (pAF), 268 (23%) persistent AF (persAF) and 358 (31%) longstanding persistent AF (LSPAF). Fixed- and random-effect models were used to calculate the pooled overall freedom from atrial arrhythmias. The 1- and 2-year pooled overall antiarrhythmic drug (AAD) free (off-AAD) success rates were 78% (95% confidence interval (CI): 72–83%, $n = 13$) and 77% (95% CI: 64–86%, $n = 6$), respectively. The 1- and 2-year pooled on-AAD success rates were 84% (95% CI: 78–89%, $n = 5$) and 85% (95% CI: 78–90%, $n = 3$), respectively. Subanalysis regarding the different types of AF revealed a 1-year pooled off-AAD success rate of 81% (95% CI: 73–86%, $n = 7$) for pAF, 63% (95% CI: 57–69%, $n = 5$) for persAF and 67% (95% CI: 52–79%, $n = 3$) for LSPAF. The overall in-hospital complication rate was <3% ($n = 36$). We conclude that the TT-maze is an effective strategy for the treatment of AF with maintained efficacy at the 2-year follow-up. Furthermore, the TT-maze has demonstrated similar efficacy to the Cox Maze IV procedure at the midterm follow-up with a lower complication rate. Extended follow-up research is needed to determine whether the high success rates after TT-maze will be stable over time.

Metanalysis of TT Maze for lone AF

- Fourteen studies, 1171 patients
 - Paroxysmal 46% (81%)
 - Persistent AF 23% (63%)
 - Long standing Persistent AF 31% (67%)
- Pooled freedom from AF off AAD
 - 78% at 1 year
 - 77% at 2 years
- On AAD
 - 84% at 1 year
 - 85% at 2 years



Surgical complications?

C. van Laar *et al.* / Interactive Cardio

Table 5: Overall in-hospital complications

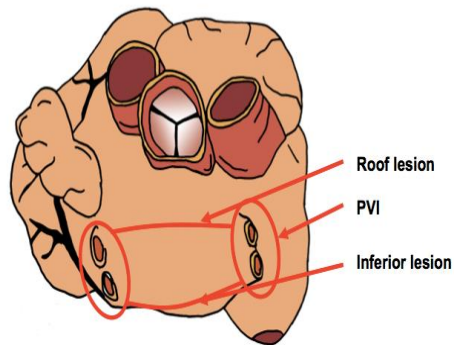
Type of in-hospital complication	n (%)
Conversion to sternotomy	10 (0.85)
Pacemaker implantation	9 (0.77)
Cerebrovascular event	4 (0.34)
Rethoracotomy	3 (0.26)
Death	3 (0.26)
Irreversible phrenic nerve paralysis	2 (0.17)
Reintubation due to respiratory insufficiency	1 (0.09)
Pulmonary embolism	2 (0.17)
Pneumonia	1 (0.09)
Overall complication rate	35 (2.9)



CASA-AF Lesion Sets

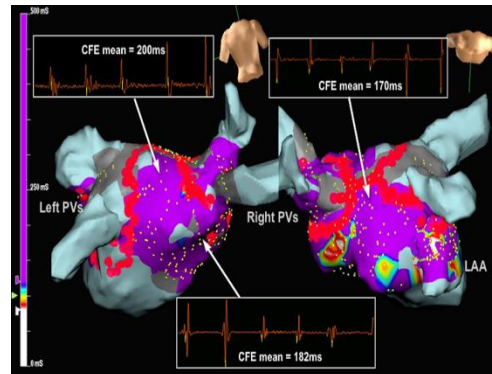
THORACOSCOPIC ABLATION

- PVI
- Roof and Inferior Line
- Ganglionated plexi
- LAA excision
- Intraoperative testing of conduction block



