Surgical AF Ablation : Lesion Sets and Energy Sources

What are the data ?

Steven F Bolling, MD
Cardiac Surgery
University of Michigan

University of Michigan Health System

Disclosures

- Consultant/Advisory Board: Abbott, Edwards Lifesciences
- Ownership Interest: Millipede, Pipeline

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Surgical AF Ablation : Lesion Sets and Energy Sources

What are the recommendations ?

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2014 AHA/ACC/HRS Guidelines Surgical AF Ablation

Recommendation	COR	LOE
An AF surgical ablation procedure is *reasonable* for selected patients with AF undergoing cardiac surgery for other indications	**IIa**	**C**

J Am Coll Cardiol. 2014;64(21):2246-80

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The effect of the Cox-maze procedure for atrial fibrillation concomitant to mitral and tricuspid valve surgery

Niv Ad, MD, S
Linda Henry,

Objectiv
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AF there
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Methods
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Conclusi
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The prevalence during the past regurgitation. T tive valvular di of life—older development of

The long-term outcome of patients with coronary disease and atrial fibrillation undergoing the Cox maze procedure

Ralph J. Damiano, Jr, MD
Sydney L. Gaynor, MD
Marci Bailey, RN
Sunil Prasad, MD
James L. Cox, MD
John P. Boineau, MD
Richard P. Schuessler, PhD

ACD

Late outcomes after the Cox maze IV procedure for atrial fibrillation

Matthew C. Henn, MD, Timothy S. Lancaster, MD, Jacob R. Miller, MD, Laurie A. Sinn, RN, BSN, Richard B. Schuessler, PhD, Marc R. Moon, MD, Spencer J. Melby, MD, Hersh S. Maniar, MD, and Ralph J. Damiano, Jr, MD

ABSTRACT

Objective: The Cox maze IV procedure (CMP gold standard for surgical ablation; however consensus definitions of treatment failure hav compare to reported outcomes of catheter-based tional outcomes of patients who underwent a 5 years of follow-up.

Methods: Between January 2002 and Septem prospectively on 576 patients with AF who un left-sided CMPIV (n = 44). Perioperative va from AF, with and without AADs, were compar

Results: Follow-up at any time point was 89%. AF was 93 of 119 (78%), and freedom from AF No differences were found in freedom from AF, 4, and 5 years for patients with paroxysmal AF (longstanding persistent AF (n = 305), or for t versus a concomitant CMP. Duration of preoper

From the Division of Cardiothorac gery, Washington University Sch Medicine at Barnes- Louis, Mo.

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Read at the Eighty-thi The American Asso Surgery, Boston, Mas

Received for publication May 2, 2 visions requested June 2, 2003;

persistent or longstanding AF. (J Thorac Cardio

Supplemental material is available online

The first effective surgical treatment for atrial (AF), now formally known as the Cox maze (CMP), was introduced by James Cox, MD, in

70 - >90% in NSR !

The Cox-Maze Procedure for Lone Atrial Fibrillation
A Single-Center Experience Over 2 Decades

Timo Weimar, MD; Stefano Schena, MD, PhD; Marci S. Bailey, RN, MSN; Hersh S. Maniar, MD; Richard B. Schuessler, PhD; James L. Cox, MD; Ralph J. Damiano, Jr, MD

Background—The Cox-Maze procedure (CMP) has achieved high success rates in the therapy of atrial fibrillation (AF) while becoming progressively less invasive. This report evaluates our experience with the CMP in the treatment of lone AF over 2 decades and compares the original cut-and-sew CMP-III to the ablation-assisted CMP-IV, which uses bipolar radiofrequency and cryoenergy to create the original lesion pattern.

Methods and Results—Data were collected prospectively on 212 consecutive patients (mean age, 53.5±10.4 years; 78% male) who underwent a stand-alone CMP from 1992 through 2010. The median duration of preoperative AF was 6 (interquartile range, 2.9–11.5) years, with 48% paroxysmal and 52% persistent or long-standing persistent AF. Univariate analysis with preoperative and perioperative variables used as covariates for the CMP-III (n=112) and the om AF n from ulation inutes; AF off

Conclusions—The CMP, although simplified and shortened by alternative energy sources, has excellent results, even with improved follow-up and stricter definition of failure. (***Circ Arrhythm Electrophysiol.* 2012;5:8-14.**)

Key Words: ablation ■ arrhythmia heartrhythmdisorders atrial fibrillation ■ surgery ■ tachyarrhythmias

Atrial fibrillation (AF) is the most common sustained arrhythmia worldwide, with an expected increase in our aging population.[1] In addition to the significant morbidity and mortality secondary to hemodynamic compromise and tachycardia-induced cardiomyopathy in some patients, stroke remains the most feared complication.[2] AF accounts for ~25% of strokes in patients >80 years and increases a person's risk of stroke by 5-fold.[3] The limitations of pharmacological therapy, with failure rates as high as 60%, have led to the development and proliferation of interventional approaches in the treatment of AF, including catheter ablation and surgery.[4–7]

Clinical Perspective on p 14

In 1987, Dr. Cox introduced the maze procedure (CMP) for

early follow-up was excellent and included 24-hour Holter monitoring, only few patients had ECGs or prolonged monitoring at long-term follow-up.[5,11] The end point was generally self-reported freedom from symptomatic AF. Moreover, this procedure was not widely adopted because of its complexity and invasiveness.

The development of alternative energy sources has enabled surgeons to create lines of ablation to replace most incisions of the original CMP-III, which shortened and simplified the procedure.[12,13] In our laboratory, bipolar radiofrequency energy was able to create reliable transmural lines of ablation while minimizing the risk of collateral damage to the surrounding tissue.[14–16] In 2002, our institution introduced a new iteration termed the CMP-IV, which used bipolar radiofrequency and cryoenergy to replace most of the original

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2017 STS Clinical Practice Guidelines

Mitral Valve

- Multiple populations studied: 11 RCTs, 4 Meta-analyses, Several Institutional experiences

Recommendation:

- Surgical ablation for AF can be performed without additional risk of operative mortality or major morbidity, and is *recommended* at the time of concomitant mitral operations to restore sinus rhythm. (COR: I, LOE: A)

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2017 STS Clinical Practice Guidelines

CABG, AVR, AVR+CABG

- Limited populations studied: 2 RCTs, 2 Meta-analyses, limited Institutional experiences

Recommendation:

- Surgical ablation for AF can be performed without additional risk operative of mortality or major morbidity, and is *recommended* at the time of concomitant isolated AVR, isolated CABG, and AVR+CABG operations to restore sinus rhythm. (COR: I, LOE: B-NR)

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2017 AATS Expert Consensus Guidelines

Stroke… and Survival

Recommendation:

- It is *reasonable* to choose to perform a concomitant surgical ablation procedure for patients with a history of AF over no treatment of AF because there is no increased risk of perioperative stroke/TIA.
- (COR: IIA, LOE: A)

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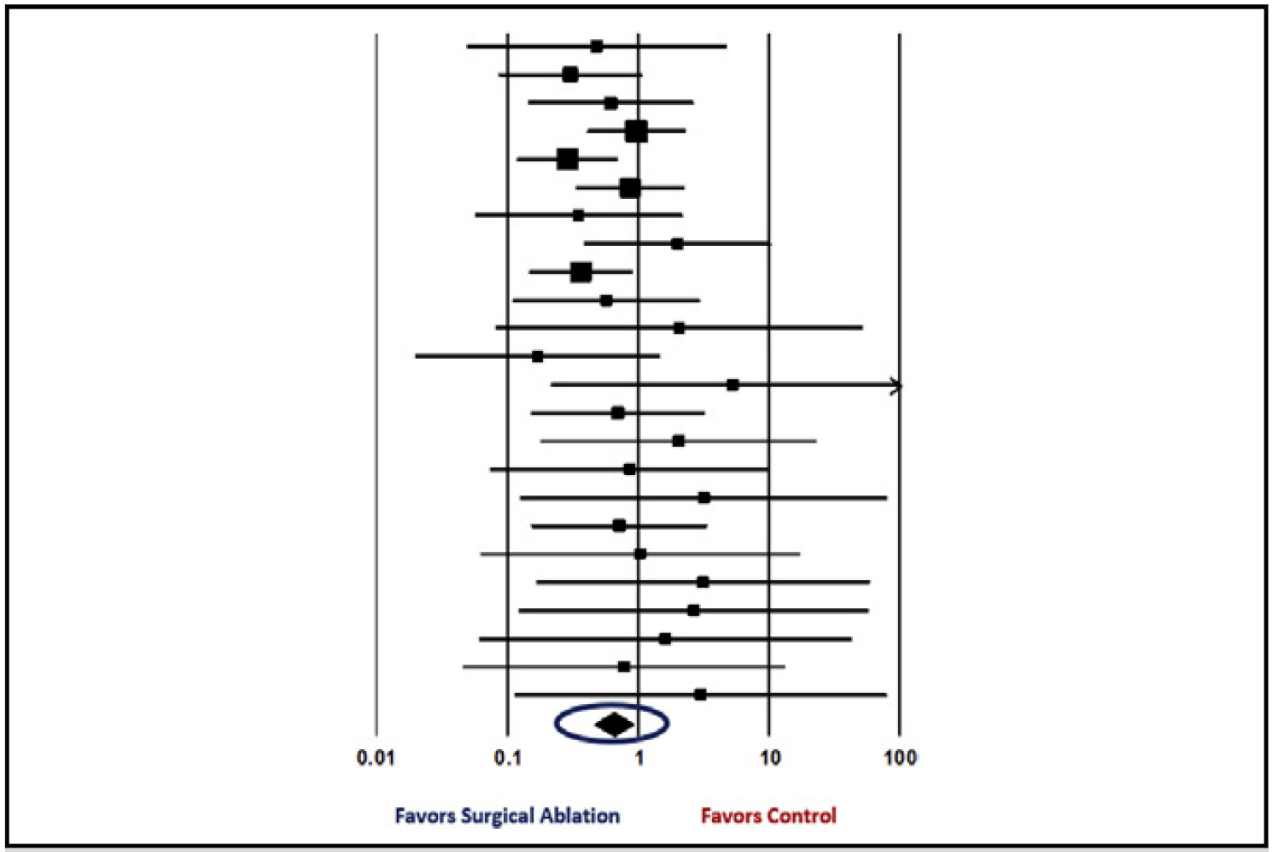
2017 AATS Expert Consensus Guidelines



Forest plot: Improved perioperative survival (<30 days) with concomitant surgical ablation.

