

# Atriyal Fibrilasyon Ablasyonu İçin Diğer Yöntemler

## Rotor Temelli Ablasyon

Dr. İlyas ATAR

The once popular *X-Files*, vignettes about a fictional FBI team's exploration of paranormal events, was in essence a program about the varying ways we react to novel and unexpected phenomena. Fox Mulder, the lead agent, driven to find explanations to their observations, was quick to embrace theories that threatened plausibility and current scientific dogma, often favoring iconoclastic solutions. In essence, he embodied many of the attributes of an "early adopter" in our world of electrophysiology. His partner, Dana Scully, was ever the scientist, maintaining a healthy skepticism that bordered on an unhealthy reluctance to tread far from accepted principles.

Electrophysiologists tend to share varying aspects of Mulder and Scully's approaches. We work in a subspecialty of medicine that most physicians neither understand nor wish to, often viewing our work as "voodoo." We tend to be driven by data and mechanistic approaches to therapy; yet, as a field, many of our advances have come from relatively iconoclas-

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nization therapy (CRT) is but one example. Many  
researchers outside of electrophysiology dismissed the novel

ter setting, analyzing other 4-second segments often proves useful.

Thus far, the most comprehensive data set employing

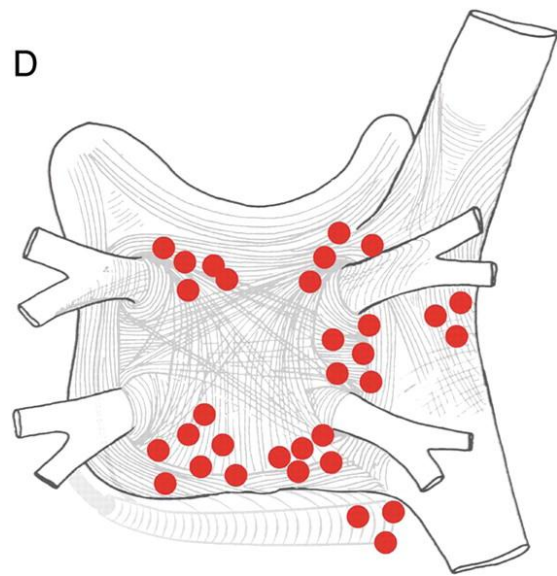
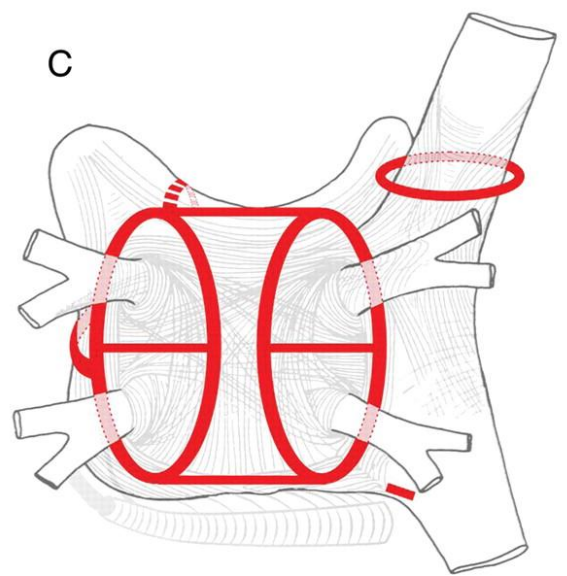
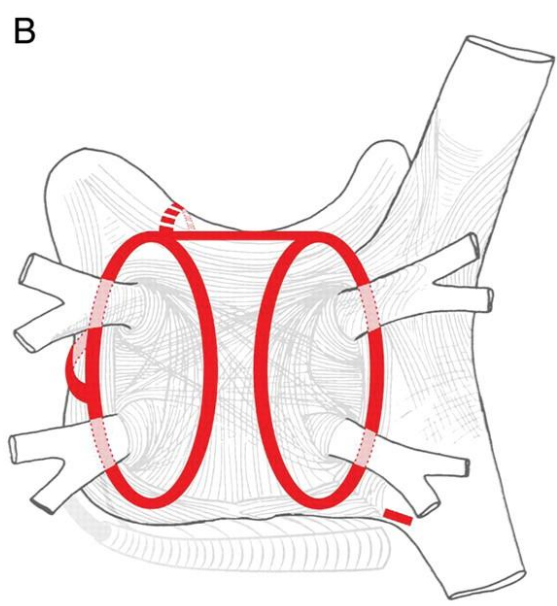
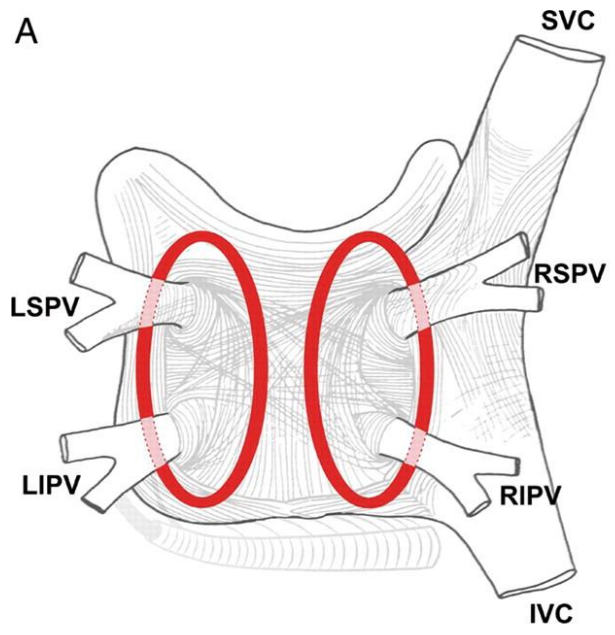
# AF tedavisi

- Ventrikül hızını kontrol etmek için ilaç tedavileri
- Kardiyoversiyon
- AV nod ablasyonu + PM
- Cox- Maze operasyonu
- Ablasyon
  - Pulmoner ven içi ektopik odak ablasyonu
  - Pulmoner ven izolasyonu
  - Çevresel pulmoner ven ablasyonu
  - Çevresel pulmoner ven ablasyonu + lineer ablasyon hatları
  - Basamaklı ablasyon yaklaşımı
  - Farklı enerjilerin ablasyonda kullanımı

# **2012 HRS/EHRA/ECAS Expert Consensus Statement on Catheter and Surgical Ablation of Atrial Fibrillation: Recommendations for Patient Selection, Procedural Techniques, Patient Management and Follow-up, Definitions, Endpoints, and Research Trial Design**

*A report of the Heart Rhythm Society (HRS) Task Force on Catheter and Surgical Ablation of Atrial Fibrillation. Developed in partnership with the European Heart Rhythm Association (EHRA), a registered branch of the European Society of Cardiology (ESC) and the European Cardiac Arrhythmia Society (ECAS); and in collaboration with the American College of Cardiology (ACC), American Heart Association (AHA), the Asia Pacific Heart Rhythm Society (APHRS), and the Society of Thoracic Surgeons (STS). Endorsed by the governing bodies of the American College of Cardiology Foundation, the American Heart Association, the European Cardiac Arrhythmia Society, the European Heart Rhythm Association, the Society of Thoracic Surgeons, the Asia Pacific Heart Rhythm Society, and the Heart Rhythm Society*

Hugh Calkins, MD, FACC, FHRS, FAHA; Karl Heinz Kuck, MD, FESC; Riccardo Cappato, MD, FESC; Josep Brugada, MD, FESC; A. John Camm, MD, PhD; Shih-Ann Chen, MD, FHRS<sup>§</sup>; Harry J.G. Crijns, MD, PhD, FESC; Ralph J. Damiano, Jr., MD<sup>^</sup>; D. Wyn Davies, MD, FHRS; John DiMarco, MD, PhD, FACC, FHRS; James Edgerton, MD, FACC, FACS, FACCP<sup>^</sup>; Kenneth Ellenbogen, MD, FHRS; Michael D. Ezekowitz, MD; David E. Haines, MD, FHRS; Michel Haissaguerre, MD; Gerhard Hindricks, MD; Yoshito Iesaka, MD<sup>§</sup>; Warren Jackman, MD, FHRS; Jose Jalife, MD, FHRS; Pierre Jais, MD; Jonathan Kalman, MD<sup>§</sup>; David Keane, MD; Young-Hoon Kim, MD, PhD<sup>§</sup>; Paulus Kirchhof, MD; George Klein, MD; Hans Kottkamp, MD; Koichiro Kumagai, MD, PhD<sup>§</sup>; Bruce D. Lindsay, MD, FHRS<sup>∞</sup>; Moussa Mansour, MD;



- AF ablasyonu: Antiaritmik ilaç olmaksızın başarı oranları
  - Tek işlem %40-60
  - Çoklu işlem %70
- WPW ablasyonu başarı oranı % 90-95
- AVNRT ablasyonu başarı oranı %95-99

- AF ablasyon başarı oranı neden daha yüksek değil?
  - Pulmoner venlerin izole edilememiş olması
  - Pulmoner ven rekonneksiyonu fazla
  - Pulmoner ven dışı tetikleyicilerin varlığı
  - **Mekanizma – Ablasyon hedef ilişkisindeki kısıtılılıklar**



# Atrialyir Firbilasyon: Mekanizma

- Tetikleyici
- Substrat
- AF'nin devamını saęlayan mekanizma
  - Çoklu dalga veya gezen dalga teorisi
  - Rotor veya fokal uyarı üretimi ve bunun AF'ye disorganize olması
- Otonom sinir sistemi

Jalife J. et al. J Cardiovasc Electrophysiol 1998;9:S2–12.

Vaquero M, et al. Heart Rhythm 2008;5:872– 879.

Narayan SM, et al. J Am Coll Cardiol. 2012;60(7):628-636

Mandapati R, et al. Circulation 2000;101:194 –9.