CATHETER ABLATION

- PVI
- Roof and MI line
- CFE
- CTI
- Conduction block testing



CASA-AF Follow-up

3-Month Follow-Up

7 day Ambulatory ECG
monitor
AF Symptom Score / SF36
Cardiac MRI

6-Month Follow-Up

7 day Ambulatory ECG
monitor
AF Symptom Score / SF36

9-Month Follow-Up

ECG & Ambulatory ECG
monitor
AF Symptom Score /
SF36
Cardiac MRI

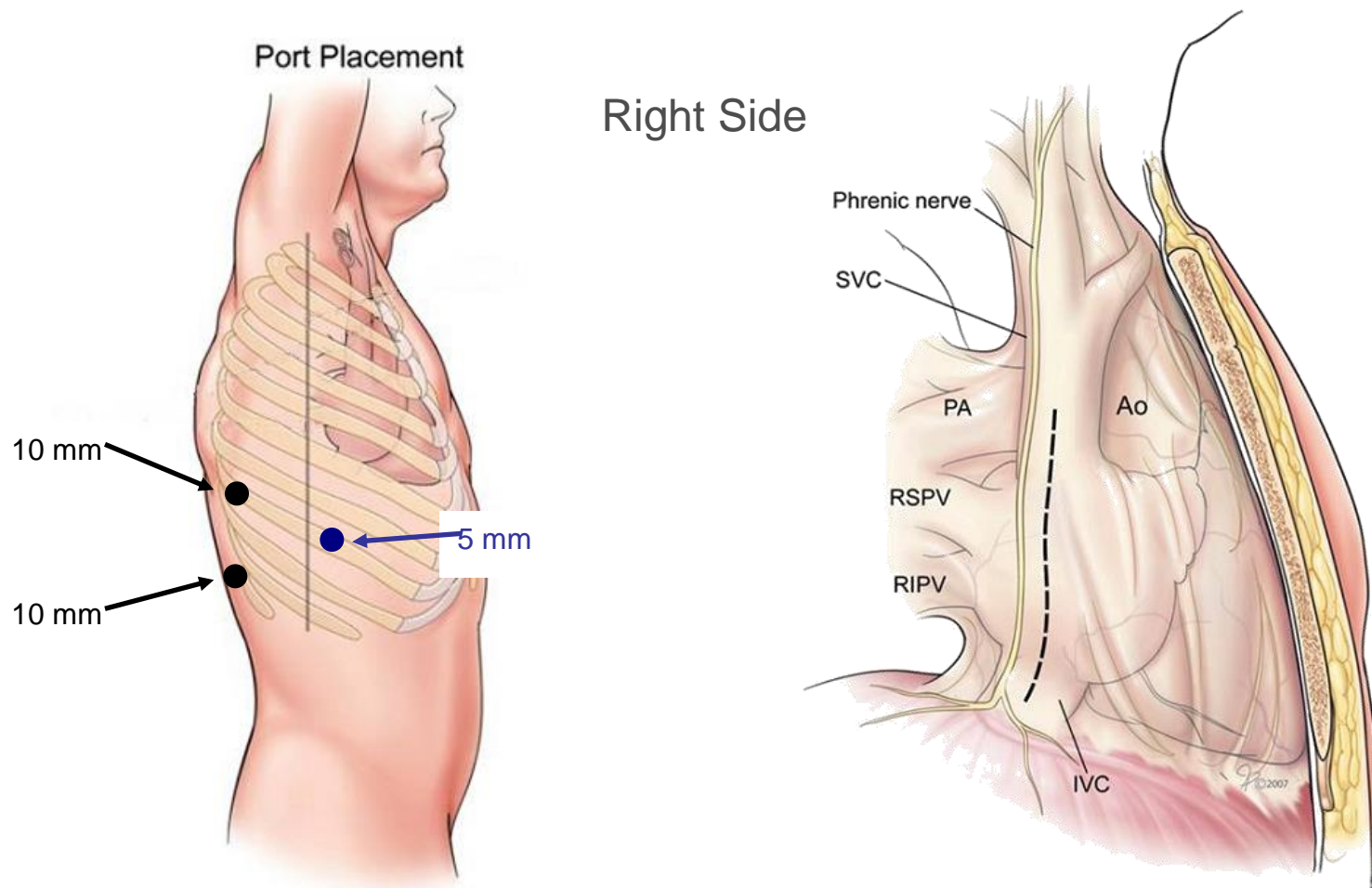
12-Month Follow-Up

ECG & Ambulatory ECG
monitor
AF Symptom Score /
SF36