(COR: I, LOE: A)

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Surgical AF Ablation : Lesion Sets and Energy Sources

We should do something

…but do we ?

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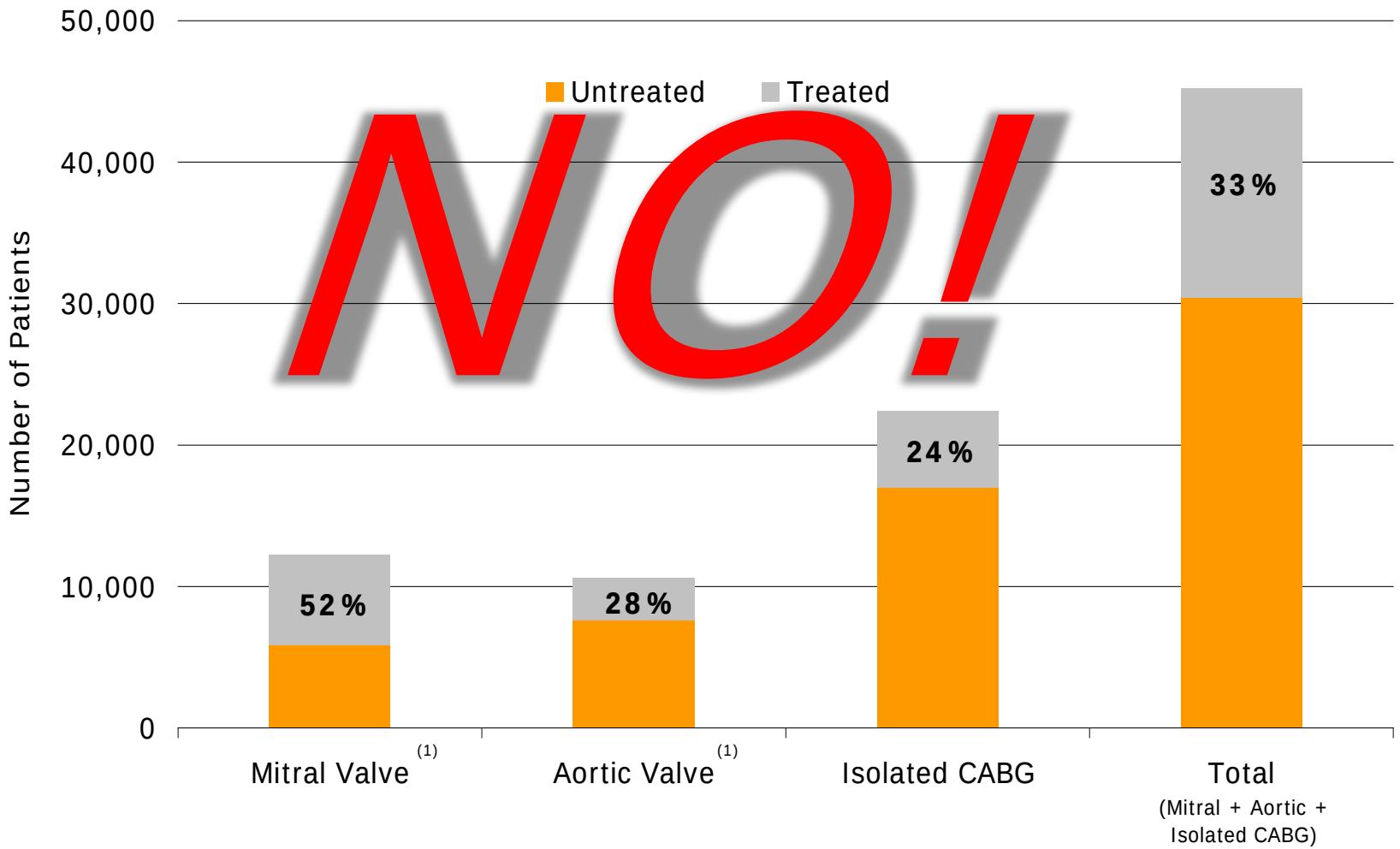
US Rates of Surgical Ablation



Cut and Sew MAZE

Complex,Morbid… and Scary!

Never adopted !

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CRYO and RF Ablation
Thermal injury

-60º C

Formation of intra and extracellular ice crystals. This disrupts the cell membrane and cytoplasmic organelles

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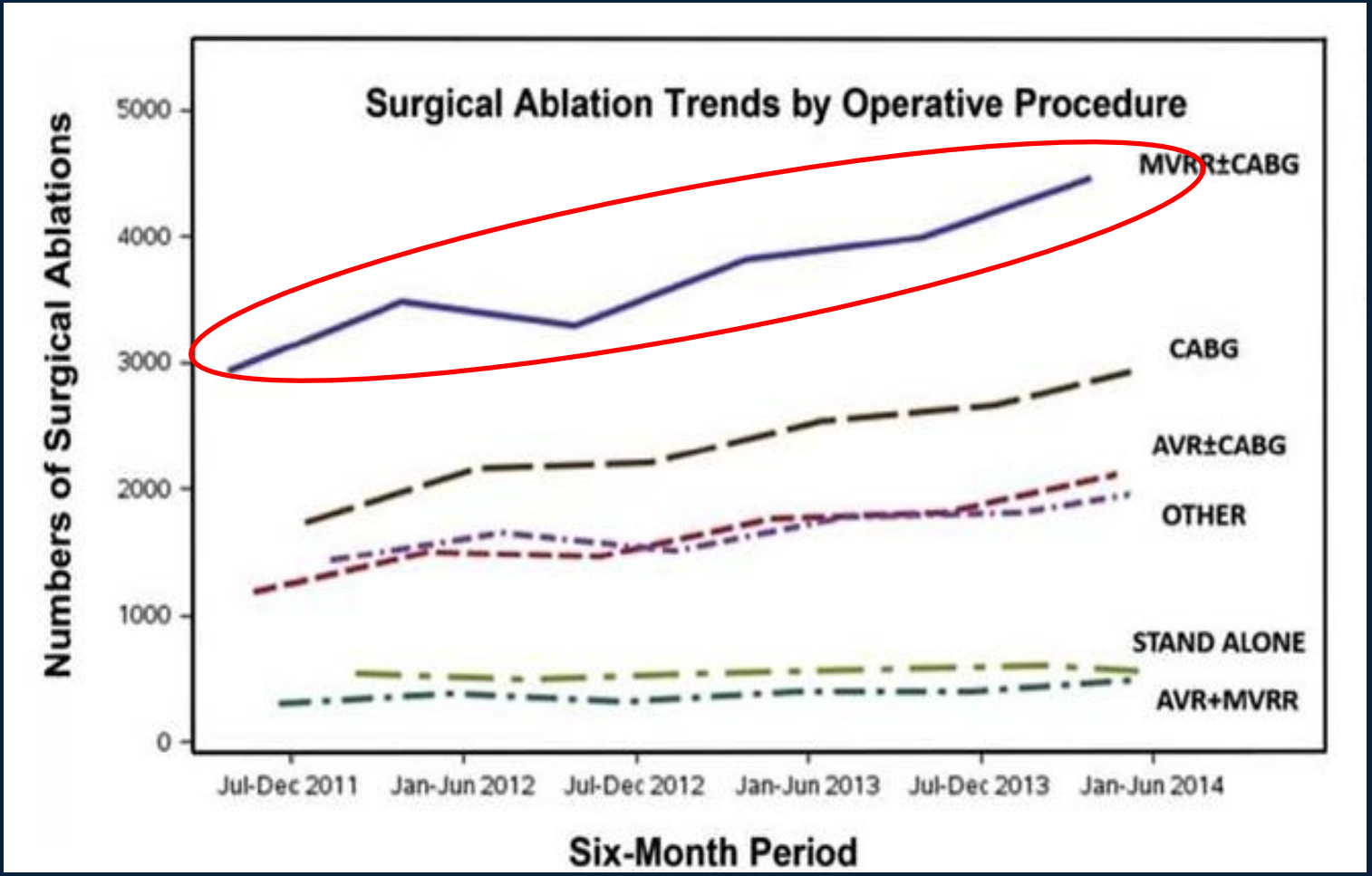
Trends in Surgical AF Ablation



Badhwar et al, Surgical Ablation of Atrial Fibrillation in the United States: Trends and Propensity Matched Outcomes. Ann Thorac Surg 2017 Aug; 104(2)493-500.