Allessie MA, et al. Cardiac Arrhythmias. New York, NY: Grune & Stratton, 1985:265–76.

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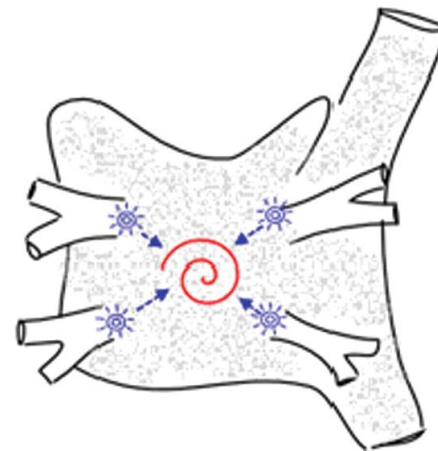
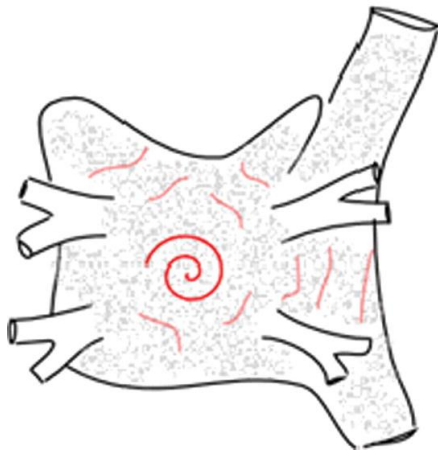
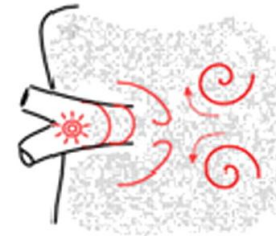
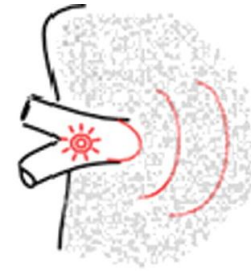
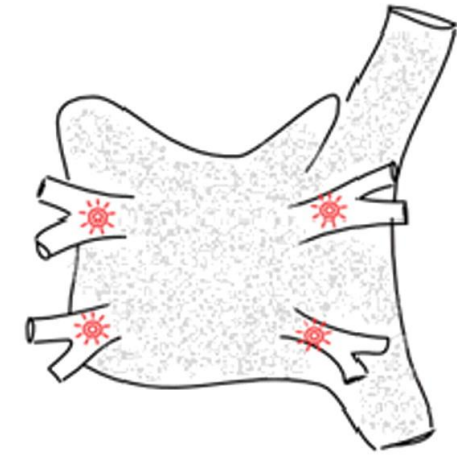


- Diğer ablasyon yöntemleri
  - CFAEs ablasyonu
  - Otonomik ganglion ablasyonu
  - Rotor temelli ablasyon

# Rotor tanımı

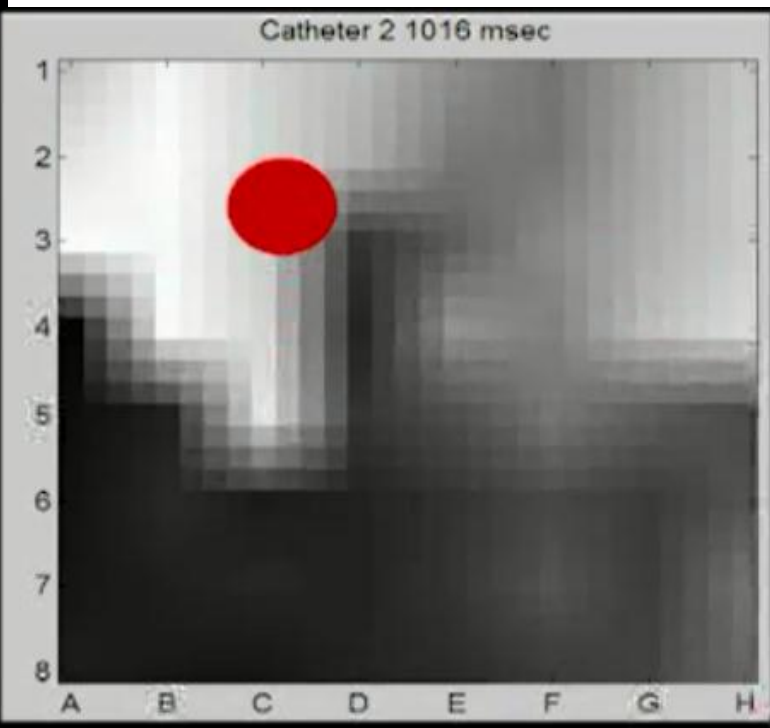
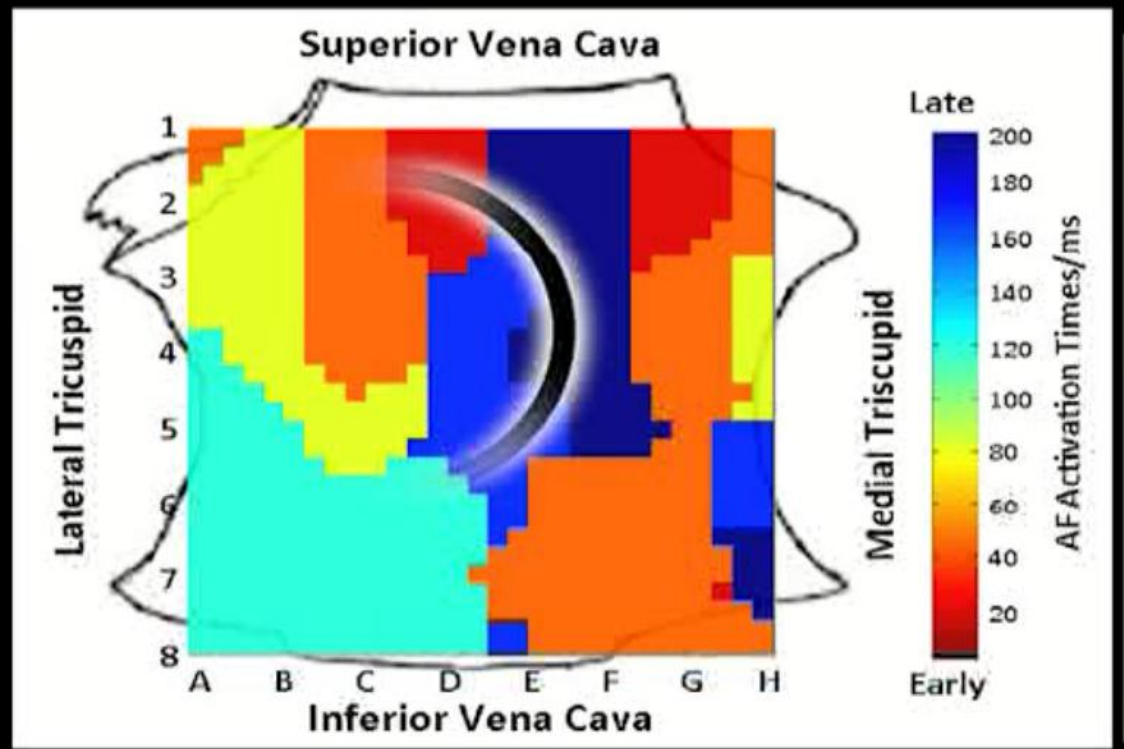
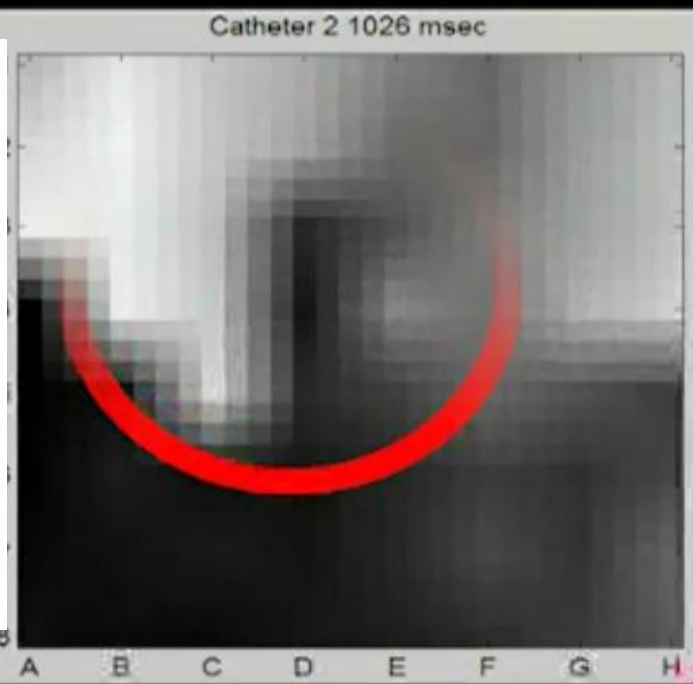
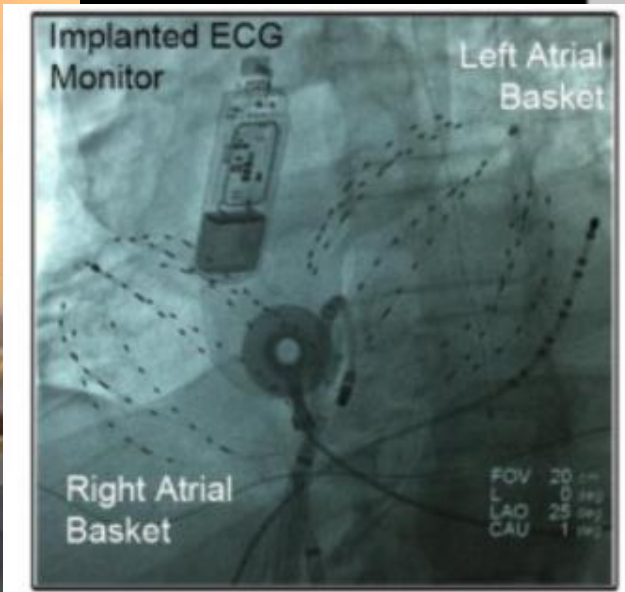
- Atriyal fibrilasyonun devamını sađlayan yüksek frekanslı sürekli reentri kaynađı
- Küçük gridap benzeri reentri halkası