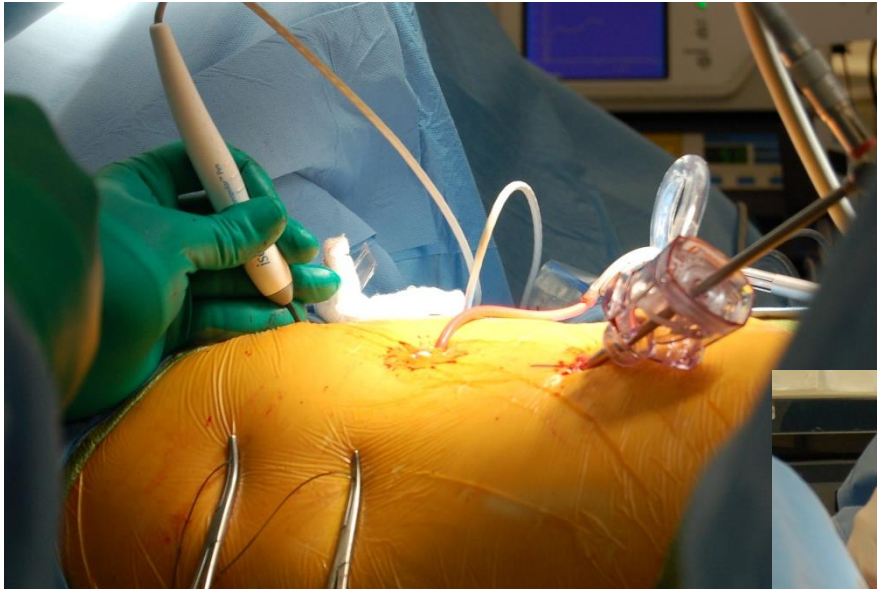


Unpublished Data

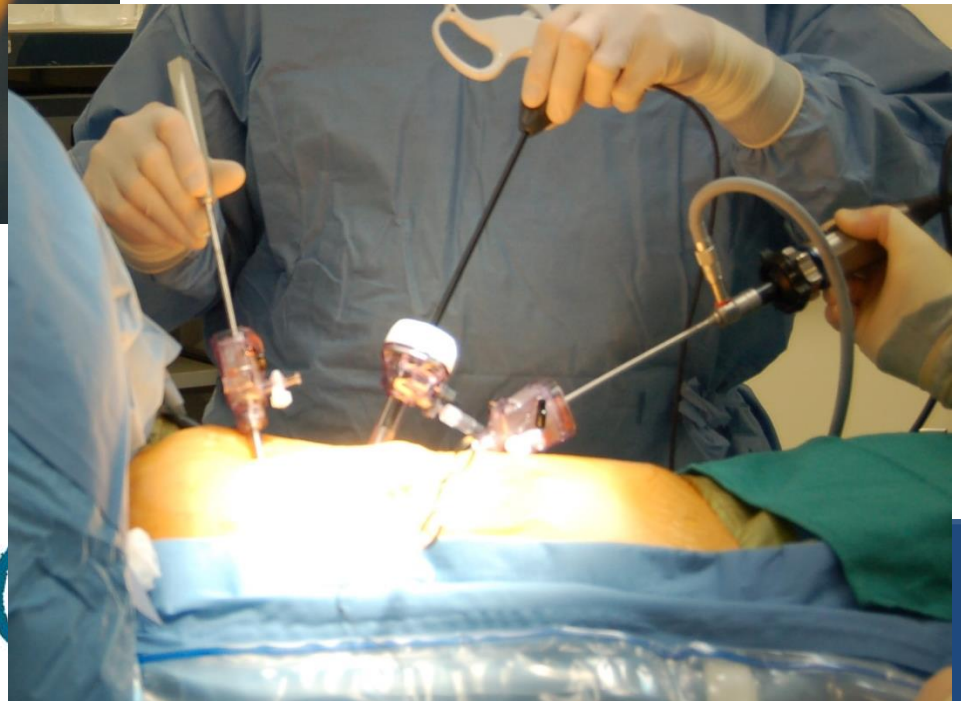
Endoscopic Ablation



Totally Thoracoscopic Ablation

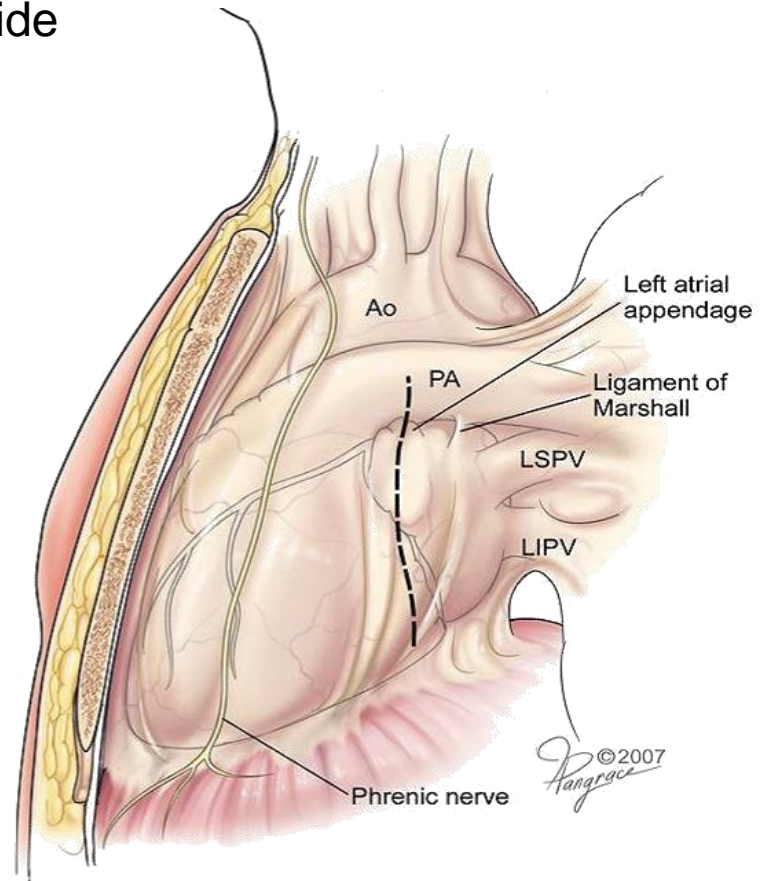
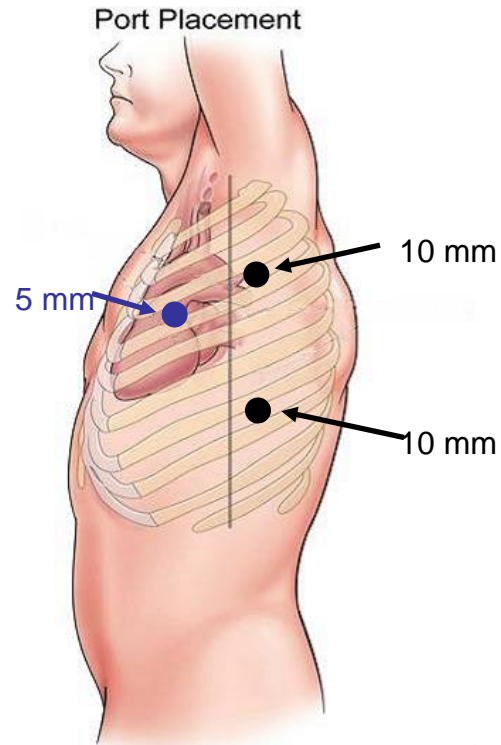