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Surgical AF Ablation

Do something!…but what ?

- *What lesions ?*
  - *Bi-atrial ?*
    - *Left atrial only ? PVI ?*
- *What energy source ?*
  - *RF, cryo,*
    - *Us, micro, laser*

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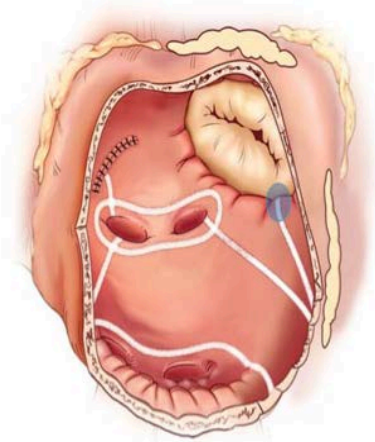
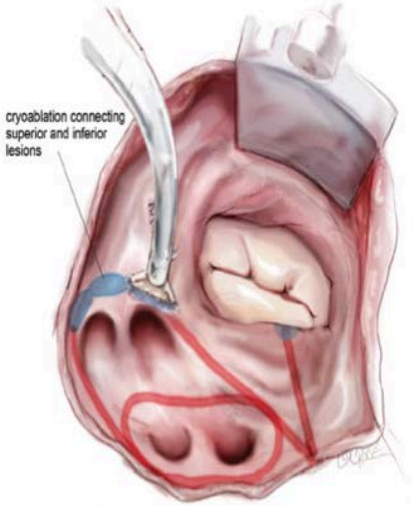
Surgical Ablation - *Modified Cox Maze IV*

Left Atrial Lesion Set

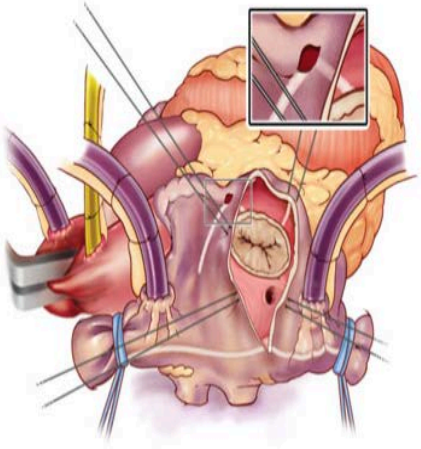


Sternotomy

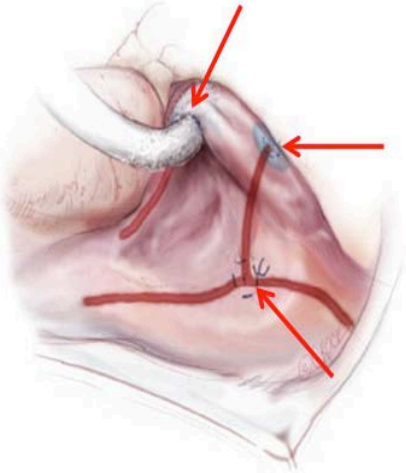


Right Mini-thoracotomy

Right Atrial Lesion Set



Sternotomy



Right Mini-thoracotomy

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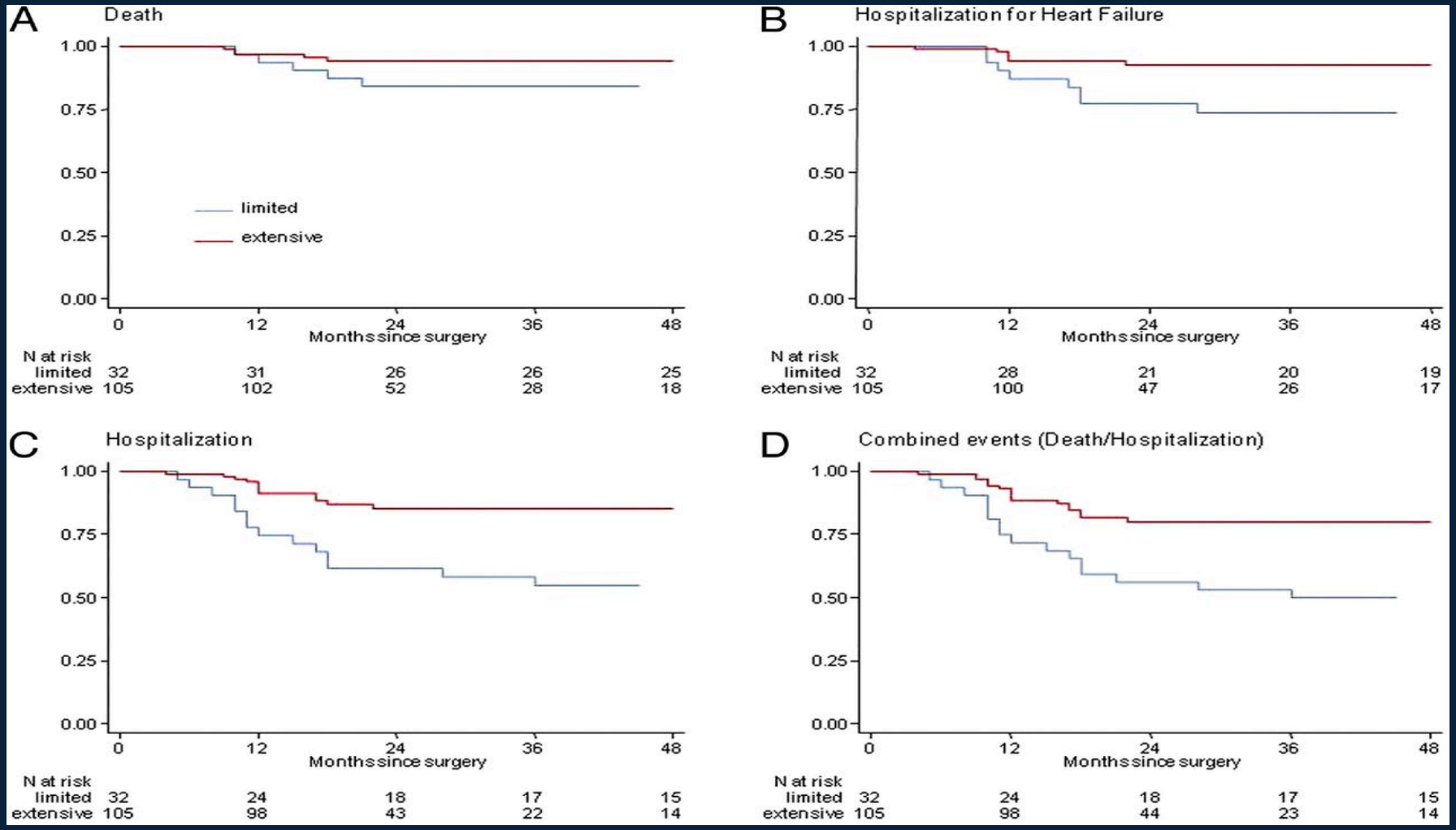

Cox : More lesions are better !

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Left Atrial Ablation Versus Biatrial Ablation in the Surgical Treatment of Atrial Fibrillation

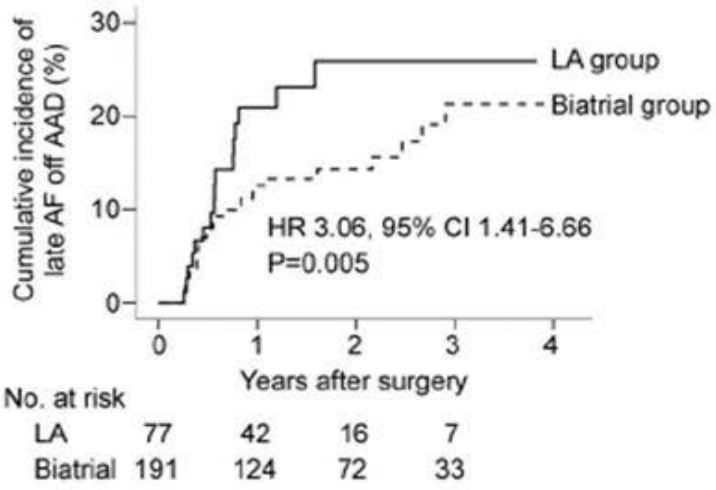

Fig 3. Cumulative incidence of late atrial fibrillation (AF) in the ab The present study revealed that, compared with bia- *group sh* trial ablation, LA ablation resulted in more frequent AF *the bia- tri* recurrence in chronic AF patients undergoing MV *inter- va* surgery. Adding the right-side ablation did not much prolong procedural time (approximately 10 minutes). Serious bradyarrhythmia was clinically irrelevant with the biatrial procedure.