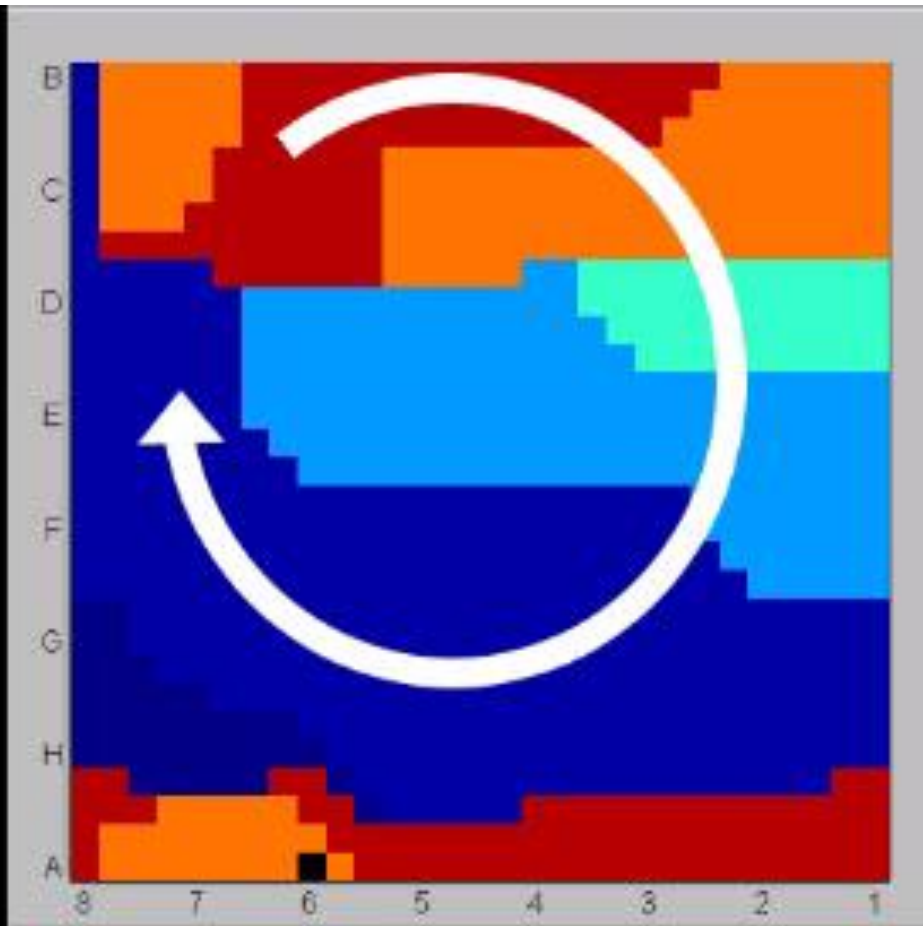
# Fokal tetikleyici tarafından Rotorun başlatılması

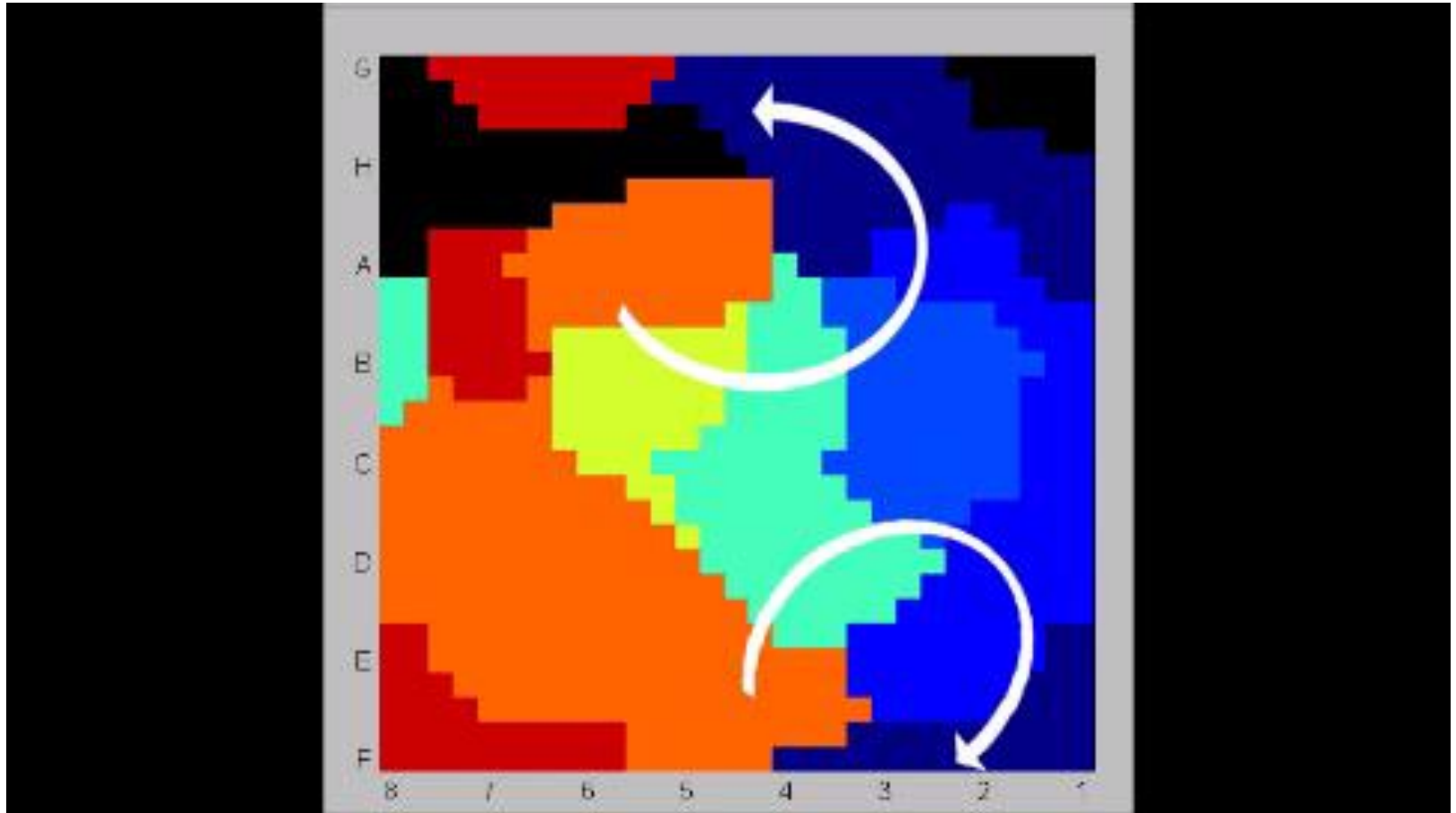


# FIRM: Focal impulse and rotor modulation

- Her ik atriyumdan eş zamanlı bakset kateter aracılığıyla AF sırasında temasa dayalı elektrogram kayıtları alınması
- 64 pollü basket kateter kullanılıyor
- Bir software aracılığıyla sinyal ileti hızı ve repolarizasyon parametreleri değerlendiriliyor
- Kaynak saptanıp ablasyona geçiliyor









# Klinik alıřmalar

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# Treatment of Atrial Fibrillation by the Ablation of Localized Sources

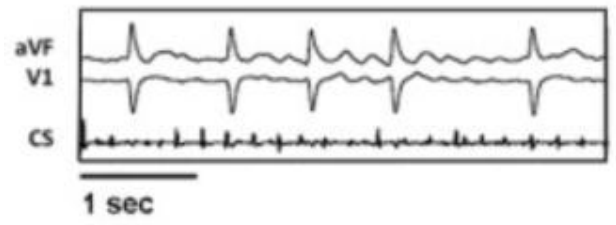
## CONFIRM (Conventional Ablation for Atrial Fibrillation With or Without Focal Impulse and Rotor Modulation) Trial

Sanjiv M. Narayan, MD, PhD,\*† David E. Krummen, MD,\*† Kalyanam Shivkumar, MD, PhD,‡  
Paul Clopton, MS,† Wouter-Jan Rappel, PhD,§ John M. Miller, MD||  
*San Diego and Los Angeles, California; and Indianapolis, Indiana*

