AF ABLATION
Patient Care & Monitoring to Prevent Procedural Complications

LI-FERN HSU
Singapore

National Heart Centre
SingHealth
PV ISOLATION TECHNIQUES

- Electrophysiologically-guided PV ostial ablation
  Now lesions moved towards PV-LA junction

- Wide encirclement of PVs without confirmation of electrical isolation
  Addition of LA linear lesions

- Wide encirclement of PVs with confirmation of electrical isolation
  Usually no additional linear lesions
SUBSTRATE-BASED TECHNIQUES

A New Approach for Catheter Ablation of Atrial Fibrillation:
Mapping of the Electrophysiologic Substrate
Koodavagee Nademanee, MD, FACC,* John McKenzie, MD,* Erol Kosar, MD,* Mark Schweb, MD,* Buncha Suanameewetayakul, MD;† Thuveekat Vasavaikul, MD; Chotikorn Khannawat, MD;† Tachaphong Ngarmulos, MD‡
Inglewood, California, and Bangkok, Thailand

Mapping & ablation of complex fractionated electrograms
JACC 2004; 43:2044-2053

Spectral Analysis Identifies Sites of High-Frequency Activity Maintaining Atrial Fibrillation in Humans
Prashanthan Sanders, MBBS, PhD;‡ Omer Berenfeld, PhD; Mélèze Hocini, MD; Pierre Jais, MD; Ravi Vaidyanathan, BE; Li-Fern Hsu, MBBS; Stéphane Garrigue, MD, PhD; Yoshihide Takahashi, MD; Martin Rotter, MD; Frédéric Sacher, MD; Christophe Scavée, MD; Robert Picozzi-Snyder, PhD; José Jalife, MD; Michel Haissaguerre, MD

Mapping & ablation of areas of dominant frequency activity
Circulation 2005; 112:789-797
CHRONIC AF

Extensive ablation

Catheter Ablation of Long-Lasting Persistent Atrial Fibrillation: Critical Structures for Termination

MICHEL HAÏSSAGUERRE, M.D., PRASHANTHAN SANDERS, M.B.B.S., PH.D., MÉLÈZE HOCINI, M.D., YOSHIHIDE TAKAHASHI, M.D., MARTIN ROTTER, M.D., FREDERIC SACHER, M.D., THOMAS ROSTOCK, M.D., LI-FERN HSU, M.B.B.S., PIERRE BORDACHAR, M.D., SYLVAIN REUTER, M.D., RAYMOND ROUDAUT, M.D., JACQUES CLEMENTY, M.D., and PIERRE JAIS, M.D.

PV isolation
Roofline
Inferior LA / CS
Organising activity at LAA, septum etc
Mitral isthmus

JCE 2005; 16:1125-1137
POTENTIAL COMPLICATIONS OF AF ABLATION

8745 patients
Cardiac Tamponade - 1.2%
Stroke/TIA - 1.0%
PV Stenosis - 1.3%
Death - 4 patients

Circulation 2005

Worldwide Survey on the Methods, Efficacy, and Safety of Catheter Ablation for Human Atrial Fibrillation

Riccardo Cappato, MD; Hugh Calkins, MD; Shih-Ann Chen, MD; Wyn Davies, MD; Yoshito Iesaka, MD; Jonathan Kalman, MD; You-Ho Kim, MD; George Klein, MD; Douglas Packer, MD; Allan Skanes, MD
POTENTIAL COMPlications OF AF ABLATION

Early complications of pulmonary vein catheter ablation for atrial fibrillation: A multicenter prospective registry on procedural safety

Emanuele Bertaglia, MD,* Franco Zoppo, MD,* Claudio Tondo, MD,† Andrea Colella, MD,† Roberto Mantovan, MD,‡ Gaetano Senatore, MD,‖ Nicola Bottini, MD,‖ Giovanni Carreras, MD,‖ Leonardo Corò, MD,*** Pietro Turco, MD,†† Massimo Mantica, MD,†† Giuseppe Stabile, MD‡‡