Ann Thorac Surg
2011;92:1397–405

Breda et al
Comparison of Bilateral and Unilateral RF Ablation In RF: Early Results

Table 3. Changes in the Cardiac Rhythm during Postoperative and Follow-Up Periods

	Uniatrial Group	Biatrial Group
Postoperative Period, %*		
Sinus rhythm	60	80
Atrial fibrillation	40	13.3
Node rhythm	–	–
Pacemaker	–	6.7
At discharge, %†		
Sinus rhythm	60	60
Atrial fibrillation	40	26.7
Node rhythm	–	13.3
Pacemaker	–	–
Follow-up period‡		
Sinus rhythm	46.7	73.3
Atrial fibrillation	53.3	13.35
Node rhythm	–	13.35
Pacemaker	–	–

*P = .215 (Fisher's exact test).
†P = .700 (Fisher's exact test).
‡P = .049 (Fisher's exact test).

The Heart Surgery Forum #2010-1119
14 (5), 2011 [Epub October 2011]
doi: 10.1532/HSF98.20101119

Bi - atrial lesions are better !

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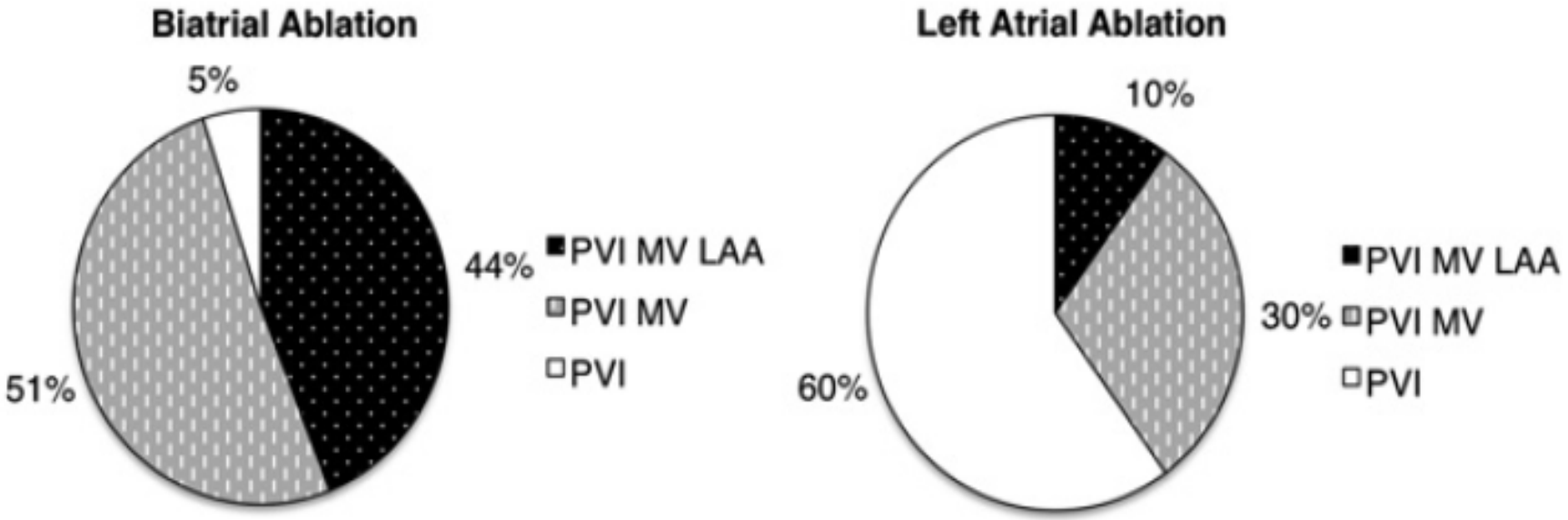
Right atrial lesions do not improve the efficacy of a complete left atrial lesion set in the surgical treatment of atrial fibrillation, but they do increase procedural morbidity

Lori K. Soni, MD, Sophia R. Cedola, BS, Jacob Cogan, BA, Jeffrey Jiang, BS, Jonathan Yang, MD, Hiroo Takayama, MD, and Michael Argenziano, MD



Bi - atrial lesions are not better !

Left-Sided Surgical Ablation for Patients With Atrial Fibrillation Who Are Undergoing Concomitant Cardiac Surgical Procedures

Niv Ad, MD, Sari D. Holmes, PhD, Deborah Lamont, RN, and Deborah J. Shuman, BS

Inova Heart and Vascular Institute, Falls Church, Virginia

Conclusions. LA-only ablation yielded acceptable success rates, primarily in patients with shorter AF duration and smaller LA. However, success was reduced in patients with traditional predictors of failure. Well-designed studies with standardized lesion sets and ablation tools are required to determine whether full Cox maze yields better outcomes in patients with more advanced AF.

Bi - atrial lesions are better…for some !

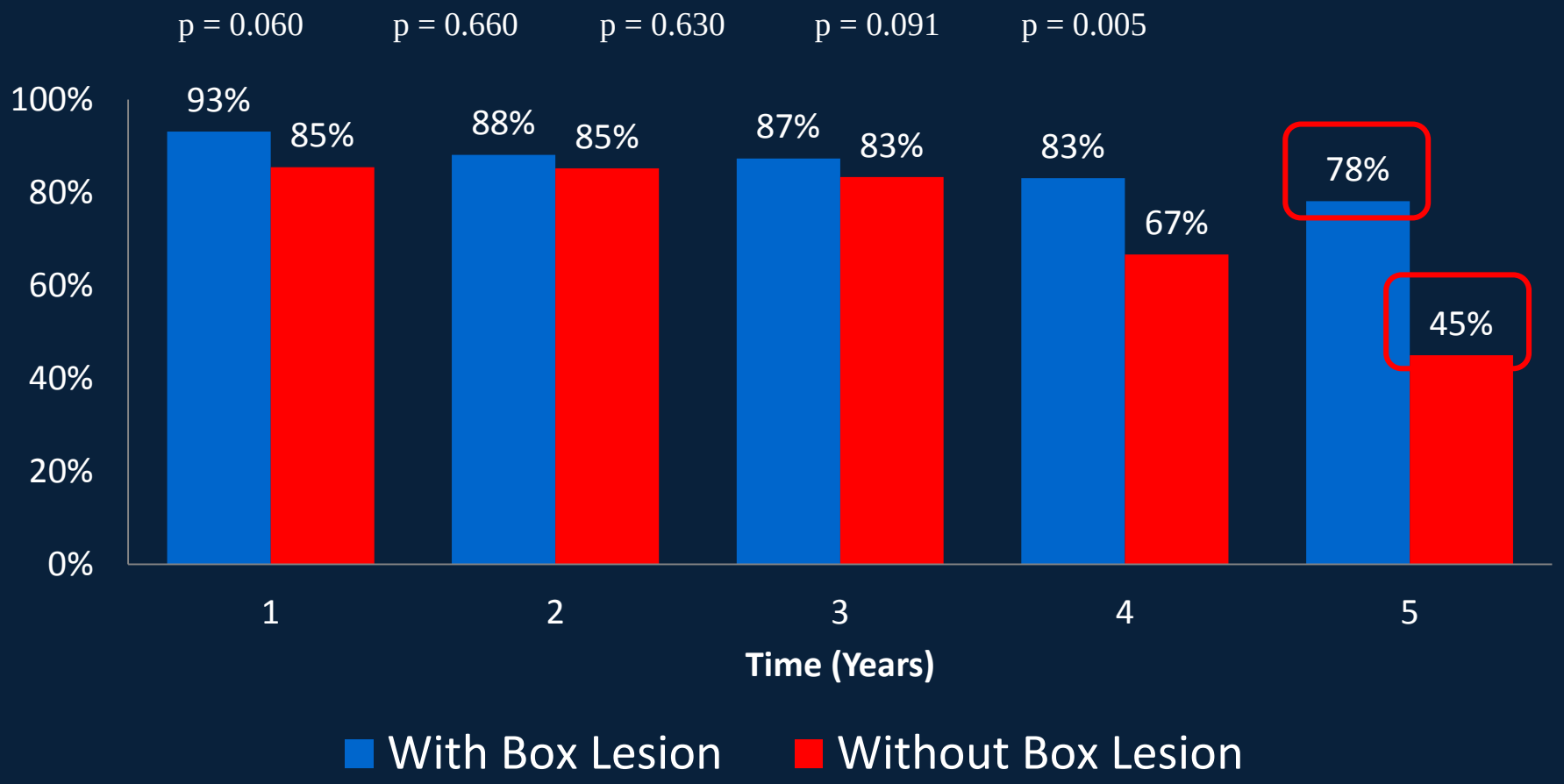
Rhythm outcome predictors after concomitant surgical ablation for atrial fibrillation: A 9-year, single-center experience

Simon Pecha, MD, Timm Schäfer, MD, Irina Subbotina, MD, Teymour Ahmadzade, MD, Hermann Reichenspurner, MD, PhD, and Florian Mathias Wagner, MD

The statistically significant predictors for SR after 1 year were left atrial diameter, AF duration, preoperative paroxysmal AF, postoperative SR, and *biatrial ablation for persistent AF.*

LA box vs. PVI (no box)

Freedom from AF - box better!