<b>Objectives</b>	We hypothesized that human atrial fibrillation (AF) may be sustained by localized sources (electrical rotors and focal impulses), whose elimination (focal impulse and rotor modulation [FIRM]) may improve outcome from AF ablation.
<b>Background</b>	Catheter ablation for AF is a promising therapy, whose success is limited in part by uncertainty in the mechanisms that sustain AF. We developed a computational approach to map whether AF is sustained by several meandering waves (the prevailing hypothesis) or localized sources, then prospectively tested whether targeting patient-specific mechanisms revealed by mapping would improve AF ablation outcome.
<b>Methods</b>	We recruited 92 subjects during 107 consecutive ablation procedures for paroxysmal or persistent (72%) AF. Cases were prospectively treated, in a 2-arm 1:2 design, by ablation at sources (FIRM-guided) followed by conventional ablation (n = 36), or conventional ablation alone (n = 71; FIRM-blinded).
<b>Results</b>	Localized rotors or focal impulses were detected in 98 (97%) of 101 cases with sustained AF, each exhibiting $2.1 \pm 1.0$ sources. The acute endpoint (AF termination or consistent slowing) was achieved in 86% of FIRM-guided cases versus 20% of FIRM-blinded cases (p < 0.001). FIRM ablation alone at the primary source terminated AF in a median 2.5 min (interquartile range: 1.0 to 3.1 min). Total ablation time did not differ between groups ( $57.8 \pm 22.8$ min vs. $52.1 \pm 17.8$ min, p = 0.16). During a median 273 days (interquartile range: 132 to 681 days) after a single procedure, FIRM-guided cases had higher freedom from AF (82.4% vs. 44.9%; p < 0.001) after a single procedure than FIRM-blinded cases with rigorous, often implanted, electrocardiography monitoring. Adverse events did not differ between groups.
<b>Conclusions</b>	Localized electrical rotors and focal impulse sources are prevalent sustaining mechanisms for human AF. FIRM ablation at patient-specific sources acutely terminated or slowed AF, and improved outcome. These results offer a novel mechanistic framework and treatment paradigm for AF. (Conventional Ablation for Atrial Fibrillation With or Without Focal Impulse and Rotor Modulation [CONFIRM]; NCT01008722) (J Am Coll Cardiol 2012;60:628-36) © 2012 by the American College of Cardiology Foundation

- 107 hasta, 1:2 dizayn
  - Focal impulse and rotor modulation [FIRM] ablasyonu + konvansiyonel ablasyon: 36 hasta (%81 persistent AF)
  - Sadece konvansiyonel ablasyon (PVI + persistentlarda roof line): 71 hasta (%66 persistent AF)
- FIRM ablasyonu akut başarı kriteri
  - AF'nin sonlanması
  - AF siklus uzunluğunun >%10 uzaması

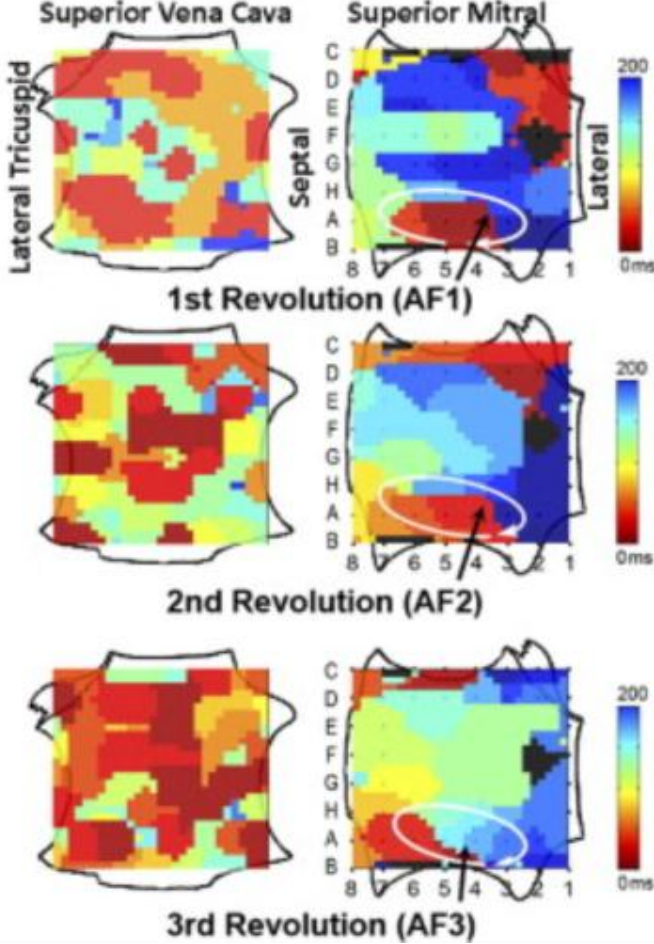
**A** ECG and Intracardiac Signals of AF



