

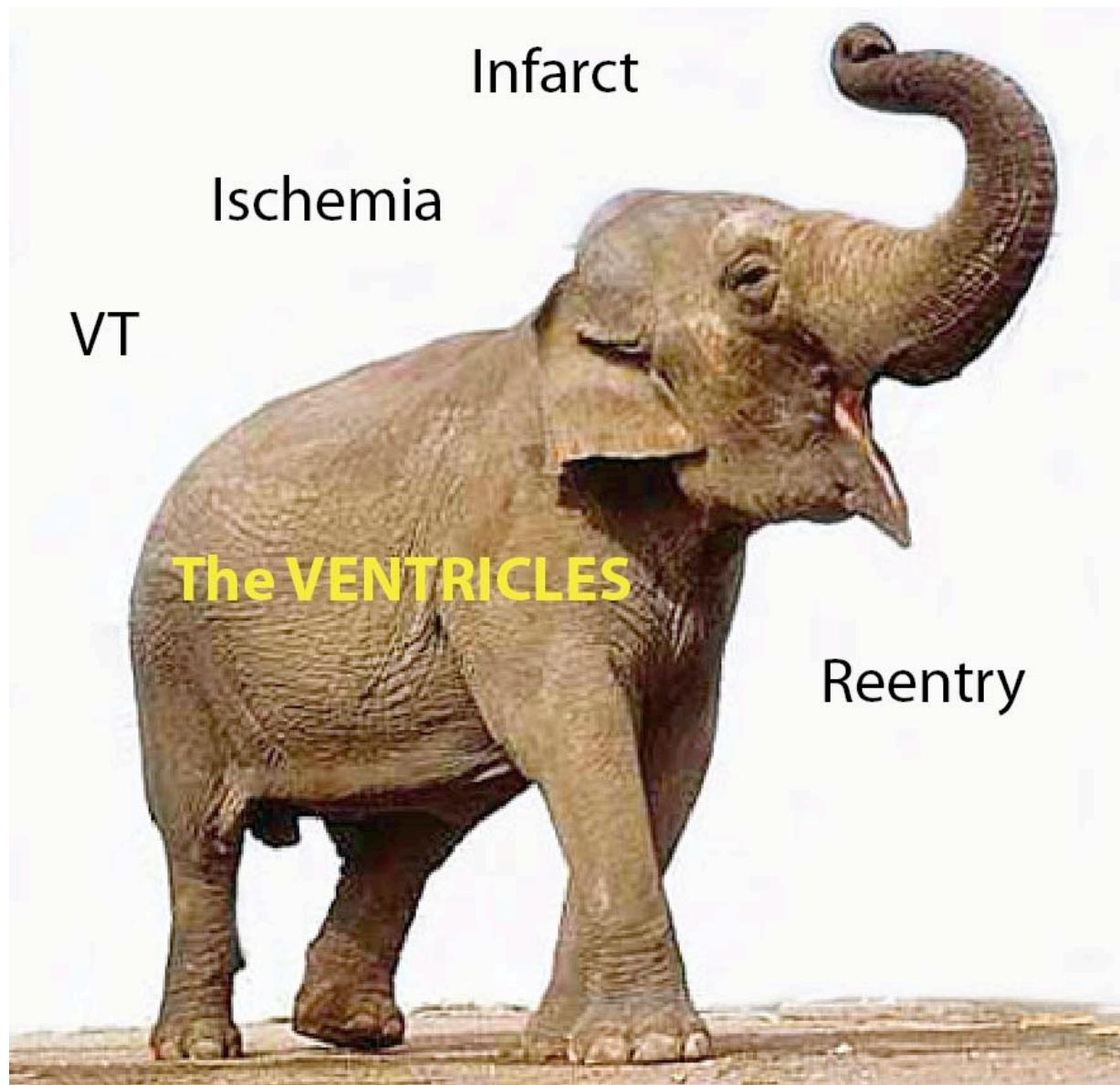
Imaging and Modeling in Atrial Fibrillation:

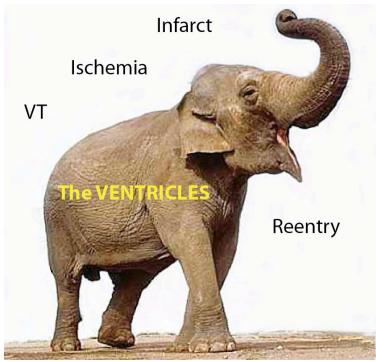
Rob MacLeod, University of Utah
CARMA Center, SCI Institute, CVRTI
Bioengineering Department





$$\bar{J}_e = g_{ix} \frac{\partial \Phi_e}{\partial x} + g_{iy} \frac{\partial \Phi_e}{\partial y} + g_{iz} \frac{\partial \Phi_e}{\partial z}$$
$$\bar{J}_i = g_{ix} \frac{\partial \Phi_i}{\partial x} + g_{iy} \frac{\partial \Phi_i}{\partial y} + g_{iz} \frac{\partial \Phi_i}{\partial z}$$