Damiano RJ, et al. *J Thorac Cardiovasc Surg*. 2011 Jan;141(1):113-21.

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Surgical AF Ablation

Do something!

- What lesions:

Bi-atrial - larger LA, longer and persistent AF

Left atrial box > PVI paroxysmal AF

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EUROPEAN SOCIETY OF CARDIOLOGY®

Europace (2015) **17**, 38–47
doi:10.1093/europace/euu220

CLINICAL RESEARCH
Ablation for atrial fibrillation

Biatrial ablation vs. left atrial concomitant surgical ablation for treatment of atrial fibrillation: a meta-analysis

Kevin Phan[1,2], Ashleigh Xie[1], Yi-Chin Tsai[3], Narendra Kumar[4], Mark La Meir[4,5], and Tristan D. Yan[1,6]*

[1]The Collaborative Research (CORE) Group, Macquarie University Hospital, Macquarie University, 2 Technology Place, Sydney, Australia; [2]Sydney Medical School, The University of Sydney, Sydney, Australia; [3]The Prince Charles Hospital, Chermside, Australia; [4]Department of Cardiothoracic Surgery and Cardiology, Academic Hospital Maastricht and Cardiovascular Research Institute Maastricht, Maastricht, The Netherlands; [5]University Hospital Brussels, Brussels, Belgium; and [6]Department of Cardiothoracic Surgery, Royal Prince Alfred Hospital, University of Sydney, Sydney, Australia

Received 30 April 2014; accepted after revision 18 July 2014; online publish-ahead-of-print 21 October 2014

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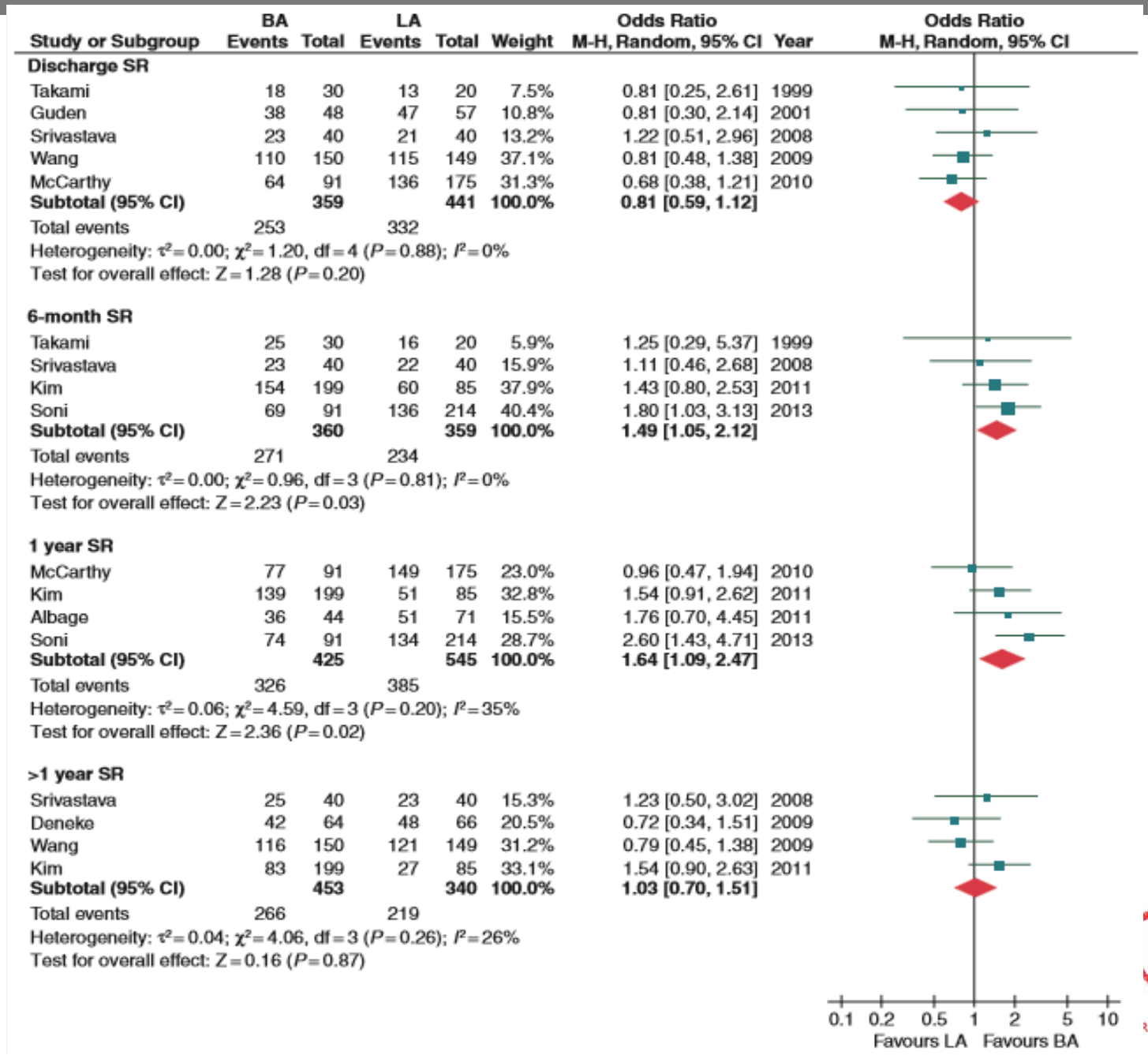
Europace 2015;17:38-47



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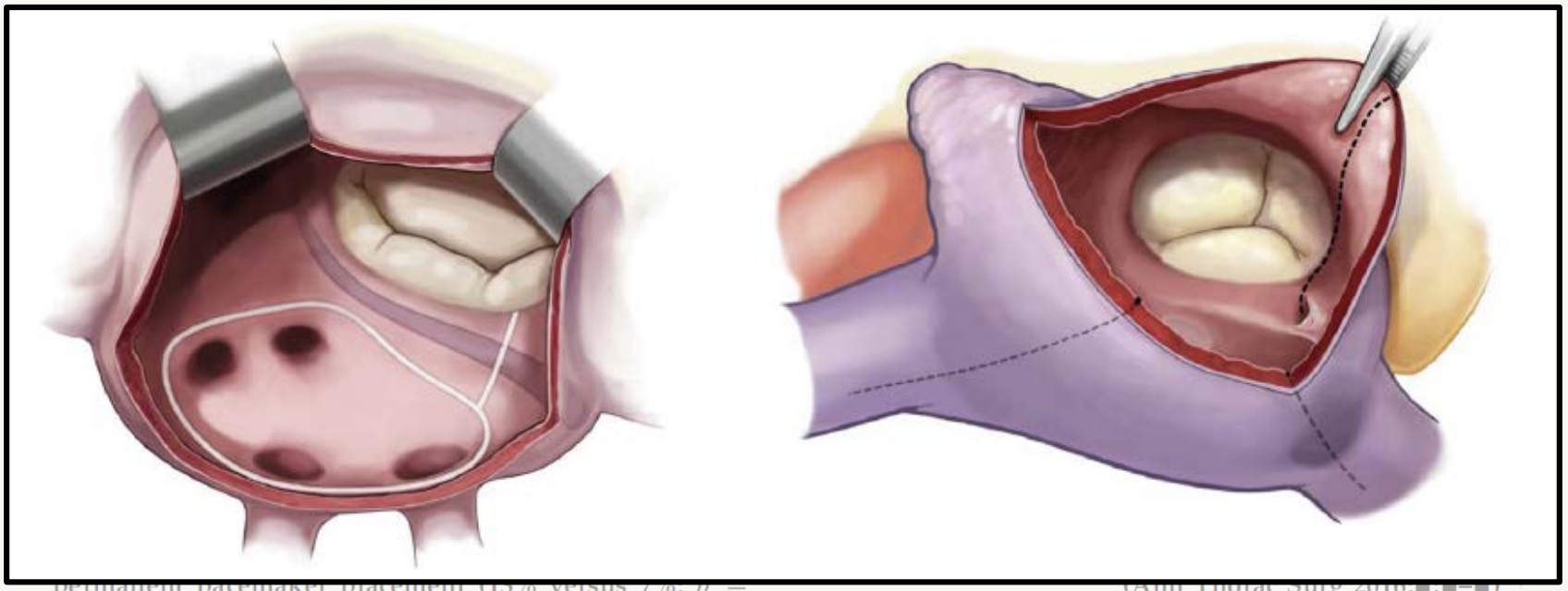
Biatrial or Left Atrial Lesion Set for Ablation During Mitral Surgery: Risks and Benefits

At Northwestern, we have never endorsed the concept that all patients must be treated with BA lesions, and have used different lesions in patients at surgeons' discretion



permanent pacemaker placement (15% versus 7%, $p = 0.006$). Freedom from atrial fibrillation off antiarrhythmic

SURGICAL ABLATION OF ATRIAL FIBRILLATION DURING MITRAL VALVE SURGERY

THE CARDIOTHORACIC SURGICAL TRIALS NETWORK

NEJM

March 16, 2015

National Institutes of Health
National Heart, Lung, and Blood Institute
National Institute of Neurological Disorders and Stroke