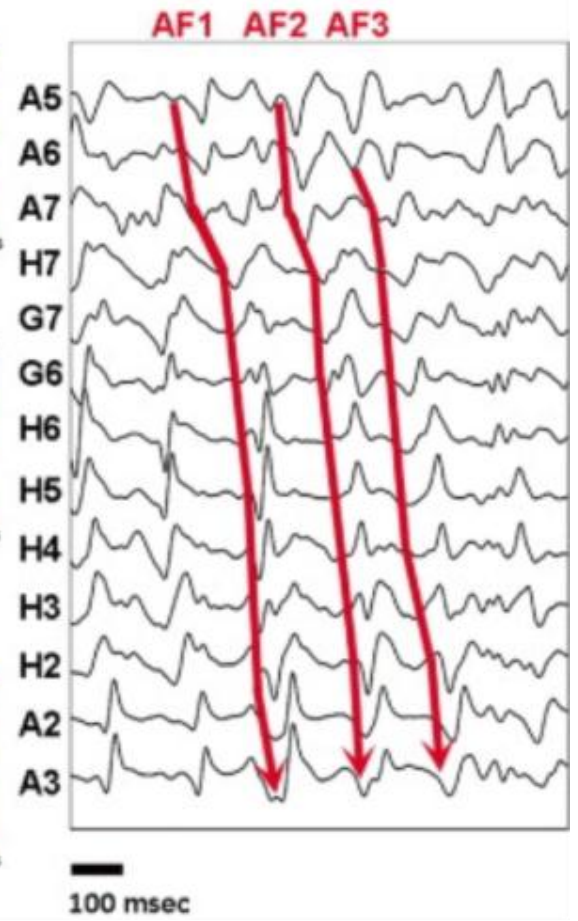
**B** Basket Catheters in Both Atria



**C** AF Rotor in Low Left Atrium

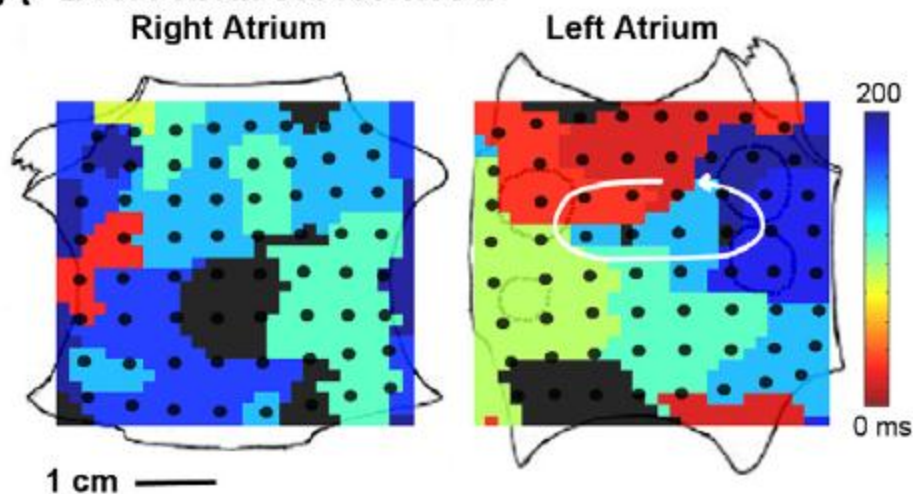


**D** Processed Intracardiac Signals Activation Along Rotor Path

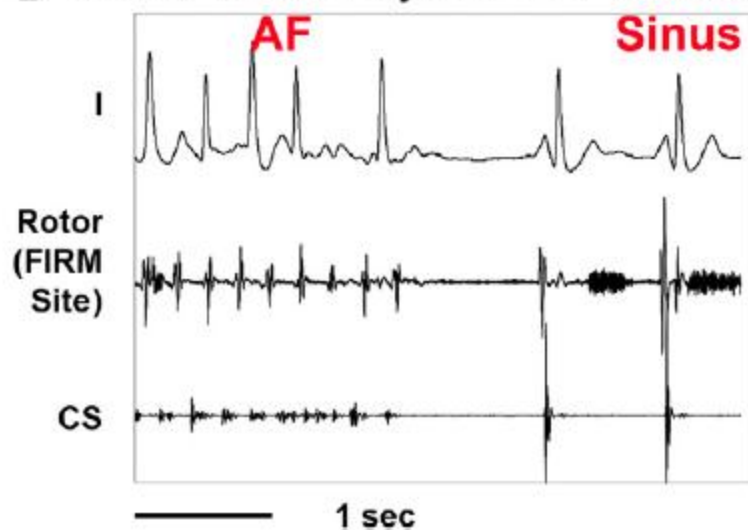




### A Left Atrial Rotor in AF

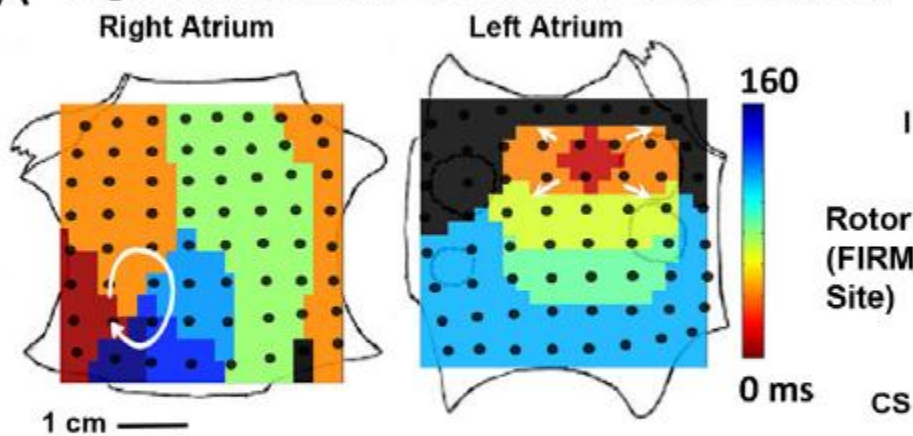


### B FIRM: Sinus Rhythm in < 1minute

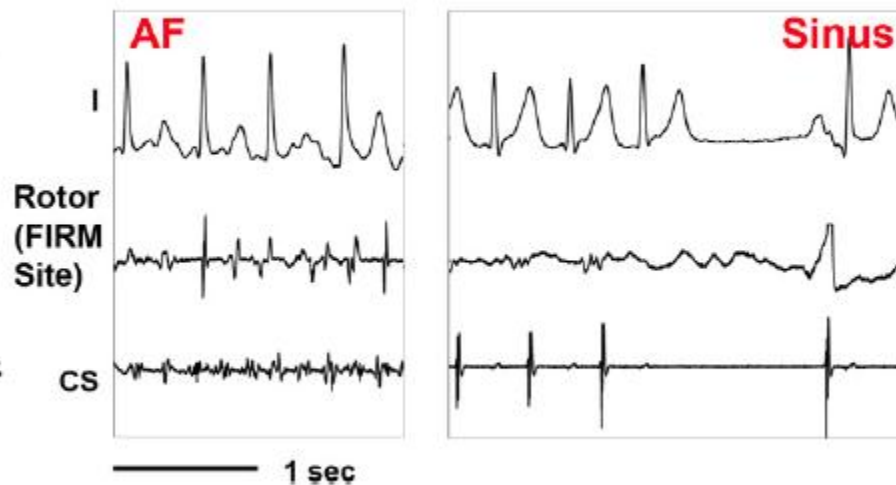


**Figure 2** Acute Termination of AF to Sinus Rhythm By FIRM Ablation

### A Right Atrial Rotor, Left Atrial Focal Beat in AF



### B FIRM: Sinus Rhythm in 5.5 minutes



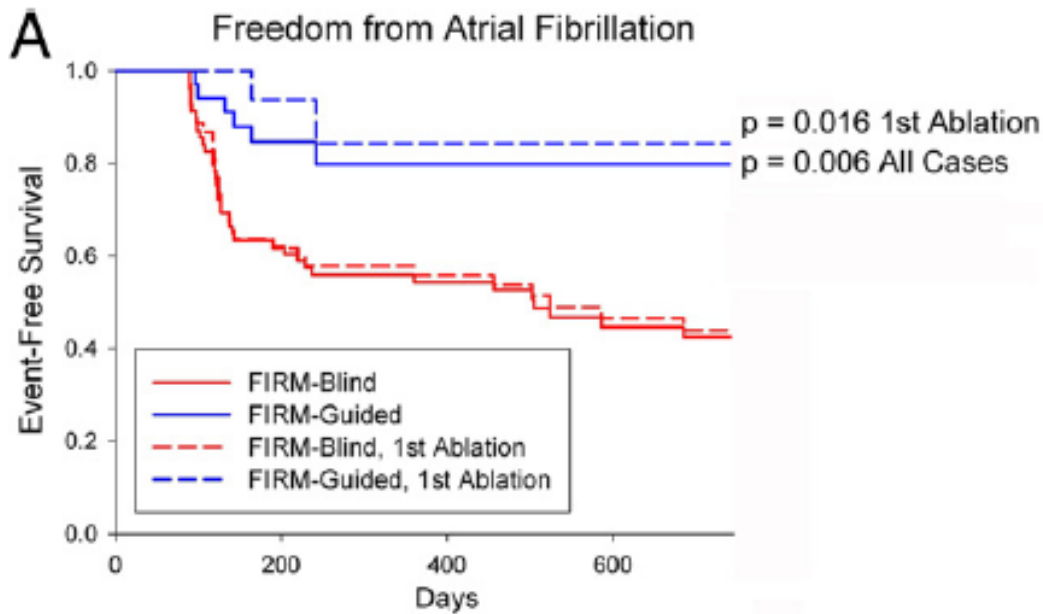
**Figure 3** Acute Termination of AF, 2 Sources, to Sinus Rhythm by FIRM Ablation

- FIRM ablasyon grubunda kaynak
  - $2.1 \pm 1.0$  kaynak/hasta
  - Rotor %70
  - Fokal odak %30
  - %20-30 hastada kaynak sağ atriyum
- Toplam ablasyon süresi
  - FIRM rehberliğinde ablasyon grubu:  $57.8 \pm 22.8$  dk min
  - Konvansiyonel ablasyon grubu:  $52.1 \pm 17.8$
  - p: 0.16

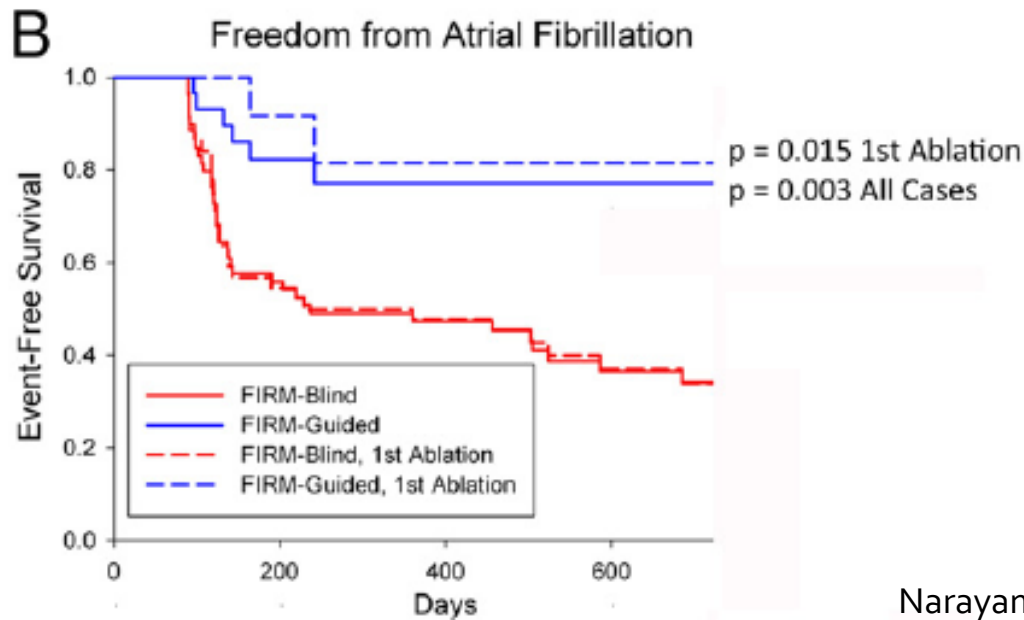
# FIRM ablasyonu akut başarısı

- FIRM rehberliğinde ablasyon grubu: % 87 başarı
  - AF'nin sonlanması: %56,
    - NSR sağlanması %44
    - Atriyal taşikardiye dönüşüm: %11
    - RF süresi:  $4.3 \pm 6.3$  dk
  - AF siklus uzunluğunun  $>10\%$  uzaması: %31
  - Toplam FIRM ablasyon süresi 16.1 dk
- Konvansiyonel ablasyon grubu: % 20 başarı
  - AF'nin sonlanması: % 9
  - AF siklus uzunluğunun  $>10\%$  uzaması: %11





Hastaların tamamı :  
AA+ ve AA-



Sadece AA-hastalar



## Direct Or Coincidental Elimination of Stable Rotors or Focal Sources May Explain Successful Atrial Fibrillation Ablation: On-Treatment Analysis of the CONFIRM (CONventional ablation for AF with or without Focal Impulse and Rotor Modulation) Trial

Sanjiv M. Narayan, MD, PhD, FACC<sup>1, 2, 3</sup>,  , David E. Krummen, MD, FACC<sup>1, 2</sup>, Paul Clopton, MS<sup>2</sup>, Kalyanam Shivkumar, MD, PhD, FACC<sup>3</sup>, John M. Miller, MD, FACC<sup>4</sup>

<sup>1</sup> Department of Medicine, University of California, San Diego

<sup>2</sup> Veterans Affairs Medical Center, San Diego

<sup>3</sup> University of California, Los Angeles

<sup>4</sup> The Krannert Institute of Cardiology, Indiana University, Indianapolis, IN

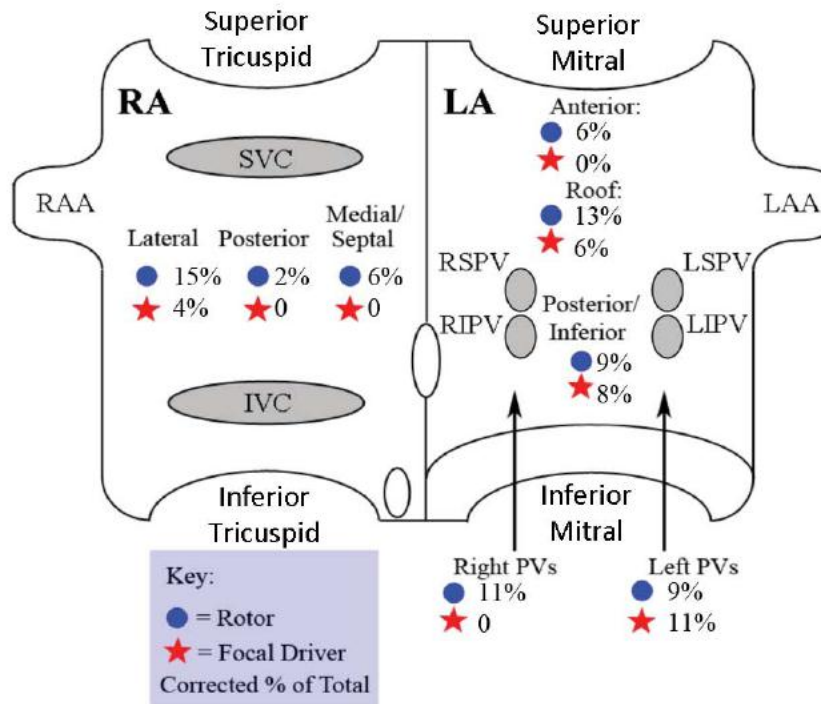
<http://dx.doi.org/10.1016/j.jacc.2013.03.021>, How to Cite or Link Using DOI