The ATRIA

Fibrillation

Flutter



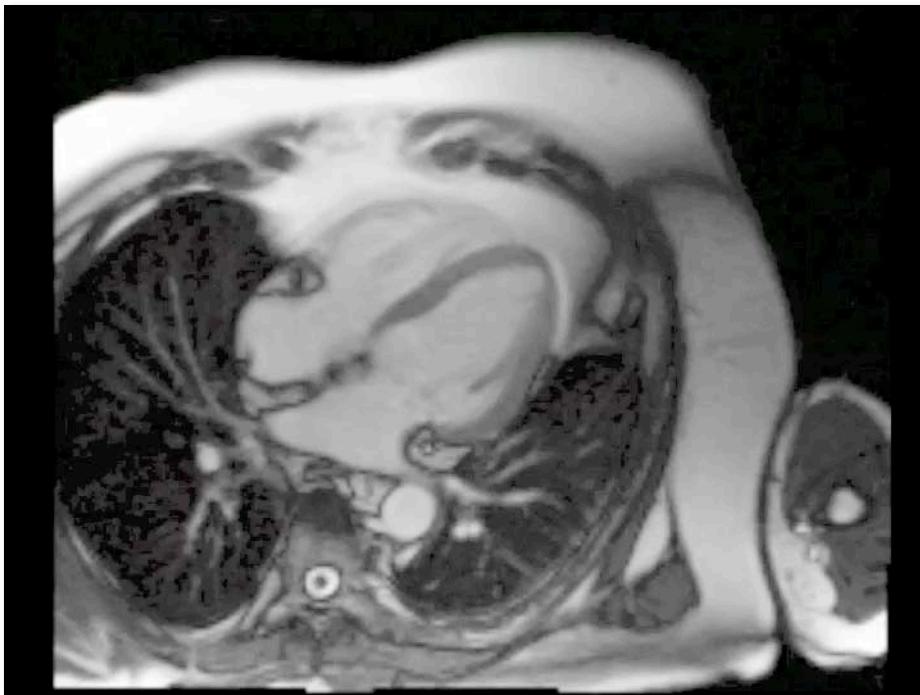
CARMA



What is Atrial Fibrillation? = Afib = AF