CIHR IRSC
Canadian Institutes of Health Research
Instituts de recherche en santé du Canada

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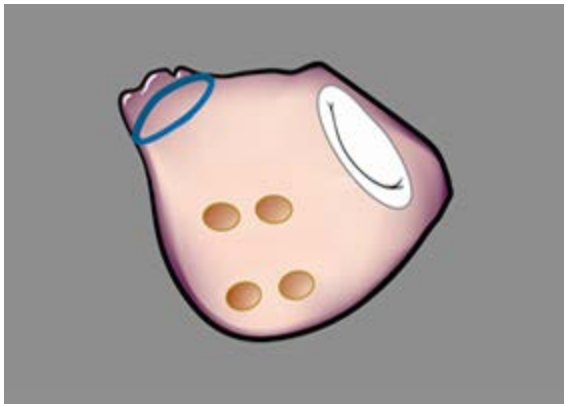
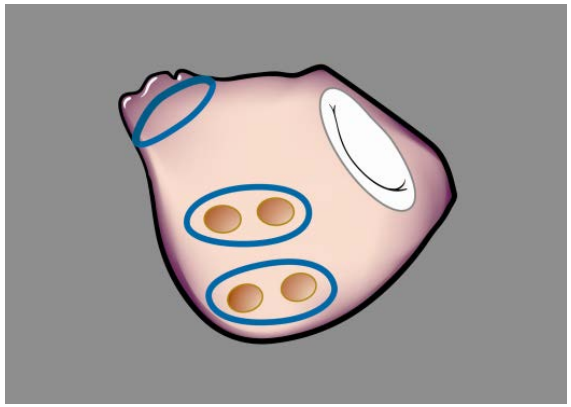
Surgical Ablation Options

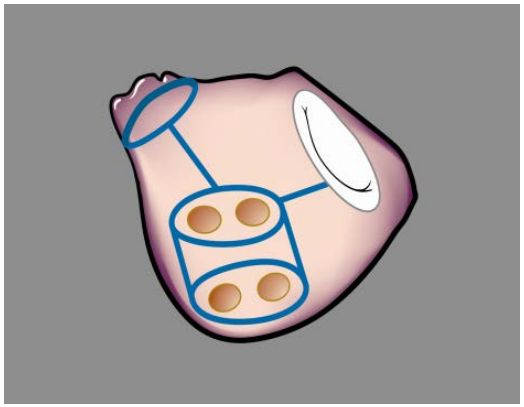
No Ablation



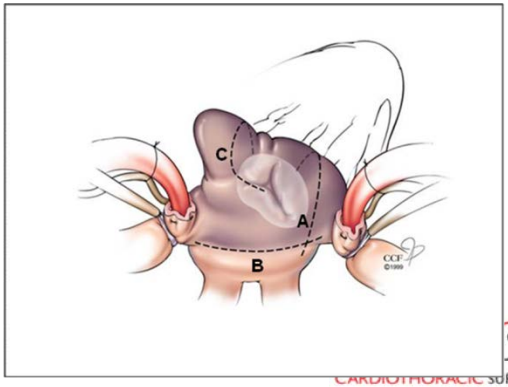
PVI



Biatrial Maze



LAA closure performed in all patients



Operative Characteristics

	MVS Alone (N=127)	MVS & Ablation (N=133)
Mitral Valve Surgery		
Replacement	**61 (48.4)**	**54 (40.6)**
Repair	**65 (51.6)**	**79 (59.4)**
Concomitant Procedures		
Tricuspid Valve Surgery	**48 (38.1)**	**50 (37.6)**
Aortic Valve Replacement	**20 (15.9)**	**14 (10.5)**
CABG	**25 (19.8)**	**27 (20.3)**
Cardiopulmonary Bypass Time (min)*	**132.5 ±51**	**147.8 ±63.3**
Cross-Clamp Time (min)	**95.9 ±36.3**	**102.9 ±41.5**

*P-Value for Cardiopulmonary Bypass Time = 0.03

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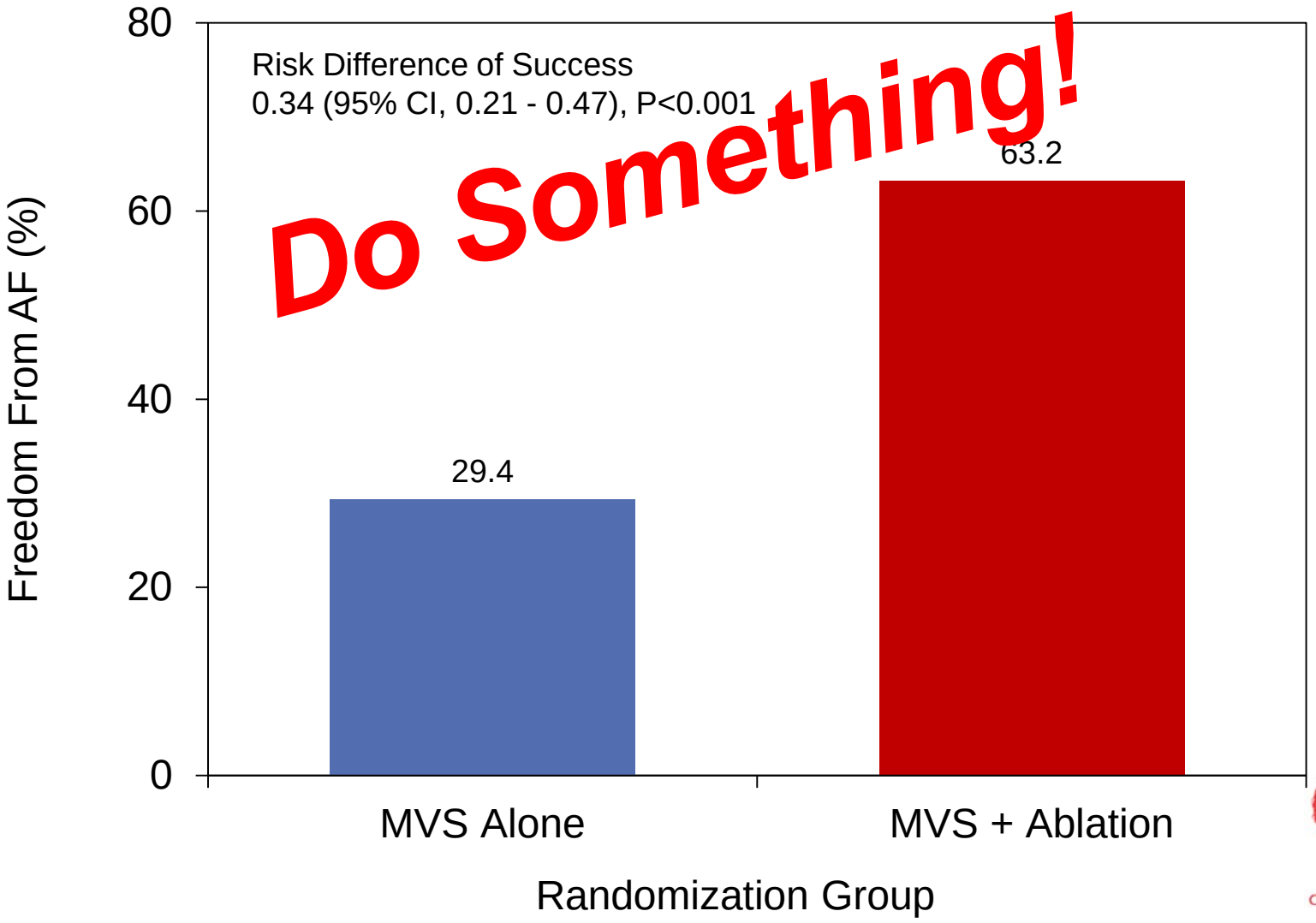
Primary Endpoint



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Quality of Life

	MVS Alone (N=127)	MVS & Ablation (N=133)	P-Value
SF-12			
Physical Function	45.3 ±7.9	44.3 ±9.0	0.38
Mental Function	48.5 ±6.5	48.0 ±6.3	0.56
AF Severity Scale			
Daily AF –no. (%)	42 (45.2)	20 (19.8)	<0.001
Life Rating (1-10, median)	8.0 (7,9)	8.0 (7,9)	0.45
NYHA Class III + IV –no. (%)	3 (2.9)	8 (7.0)	0.17