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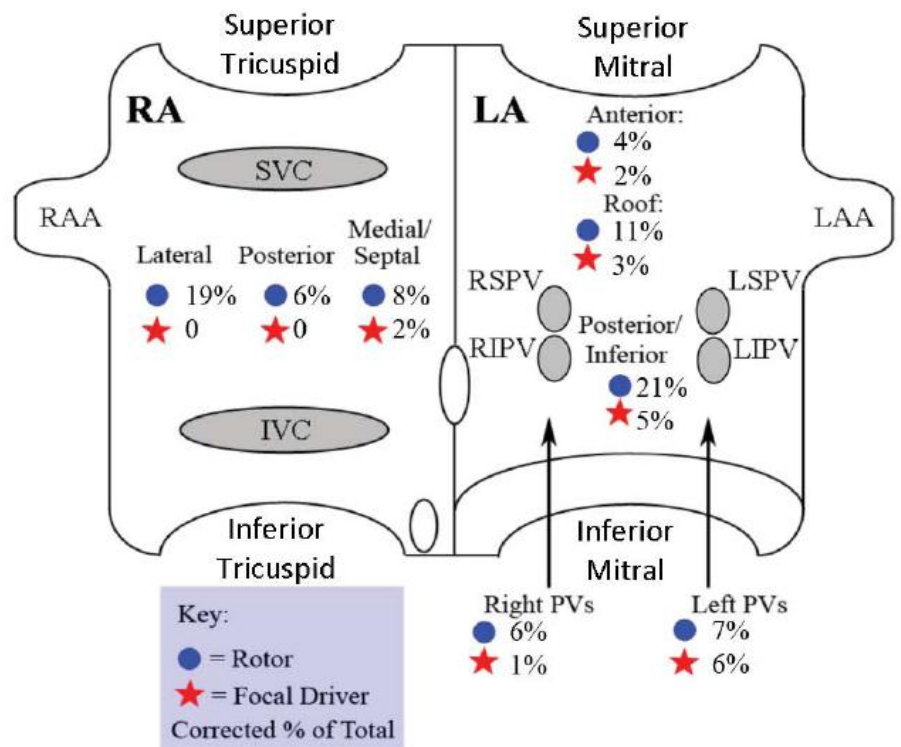
- 94 hasta on-treatment analiz
- Tüm kaynakların ablate edildiği grup:
  - 61 hasta
- Kaynak ablasyonu olmayan grup:
  - 33 hasta

# CONFIRM çalışması

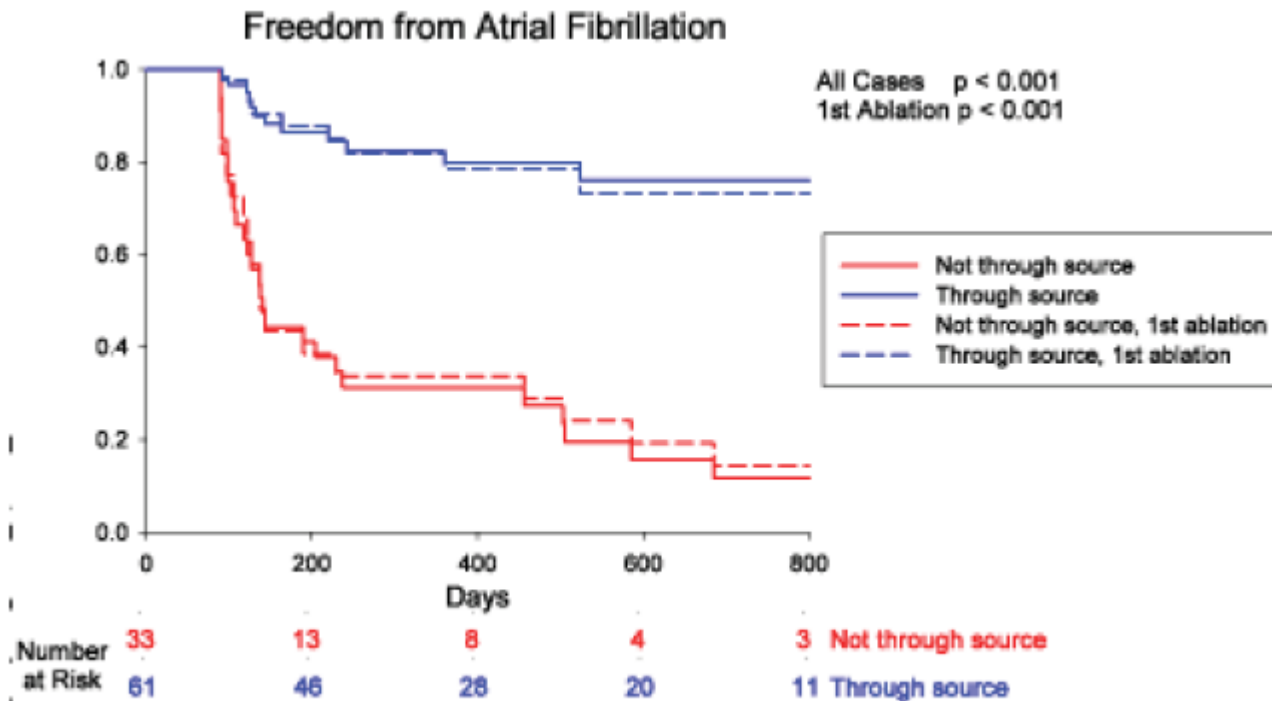
A. AF Source Locations - CONFIRM Paroxysmal AF



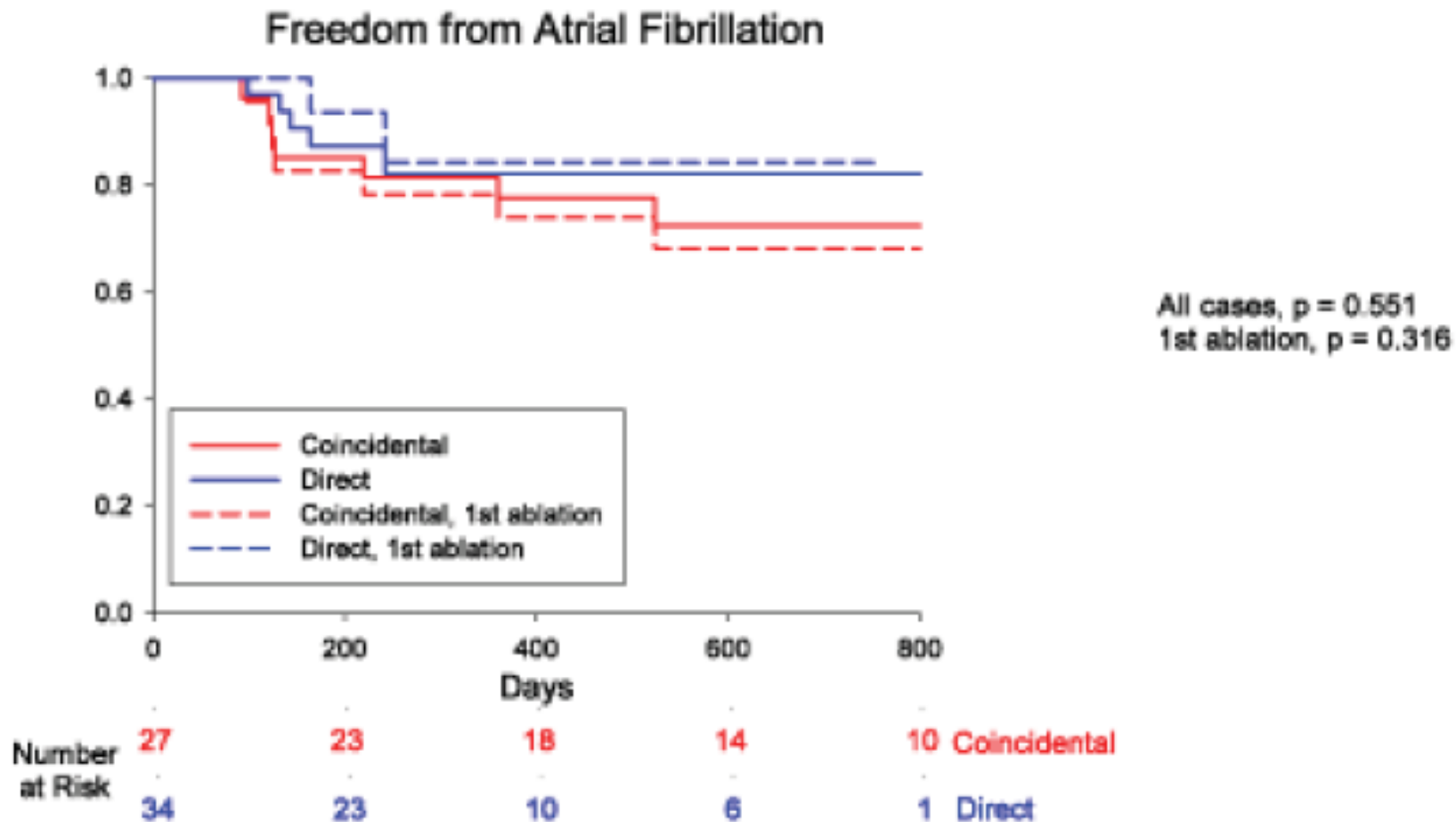
B. AF Source Locations - CONFIRM Persistent AF