1011 patients

- Cardiac Tamponade - 0.6%
- Stroke/TIA - 0.5%
- PV Stenosis - 0.4%
- Death - 0 patients

Heart Rhythm 2007
PATIENT MONITORING FOR AF ABLATION
PATIENT MONITORING FOR AF ABLATION

WHY MONITOR?
- Prevention of complications
- Early detection of complications

WHEN TO MONITOR?
- During procedure
- After procedure
CARDIAC PERFORATION

POTENTIAL FOR CARDIAC PERFORATION

- INCIDENCE - Low
- CONSEQUENCES - Potentially serious

- STAGES OF PROCEDURE
  - Transeptal puncture
  - LA ablation
  - RA ablation
CARDIAC PERFORATION
MECHANISMS FOR CARDIAC PERFORATION

Incidence and Prevention of Cardiac Tamponade Complicating Ablation for Atrial Fibrillation

LI-HERN HSU, PIERRE JAIS, MELÈZE HOCINI, PRASHANTHAN SANDERS,
CHRISTOPHE SCAVÉE, FREDERIC SACHER, YOSHIHIDE TAKAHASHI, MARTIN ROTTER,
JEAN-LUC PASQUIE, JACQUES CLÉMENTY, and MICHEL HAÏSSAGUERRE
From the Hôpital Cardiologique du Haut-Lévêque, Bordeaux-Pessac, France

Risk higher during linear ablation compared to PV isolation

- Catheter manipulation
- “Popping” during RF Delivery
  mainly related to energy delivery

PACE 2005
CARDIAC PERFORATION PREVENTION

TRANSEPTAL ACCESS
- Pre-procedure TEE
- PFO
- Single vs double puncture
- Needle Tracking
- ICE

“POPPING”
- Energy delivery
- as low as necessary
- ICE
- “microbubbles”

CATHETER MANIPULATION
- Pre-procedure Imaging
- CT / MRI
- Catheter Tracking
- fluoroscopy
- Carto / NAVx
- ICE
CARDIAC PERFORATION
IF PREVENTION FAILS.....

CLINICAL MONITORING

- BP Monitoring
  - ? arterial line
- Fluoroscopy

INTRACARDIAC ECHO

- Early detection
  - effusion detected
  - ~22min prior to hemodynamic instability
- Monitoring progression

Outcomes After Cardiac Perforation During Radiofrequency Ablation of the Atrium
T. JARED BUNCH, M.D., SAMUEL J. ASIRVATHAM, M.D., PAUL A. FRIEDMAN, M.D., KRISTI H. MONAHAN, R.N., THOMAS M. MUNGER, M.D., ROBERT F. REA, M.D., LAWRENCE J. SINAK, M.D., and DOUGLAS L. PACKER, M.D.

JCE 2005
Activation of coagulation cascade by
- Intravascular catheter placement
- Duration of procedure

Left Atrial Thrombus Associated
With Ablation for Atrial Fibrillation:
Identification With Intracardiac Echocardiography
Jian-Fang Ren, MD, FACC, Francis E. Marchlinski, MD, FACC, David J. Callans, MD, FACC
Philadelphia, Pennsylvania

Thrombus formation even with
intraprocedural anticoagulation with
ACT >250 s
THROMBOEMBOLIC EVENTS
RISK OF THROMBUS FORMATION

Intracardiac Ultrasound Detection of Thrombus on Transseptal Sheath: Incidence, Treatment, and Prevention

KATANEH MALEKI, M.D., REZA MOHAMMADI, M.D., DAVID HART, M.D., DELIA COTIGA, M.D., NADA FARHAT, M.S., and JONATHAN S. STEINBERG, M.D., F.A.C.C.