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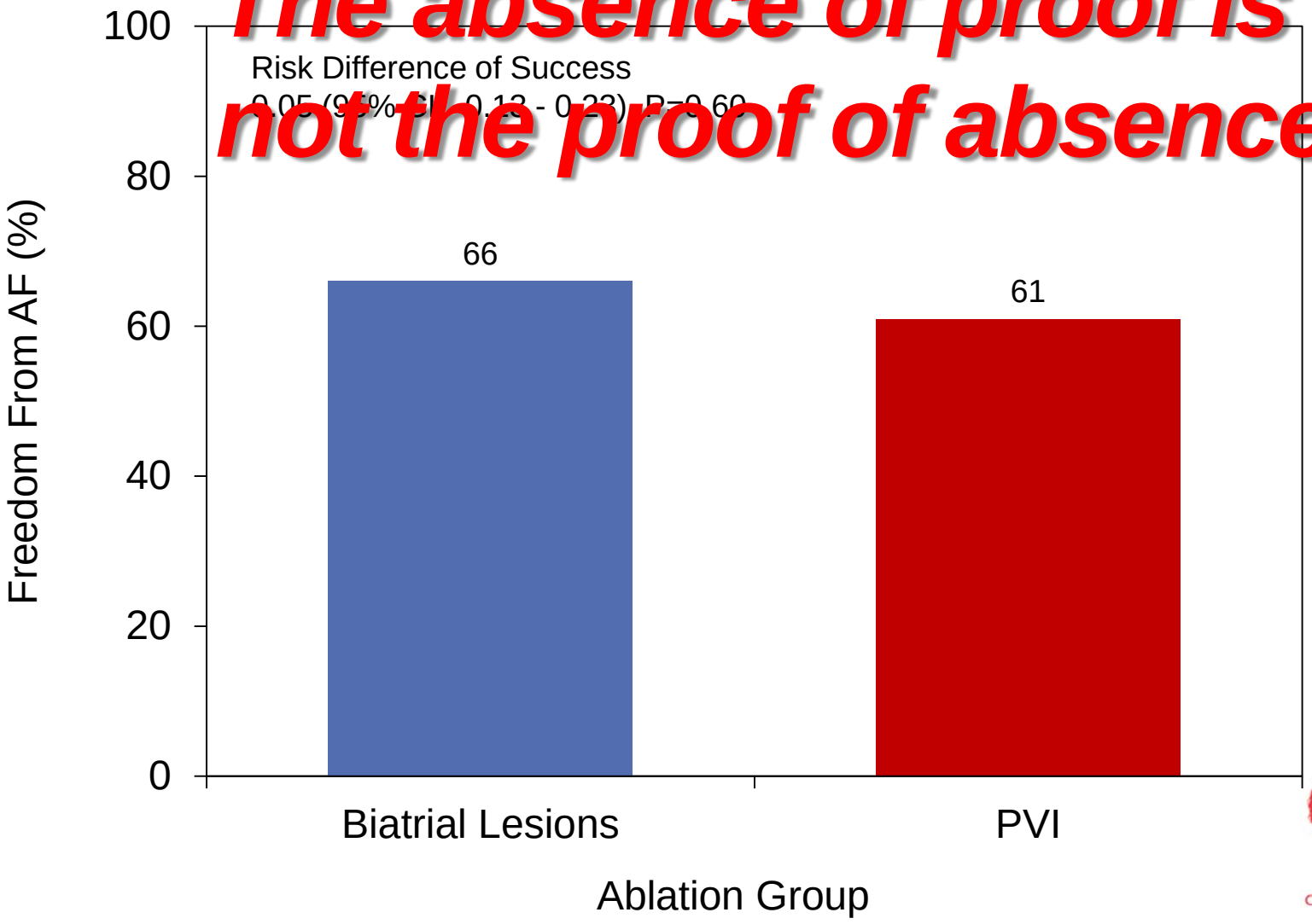
Biatrial Maze vs. PVI

The absence of proof is not the proof of absence



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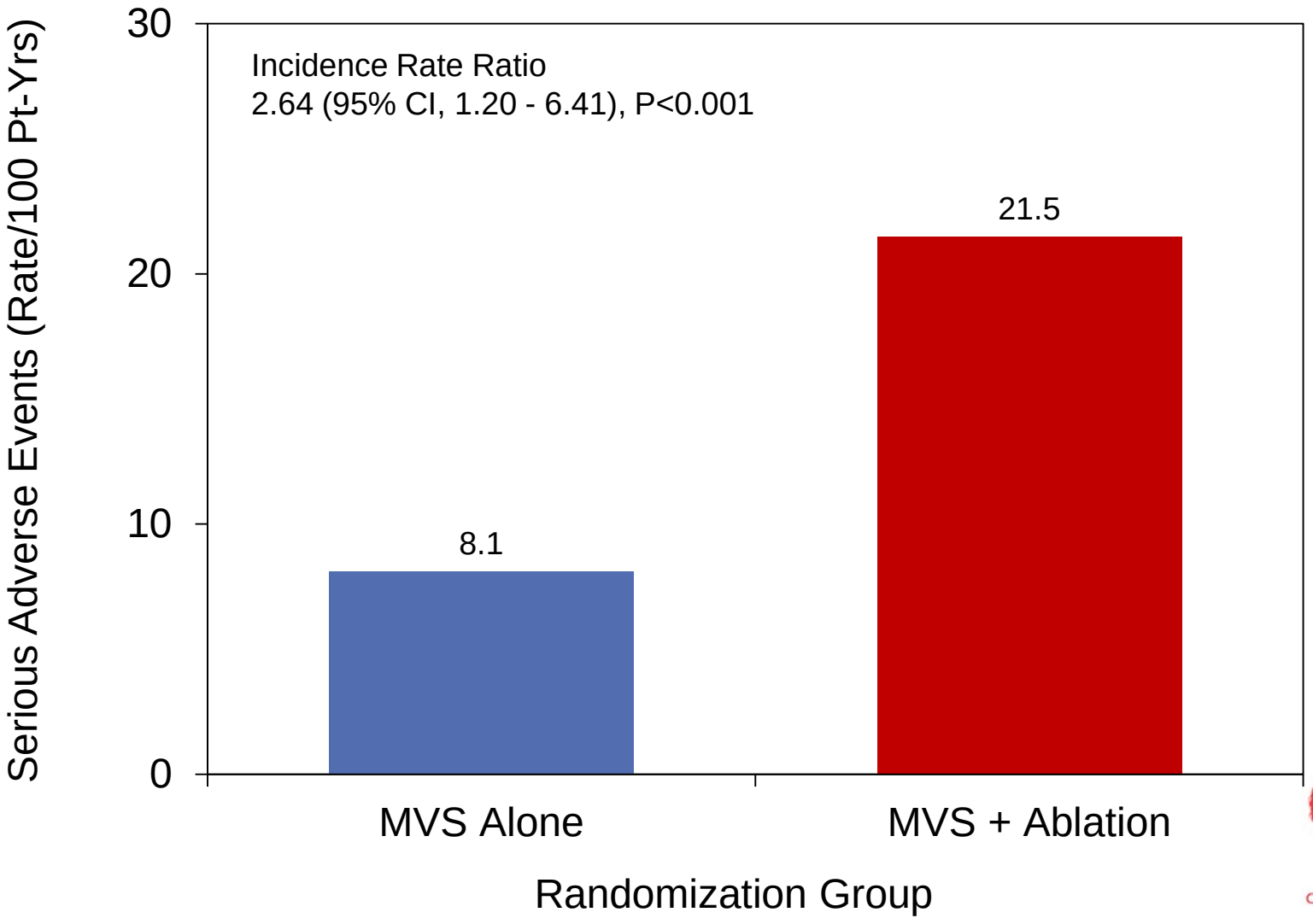
Pacemaker Implantation



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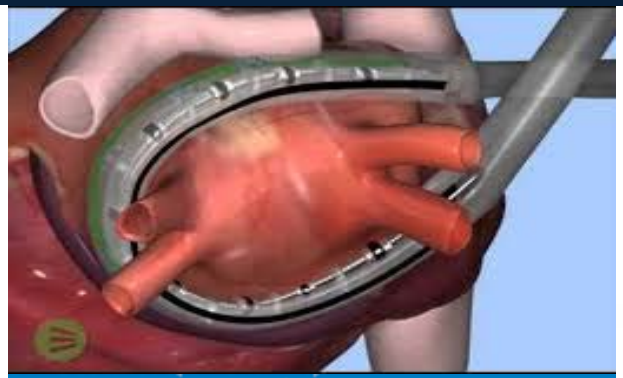
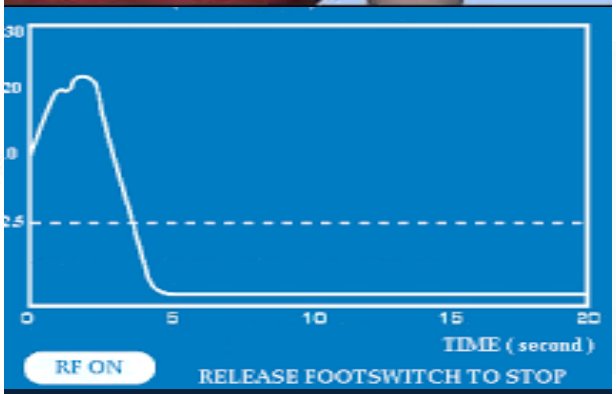
What Energy Source ?