# Kaynak ablate edilen ve edilmeyen hastalar

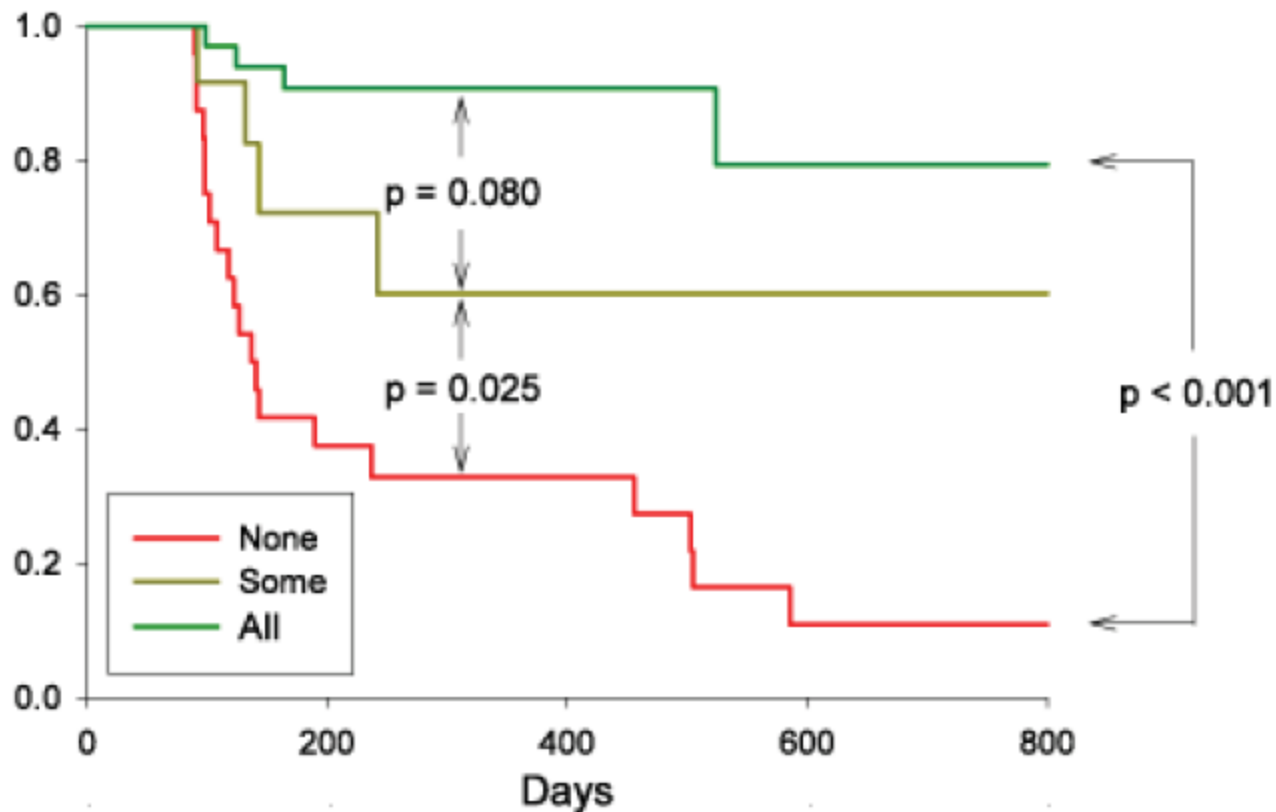


# Kaynağın tesadüfi veya isteyerek abalte edilmesi farkı



# Kaynak ablasyon miktarı önemi

Freedom from Atrial Fibrillation



	0	200	400	600	800	
Number at Risk	24	9	6	2	2	None
	12	6	4	3	2	Some
	33	26	12	7	1	All



# Acute Termination of Human Atrial Fibrillation by Identification and Catheter Ablation of Localized Rotors and Sources: First Multicenter Experience of Focal Impulse and Rotor Modulation (FIRM) Ablation

KALYANAM SHIVKUMAR, M.D., PH.D.,\* KENNETH A. ELLENBOGEN, M.D.,† JOHN D.  
HUMMEL, M.D.,‡ JOHN M. MILLER, M.D.,§ and JONATHAN S. STEINBERG, M.D.¶

From the \*UCLA Cardiac Arrhythmia Center, Los Angeles, California, USA; †Medical College of Virginia, Richmond, Virginia, USA; Ohio State University, Columbus, Ohio, USA; §Indiana University, Indianapolis, Indiana, USA; and ¶Valley Health System/Columbia University College of Physicians & Surgeons, New York, New York, USA

**FIRM Ablation of Human AF Rotors.** *Introduction:* Catheter ablation of atrial fibrillation (AF) currently relies on eliminating triggers, and no reliable method exists to map the arrhythmia itself to identify ablation targets. The aim of this multicenter study was to define the use of Focal Impulse and Rotor Modulation (FIRM) for identifying ablation targets.

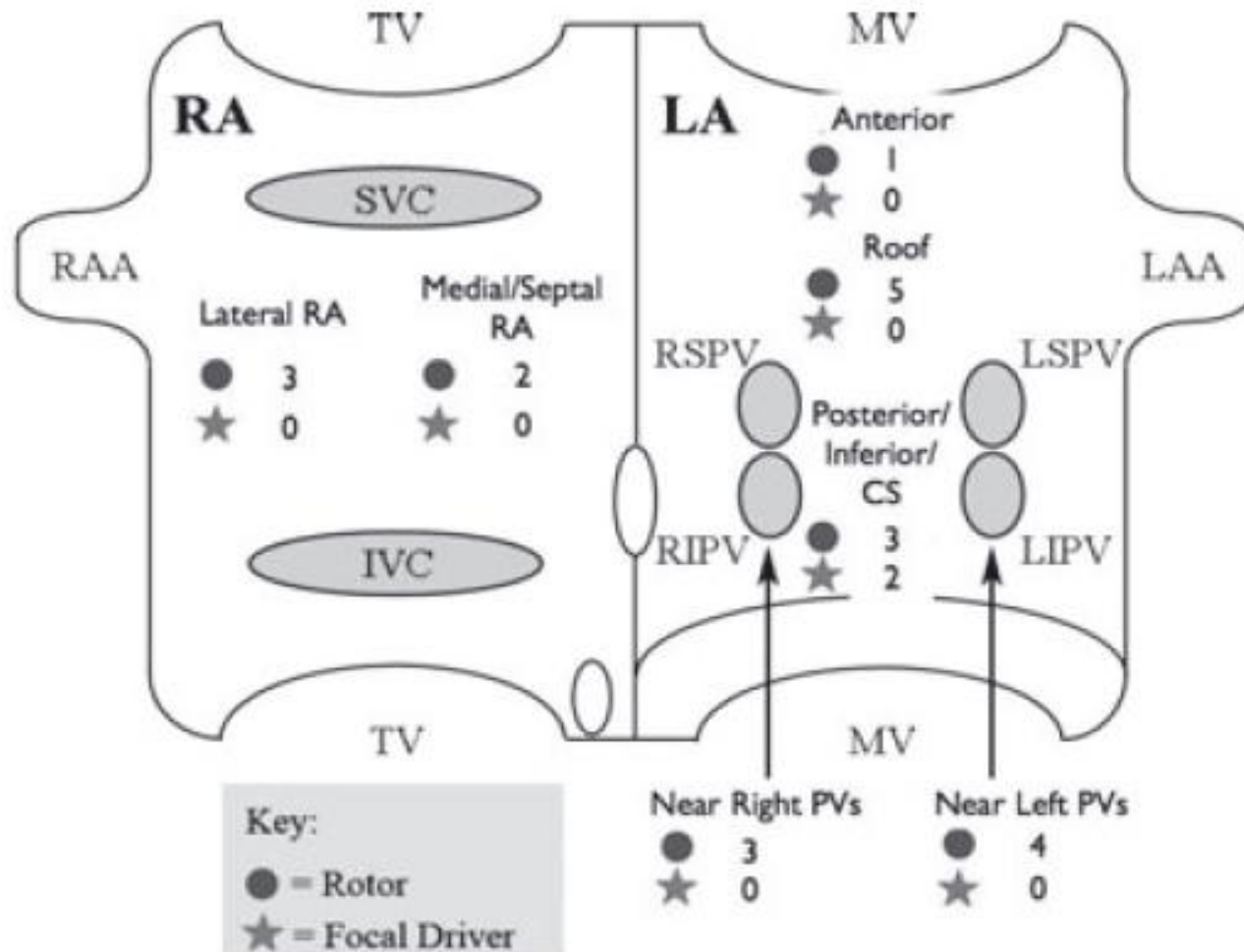
*Methods:* We prospectively enrolled the first (n = 14, 11 males) consecutive patients undergoing FIRM-guided ablation for persistent (n = 11) and paroxysmal AF at 5 centers. A 64-pole basket catheter was used for panoramic right and left atrial mapping during AF. AF electrograms were analyzed using a novel system to identify sustained rotors (spiral waves), or focal beats (centrifugal activation to surrounding atrium). Ablation was performed first at identified sources. The primary endpoints were acute AF termination or organization (>10% cycle length prolongation). Conventional ablation was performed only after FIRM-guided ablation.

*Results:* Twelve out of 14 cases were mapped. AF sources were demonstrated in all patients (average of  $1.9 \pm 0.8$  per patient). Sources were left atrial in 18 cases, and right atrial in 5 cases, and 21/23 were rotors. FIRM-guided ablation achieved the acute endpoint in all patients, consisting of AF termination in n = 8 ( $4.9 \pm 3.9$  minutes at the primary source), and organization in n = 4. Total FIRM time for all patients was  $12.3 \pm 8.6$  minutes.