From the Arrhythmia Service and Division of Cardiology, St. Luke's-Roosevelt Hospital Center and Columbia University College of Physicians and Surgeons, New York, New York; and the Valley Hospital, Ridgewood, New Jersey, USA

Thrombus formation associated with
- LA spontaneous echo contrast
- Increased LA diameter
- Persistent AF

JCE 2005
THROMBOEMBOLIC EVENTS

AIR EMBOLISM
THROMBOEMBOLIC EVENTS

PREVENTION

BEFORE PROCEDURE
- Adequate anticoagulation
- TEE to screen for thrombi

DURING PROCEDURE
- Adequate heparinization
- ACT 250-300 (>300 for LASEC)
- Transeptal sheath management

Increased Intensity of Anticoagulation May Reduce Risk of Thrombus During Atrial Fibrillation Ablation Procedures in Patients with Spontaneous Echo Contrast

JIAN-FANG REN, M.D., FRANCIS E. MARCHELSKI, M.D., DAVID J. CALLANS, M.D., EDWARD P. GERSTENFELD, M.D., SANJAY DIXIT, M.D., DAVID LIN, M.D., HEMAL M. NAYAK, M.D., and HENRY H. HSIA, M.D.

From the Division of Cardiovascular Medicine, Department of Medicine, University of Pennsylvania, School of Medicine, Philadelphia, Pennsylvania, USA.
THROMBOEMBOLIC EVENTS
PREVENTION

TRANSEPTAL SHEATH

- High-flow continuous perfusion with heparinized saline
- Withdraw sheath into RA whenever possible
- Single transeptal sheath

High-Flow Perfusion of Sheaths for Prevention of Thromboembolic Complications During Complex Catheter Ablation in the Left Atrium

BRUNO CAUCHEMEZ, M.D., FABRICE EXTRAMIANA, M.D., SIMON CAUCHEMEZ, Ph.D.,
STÉPHANE COSSON, M.D., HANANE ZOUZOU, M.D., MOHAMED MEDDANE, M.D.,
LAURE REVIAULT D’ALLONNES, M.D., THOMAS LAVERGNE, M.D.,
ANTOINE LEENHARDT, M.D., PHILIPPE COUMEL, M.D., and EMMANUEL HOUDART, M.D.

From the Department of Cardiology, Lariboisière Hospital, Paris, France; INSERM U444, Paris, France; Department of Cardiology, Georges Pompidou Hospital, Paris, France; and Department of Neuroradiology, Lariboisière Hospital, Paris, France
PULMONARY VEIN STENOSIS

Decreasing incidence but still important....

Significant pulmonary vein stenosis occurs in ~1% patients after AF ablation

Symptoms highly variable, often mimic pulmonary disease
PULMONARY VEIN STENOSIS

Pulmonary Vein Stenosis After Radiofrequency Ablation of Atrial Fibrillation

Functional Characterization, Evolution, and Influence of the Ablation Strategy

Eduardo B. Saad, MD; Antonio Rossillo, MD; Cynthia P. Saad, MD; David O. Martin, MD; Mandep Bhargava, MD; Demet Erciyes, MD; Dianna Bash, RN; Michelle Williams-Andrews, RN; Salwa Beheiry, RN; Nassir F. Marrouche, MD; James Adams, MD; Ennio Pisanò, MD; Raffaele Fanelli, MD; Domenico Potenza, MD; Antonio Raviele, MD; Aldo Bonso, MD; Sakis Themistoclakis, MD; Joanna Brachmann, MD; Walid I. Saliba, MD; Robert A. Schweikert, MD; Andrea Natale, MD

- Incidence decreases with more ostial/antral ablation
- Severe stenosis (>70%) - symptomatic
- Mild to moderate stenosis - no symptoms
- However, mild narrowing initially does not preclude future development of severe stenosis