RF vs Cryo





The NEW ENGLAND JOURNAL of MEDICINE

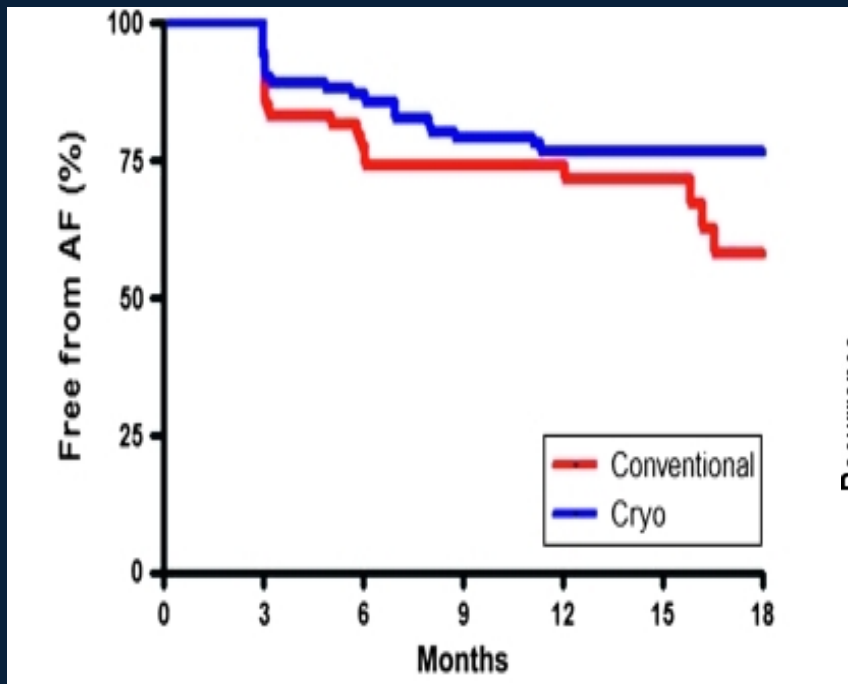
ORIGINAL ARTICLE

Surgical Ablation of Atrial Fibrillation during Mitral-Valve Surgery

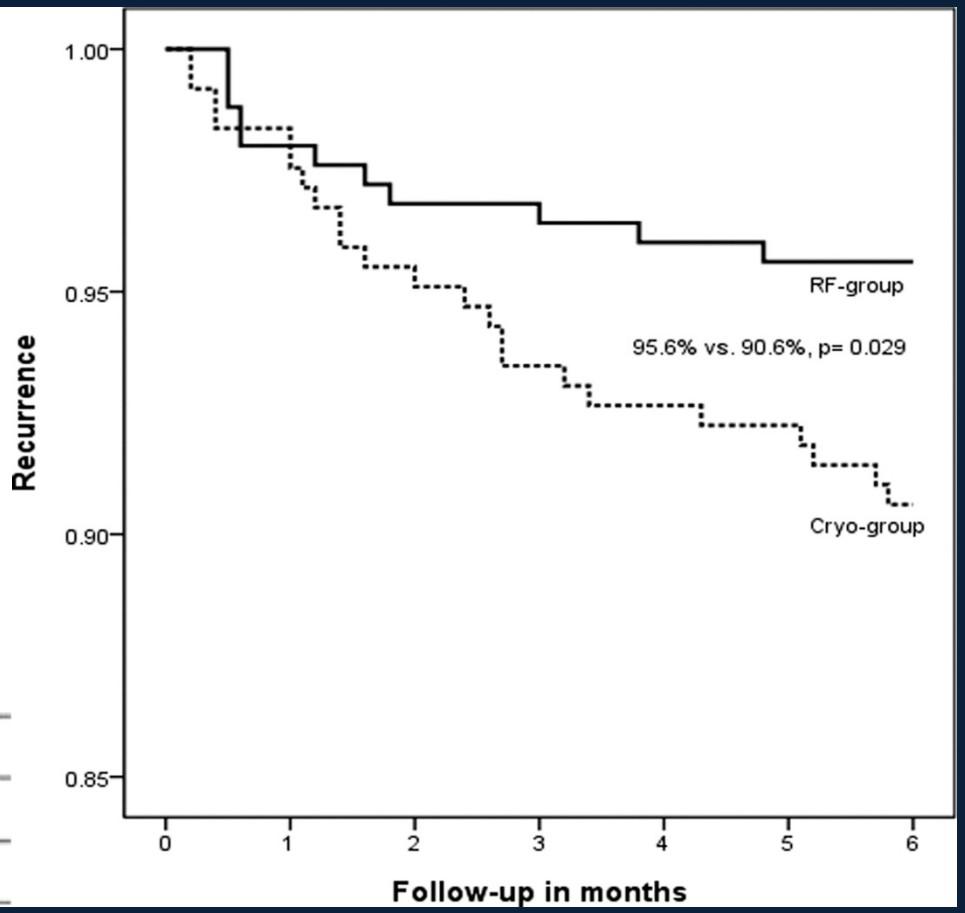
A. Marc Gillinov, M.D., Annetine C. Gelijns, Ph.D., Michael K. Parides, Ph.D., Joseph J. DeRose, Jr., M.D., Alan J. Moskowitz, M.D., Pierre Voisine, M.D., Gorav Ailawadi, M.D., Denis Bouchard, M.D., Peter K. Smith, M.D., Michael J. Mack, M.D., Michael A. Acker, M.D., John C. Mullen, M.D., Eric A. Rose, M.D., Helena L. Chang, M.S., John D. Puskas, M.D., Jean-Philippe Couderc, Ph.D., Timothy J. Gardner, M.D., Robin Varghese, M.D., Keith A. Horvath, M.D., Steven F. Bolling, M.D., Robert E. Michler, M.D., Nancy L. Geller, Ph.D., Deborah D. Ascheim, M.D., Marissa A. Miller, D.V.M., Emilia Bagiella, Ph.D., Ellen G. Moquete, R.N., Paula Williams, M.S., Wendy C. Taddei-Peters, Ph.D., Patrick T. O'Gara, M.D., Eugene H. Blackstone, M.D., and Michael Argenziano, M.D., for the CTSN Investigators*

TR surgery	26 (38.8)	24 (36.4)
AVR	8 (11.9)	6 (9.1)
CABG[+]	8 (11.9)	19 (28.8)
Other	10 (14.9)	6 (9.1)
Cardiopulmonary Bypass Time (minutes)	143.3 ±65.9	152.4 ±60.8
Cross-clamp Time (minutes)	98.4 ±38.7	107.4 ±44.0
Ablation Device[€]		
Unipolar RF	18 (26.9%)	26 (40.0%)
Bipolar RF	29 (43.3%)	24 (36.9%)
Cryoablation	25 (37.3%)	41 (63.1%)

Catheter ablation - RF vs Cryo



Months after ablation	0	6	12	18
Cryoablation	90	79	69	26
Radiofrequency Ablation	53	42	33	12



University of Michigan Health System

STS Adult Cardiac Surgery Database
July 1, 2011 – June 30, 2014

89,668 Patients isolated MVRR

Included: Patients with associated CABG, ASD closure, and tricuspid valve repair (TVr).
Excluded: Previous MitraClip procedures, missing gender or age information, and/or right atrial SA only

88,765 Patients

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Results

Effects of AF Type, Energy Source, and Lesion Set

In-Hospital Outcomes	Variable	Risk Adjusted OR [95% CI]	p-value
Operative Mortality	Parox/Persist AF	1.02 [0.91-1.15]	0.7450
	Cryo vs. RF	0.71 [0.54-0.92]	0.0111
	RF+Cryo vs. RF	0.81 [0.60-1.09]	0.1584
	C&S vs. RF	0.81 [0.55-1.19]	0.2844
	LA vs. BA	0.85 [0.71-1.02]	0.0775
Composite Major Morbidity	Parox/Persist AF	0.98 [0.92-1.04]	0.3913
	Cryo vs. RF	1.06 [0.94-1.20]	0.3492
	RF+Cryo vs. RF	1.02 [0.87-1.20]	0.8168
	C&S vs. RF	0.83 [0.66-1.05]	0.1220
	LA vs. BA	0.92 [0.83-1.03]	0.1474

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Surgical Ablation Procedures Performed by Operation Type

Variable	MVRR ±CABG (N=21,992)	AVR± CABG (N=9,875)	AVR +MVRR (N=2,304)	Isolated CABG (N=14,334)	Other Concomitant (N=10,252)	Stand Alone (N=3,268)	p-value
LA only location	50.9	57.9	52.1	58.0	50.5	37.2	
Bi-atrial location	40.0	30.7	37.9	29.3	38.1	56.3	<0.0001
Atrial Location Not Documented	9.1	11.4	10.0	12.7	11.4	6.5	
Primarily Endocardial	52.4	26.6	49.3	22.0	39.9	23.6	
Primarily Epicardial	31.2	56.3	35.6	55.8	43.4	72.5	<0.0001
Ablation Location Not Documented	16.4	17.1	15.1	22.2	16.7	3.9	
RF only	27.0	43.1	28.8	42.5	34.0	67.8	
Cryo only	23.8	8.9	19.5	7.4	15.1	9.2	
CAS only	7.6	8.6	9.0	10.2	9.5	0.8	<0.0001
RF+Cryo	11.8	[illegible]	11.8	[illegible]	[illegible]	11.0	
LAA obliterated	87.7	88.5	86.3	88.6	85.9	63.9	<0.0001

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Surgical AF Ablation

Do something!

Lesions: Bi-atrial - larger LA,
longer and persistent AF
LA box > PVI - parox AF

Energy : Cryo inside - MVr
RF outside - AVR/ CABG

Take the LAA!

University of Michigan Health System