- 3 - 4 ports with insufflation
 - Two 5mm
 - One 10-12mm



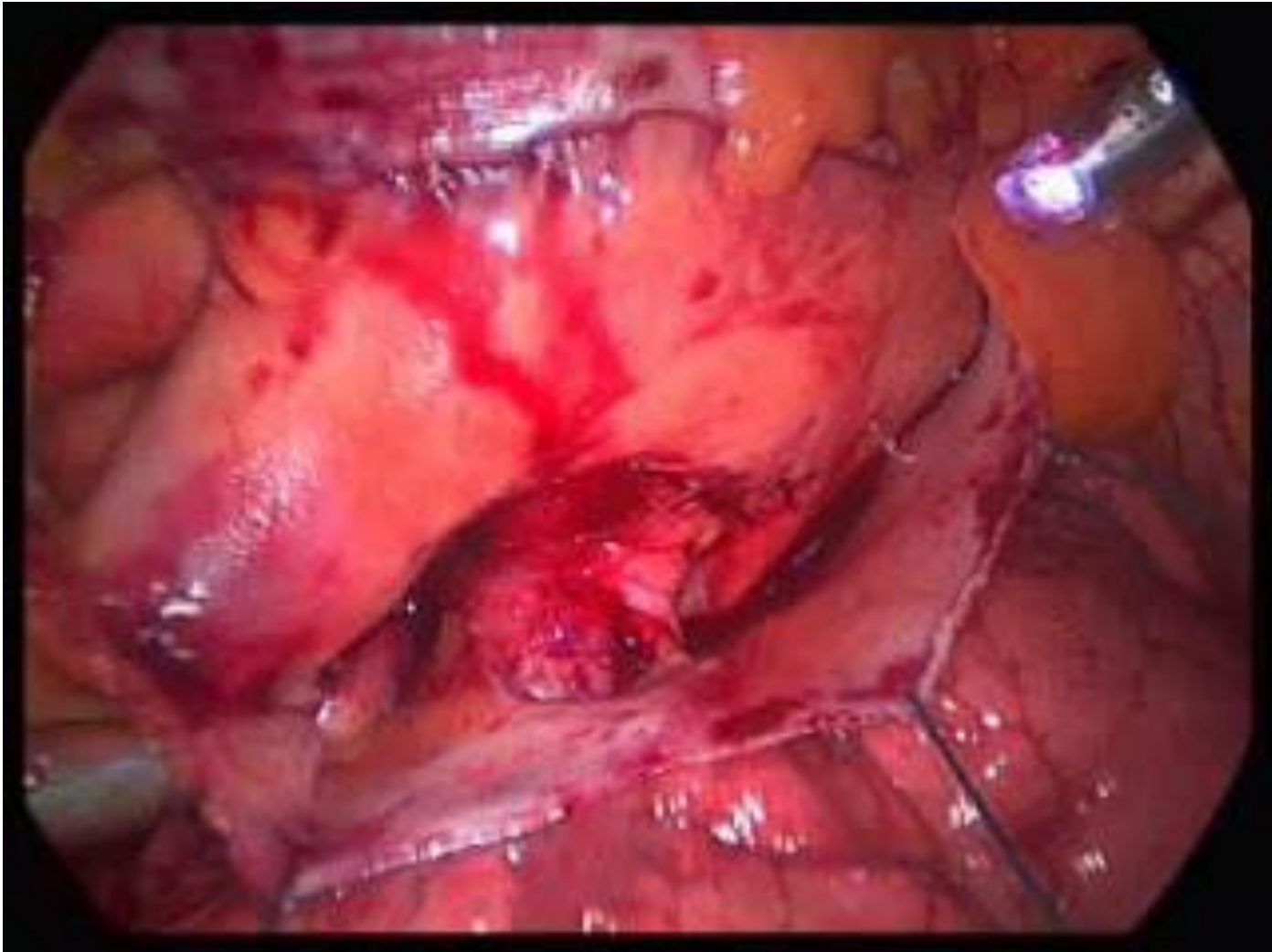
Endoscopic Ablation

Left Side





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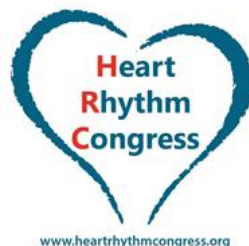
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CASA-AF Index Procedural Data

	Catheter Ablation (n=25)	Surgical Ablation (n=26)	P value
Procedural time (mins)	259±70	242±64	0.43
Acute procedural success (%)	24/25 (96%)	22/26 (85%)	0.97
Inpatient stay (days)	4.1±3	7.4±3	0.001



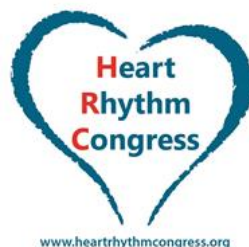
CASA-AF Outcome data

Endpoints	Catheter Ablation (n=25)	Surgical Ablation (n=26)	P value
12 month Single procedure Freedom from AF/AT Off AAD	8/25 (32%)	19/26 (73%)	0.003
12 month Multi- procedure Freedom from AF/AT Off AAD	15/25 (60%)	20/26 (77%)	0.19
12 month Clinical success Freedom from AF/AT +/- AAD	14/25 (56%)	19/26 (73%)	0.20

Unpublished Data

CASA-AF Major Complications

Major Complications	Catheter (n=25)	Surgical (n=26)	p-value
Pneumonia	-	2	
Pleural effusion	-	1	
Pulmonary vein stenosis	1	3	
Phrenic nerve palsy	-	2	
Vascular access complications	-	-	
Acute pulmonary oedema	1	-	
Cardiac tamponade	-	-	
Sternotomy for complication	-	-	
Stroke	-	-	
Death	-	-	
Total	2 (8.0%)	8 (30.7%)	p=0.04



Unpublished Data

Consent

- 1% risk of mortality
- Surgery for symptom relief
- “Benign disease”



Patient Experience

- Positive
- QoL score improvements
 - Surgery 9/10
 - Catheter ablation 2/10



Learning Curve

- Dissecting into the oblique and transverse sinuses
- Encircling the pulmonary veins
- How many centres?
- 1-2 surgeons per centre?





A New Day in Epicardial Ablation

Hybrid Procedure

- Minimally invasive epicardial and percutaneous endocardial ablation
- EP mapping for completeness and “touch up”
- Mitral Isthmus line
 - Circumflex coronary artery
 - Coronary sinus position
 - Poor visualization
- Oesophagus/ phrenic protected
- No risk of tamponade
- Reduced risk of emboli by reducing endocardial ablation



Conclusions

- Thoracoscopic AF ablation is effective
 - Transmurality
 - Durability
 - GP ablation and LAA exclusion
- Efficacy maintained at mid term follow up
- Low complication rates



Future Developments

- Is the future hybrid?
 - Reimbursement for non hybrid TT maze
 - Staged hybrid at 3 months
- Untapped potential?