Circulation 2003
PULMONARY VEIN STENOSIS

PREVENTION

- Change ablation site to as proximal as possible
  - a) fluoroscopy
  - b) Carto / NAVx
  - c) ICE
- Reduce energy delivery
- Catheter impedance monitoring
Detection of Inadvertent Catheter Movement into a Pulmonary Vein During Radiofrequency Catheter Ablation by Real-Time Impedance Monitoring

PETER CHEUNG, M.D., BURR HALL, M.D., AMAN CHUGH, M.D., ERIC GOOD, D.O., KRISTINA LEMOLA, M.D., JIHN HAN, M.D., KAMALA TAMIRISA, M.D., FRANK PELOSI, Jr., M.D., FRED MORADY, M.D., and HAKAN ORAL, M.D.
PULMONARY VEIN STENOSIS

IF PREVENTION FAILS......
PULMONARY VEIN STENOSIS

Monitoring Post-Angioplasty or Stent

Restenosis rate is high after PV angioplasty, especially without concomitant stenting
ATRIO-ESOPHAGEAL FISTULA

Atrio-Esophageal Fistula as a Complication of Percutaneous Transcatheter Ablation of Atrial Fibrillation

Carlo Pappone, MD, PhD; Hakan Oral, MD; Vincenzo Santinelli, MD; Gabriele Vicedomini, MD; Christopher C. Lang, MB, ChB; Francesco Manguso, MD, PhD; Lucia Torracca, MD; Stefano Benussi, MD; Ottavio Alfieri, MD; Robert Hong, MD; William Lau, MD; Kirk Hirata, MD; Neil Shikuma, MD; Burr Hall, MD; Fred Morady, MD

Position of LA & Esophagus

Close proximity of LA posterior wall to esophagus

Fat pad of variable thickness separates posterior LA wall from esophagus

Circulation 2004
RF application in LA near course of esophagus results in increased luminal temperature

Esophageal course variable

Kuwahara et al.
JCE 2009
ATRIO-ESOPHAGEAL FISTULA
PREVENTION

Esophageal imaging and strategies for avoiding injury during left atrial ablation for atrial fibrillation
Jian-Fang Ren, MD, David Lin, MD, Francis E. Marchlinski, MD, David J. Callans, MD, Vickas Patel, MD, PhD

ESOPHAGEAL IMAGING
- Barium swallow
- ICE

ESOPHAGEAL MONITORING
- Temperature probe

RF DELIVERY
- Reduce power
PHRENIC NERVE INJURY

How Close Are the Phrenic Nerves to Cardiac Structures? 
Implications for Cardiac Interventionalists

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JCE 2005; 16:309-313

Left appendage

RSPV

RIPV
PHRENIC NERVE INJURY

Phrenic Nerve Injury After Atrial Fibrillation Catheter Ablation
Characterization and Outcome in a Multicenter Study
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Stuart P. Thomas, MD,‡ Neil Davidson, MD,§ Pedro Adereso, MD,¶
Prashanthan Sanders, MBBS, PhD,§ Pedro Adereso, MD,¶
Mélie Hocini, MD,* Yoshihide Takahashi, MD,*
Martin Rotter, MD,* Thomas Rostock, MD,* Li-Fern Hsu, MBBS,* Jacques Clémenty, MD,*
Michel Haffaguerre, MD,* David L. Ross, MD,‡ Douglas L. Packer, MD,‡ Pierre Jais, MD*

Rochester, Minnesota; Sydney, Australia; Manchester, United Kingdom; and Carnaxide, Portugal

- Occurs after ablation in following locations
  - RSPV, SVC, LAA
- High output pacing prior to ablation in susceptible areas to identify location of phrenic nerve may avoid this complication

JACC 2006; 47:2498-2503
CONCLUSION

Despite advances in technology and refinements in technique, AF ablation is still associated with a small but significant risk of complications.

Minimization/prevention of these complications starts with pre-procedure planning, followed by intra-procedural monitoring, and post-procedural surveillance.

Early detection and recognition of these complications is important.