*Conclusions:* FIRM-guided ablation revealed localized AF rotors/focal sources in patients with paroxysmal, persistent and longstanding persistent AF. Brief targeted FIRM-guided ablation at a priori identified sites terminated or substantially organized AF in all cases prior to any other ablation. (*J Cardiovasc Electrophysiol*, Vol. 23, pp. 1277-1285, December 2012)

- Çok merkezli çalışma, 5 merkez
- İlk 14 hasta alınmış, 12 hastaya FIRM yapılabilmış
  - Paroksizmal AF 3 hasta
  - Persistent AF 11 hasta
- FIRM rehberliğinde ablasyon + Konvansiyonel ablasyon (PVI + persistentlarda roof line)
- Primer son nokta
  - FIRM ablasyonu sonrası
    - AF'nin sonlanması
    - AF siklus uzunluğunun >%10 uzaması

- 14 hastada da AF kaynağı saptanmış
  - $1.9 \pm 0.8$  adet/hasta
  - Sol atriyum 18 adet
  - Sağ atriyum 5 adet
  - 21 rotor, 2 fokal odak
- FIRM ablasyon süresi:  $12.2 \pm 8.5$  kaynaklar/ hasta
- FIRM ablasyon başarısı %100
  - AF'nin sonlanması: 8 hasta
    - NSR sağlanması 7 hasta
    - Atriyal taşikardiye dönüşüm: 1 hasta
    - Ablasyon süresi  $4.9 \pm 3.9$  dk
  - AF siklus uzunluğunun >%10 uzaması: 4 hasta
  - Toplam FIRM ablasyon süresi  $12.25 \pm 8.59$  dk/hasta



# Sonuç

- Rotor ablasyonu, gelecekte AF mekanizması hakkındaki fikirlerimizde ve ablasyon stratejilerinde ciddi deęişiklikler getirecek gibi gözüküyor
- Rotor ablasyonu kısıtlılıkları
  - Software kısıtlılıkları
  - Basket kateteri kısıtlılıkları
  - Farklı hasta gruplarında test edilmemiş olması !!
  - Hangi hastaya uygulanmalı
  - Ablasyon hedefi/Başarı kriteri netleştirilmesi
  - Çok merkezli veri yetersizliği
  - Maliyet



## A FIRM Grip on Atrial Fibrillation\*

Karl-Heinz Kuck, MD, PHD, Erik Wissner, MD

*Hamburg, Germany*

In conclusion, the authors need to be congratulated on bringing to the electrophysiology community a truly novel approach to AF ablation. FIRM ablation bears enormous potential if other investigators can reproduce similar results. Electrophysiologists may at last be able to move from a “blind” substrate-based approach to a mechanistic ablation strategy targeting localized sources within the atria that perpetuate AF.



**Table 1** Characteristics of Clinical Cases

Characteristics	Conventional Ablation (n = 71)	FIRM-Guided Ablation (n = 36)	p Value
AF presentation			0.12
Paroxysmal	24 (34%)	7 (19%)	
Persistent	47 (66%)	29 (81%)	
Age, yrs	61 ± 8	63 ± 9	0.34
Male/female	68/3	34/2	1.00
Nonwhite race	9 (13%)	6 (17%)	0.57
History of AF, months	45 (18–79)	52 (38–110)	0.04
Left atrial diameter, mm	43 ± 6	48 ± 7	0.001
LVEF, %	55 ± 12	53 ± 15	0.59
CHADS <sub>2</sub> score			
0 or 1	38 (54%)	13 (36%)	0.09
2 or more	33 (46%)	23 (64%)	
NYHA functional class			0.47
0 to I	61 (86%)	29 (81%)	
II to III	10 (14%)	7 (19%)	
Comorbid conditions			
Hypertension	50 (70%)	31 (86%)	0.07
Diabetes mellitus	22 (31%)	12 (33%)	0.81
Prior stroke/TIA	12 (17%)	6 (17%)	0.95
Coronary disease	20 (28%)	18 (50%)	0.03
Hypercholesterolemia	48 (68%)	30 (86%)	0.05
Prior conventional ablation	18 (25%)	15 (42%)	0.08
Previously failed >1 antiarrhythmic drug	16 (23%)	16 (44%)	<0.05
Class I	16 (23%)	9 (25%)	0.78
Sotalol	30 (42%)	17 (47%)	0.63
Dofetilide	9 (13%)	8 (22%)	0.20
Amiodarone	27 (38%)	22 (61%)	0.02
Days since amiodarone discontinued	150 (60–365)	365 (69–730)	0.08
Concomitant drug therapy			
ACEI/ARB	45 (63%)	21 (58%)	0.61
Beta-adrenoceptor antagonists	48 (68%)	24 (67%)	0.92
Calcium-channel blockers	21 (30%)	11 (31%)	0.92
Statins	42 (59%)	19 (53%)	0.53

Values are n (%), mean ± SD, or median (interquartile range).

ACEI = angiotensin-converting enzyme inhibitor; AF = atrial fibrillation; ARB = angiotensin-receptor blocker; CHADS<sub>2</sub> = defined in Calkins et al. (3); FIRM = focal impulse and rotor modulation; LVEF = left ventricular ejection fraction; NYHA = New York Heart Association; TIA = transient ischemic attack.

**Table 2****Acute Results in All Cases or Those With Sustained AF During Their Procedure**

Characteristic	Conventional Ablation	FIRM-Guided Ablation	p Value
Cases with intraprocedural sustained AF	65/71 (92%)	36/36 (100%)	0.10
Subjects with AF sources	63/65 (97%)	35/36 (97%)	1.00
Acute endpoint achieved	13/65 (20%)	31/36 (86%)	<0.001
AF termination endpoint	6/65 (9%)	20/36 (56%)	<0.001
Ablation time, min, at primary source	—	2.5 (1.0–3.1)	
To sinus rhythm/atrial tachycardia	3/3	16/4	0.29
AF slowing (CL prolongation) endpoint	7/65 (11%)	11/36 (31%)	0.01
Extent of AF CL prolongation, ms	28 ± 8 (18 ± 6%)	33 ± 12 (19 ± 8%)	0.38
Ablation time for acute endpoint, min	31.8 (22.1–71.5)	18.5 (7.9–24.5)	<0.001
Total procedural ablation (all cases), min	52.1 ± 17.8	57.8 ± 22.8	0.16
Complications, all cases	6 (8%)	2 (6%)	0.72
Cardiac tamponade	2	1	
Groin bleed requiring transfusion	3	1	
Vascular injury requiring surgical repair	0	0	
Permanent diaphragmatic paralysis	0	0	
Symptomatic pulmonary vein stenosis	1*	0	
Stroke/TIA	0	0	
Atrioesophageal fistula	0	0	
Death	0	0	

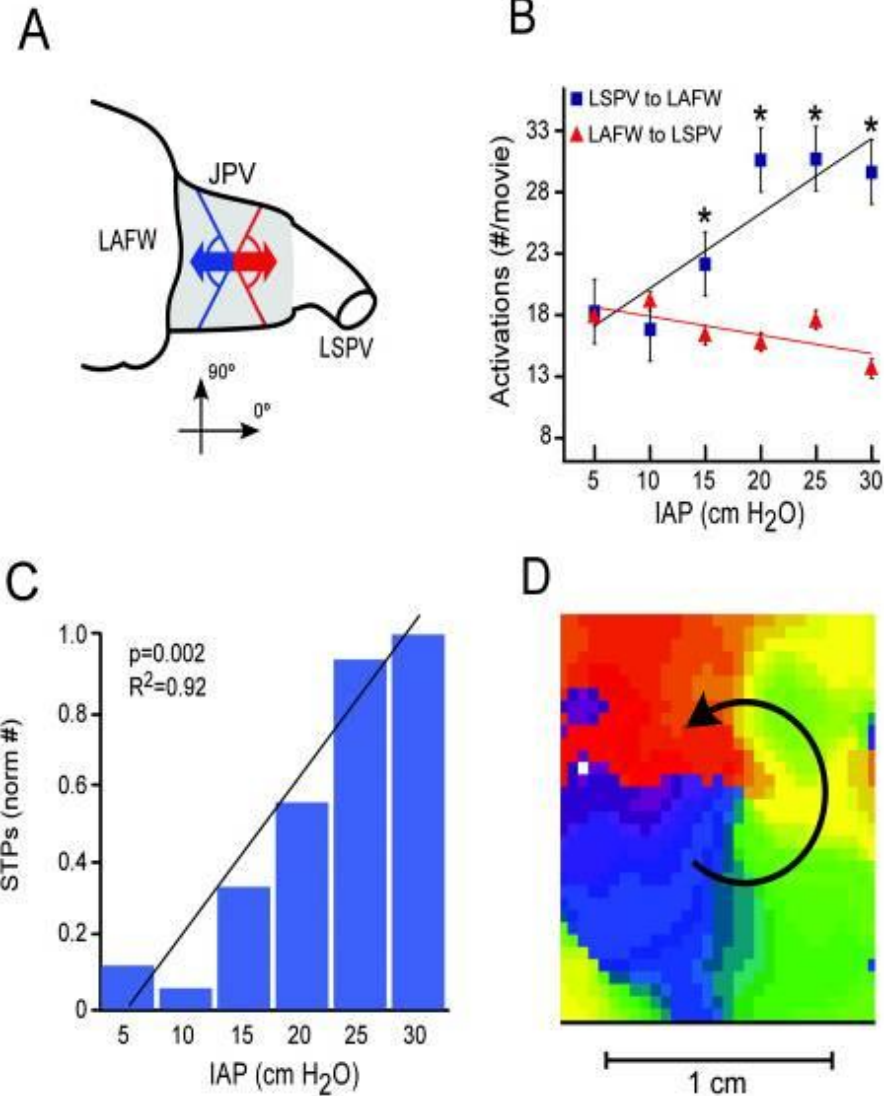
Values are n/N (%), mean ± SD, median (interquartile range), n (%), or n. \*Required stent.

CL = cycle length; other abbreviations as in Table 1.

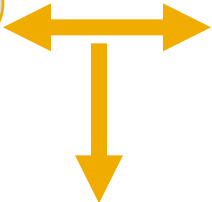
# Effect of intra-atrial pressure on AF



Increases in intra-atrial pressure increases the number of waves (rotors) emanating from the PVs



Trigger



Substrat