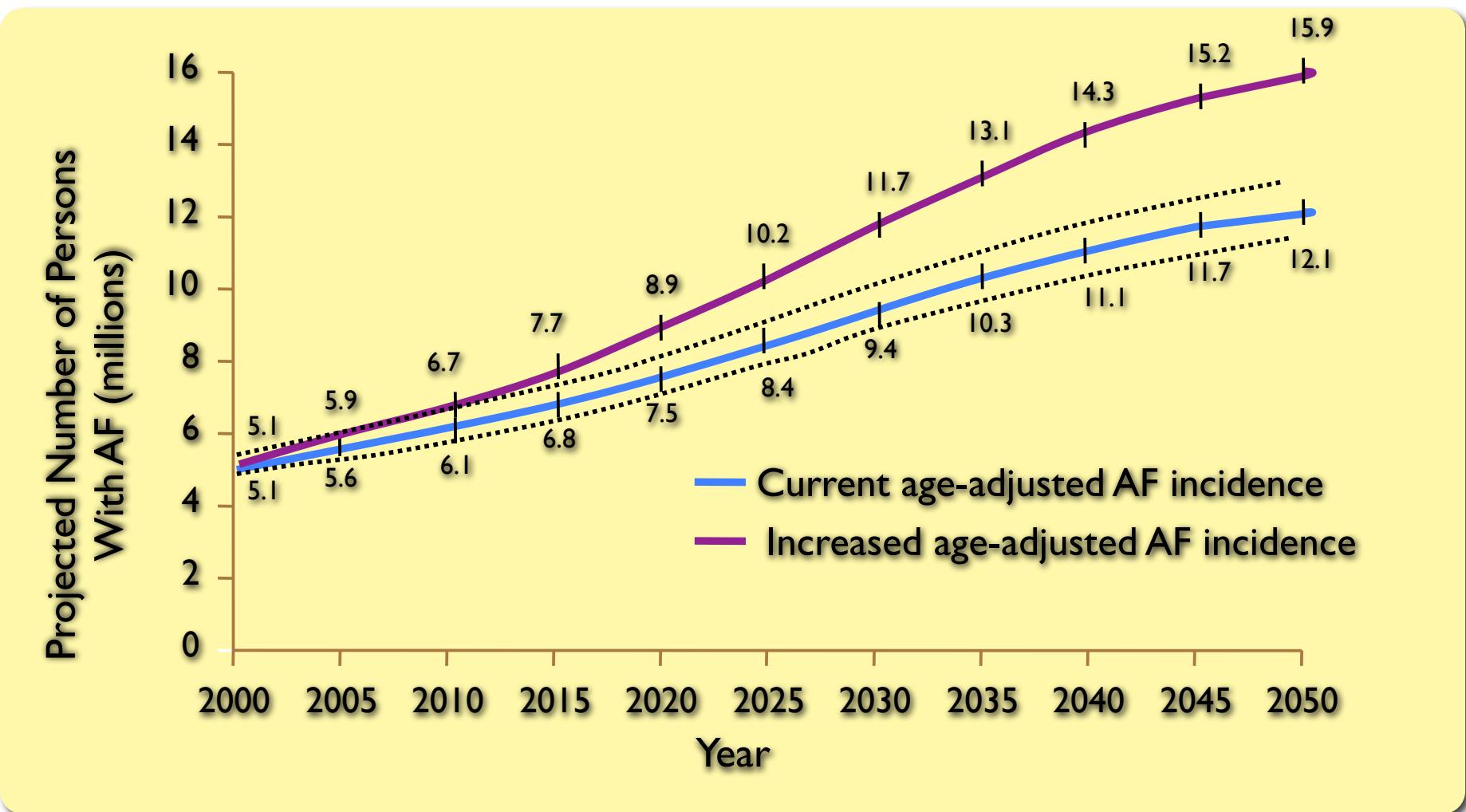
Normal Contraction



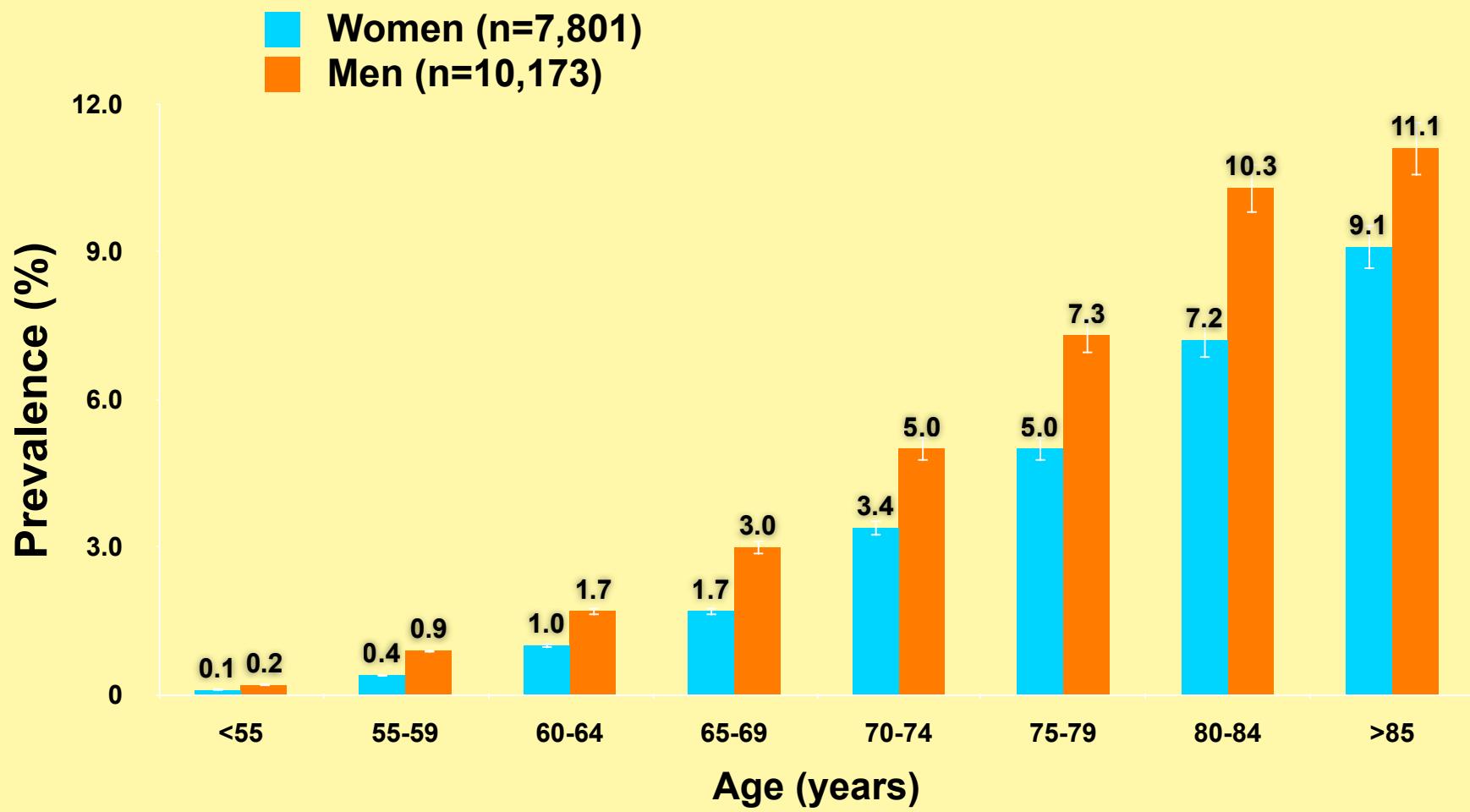
Atrial Fibrillation



AF Prevalence



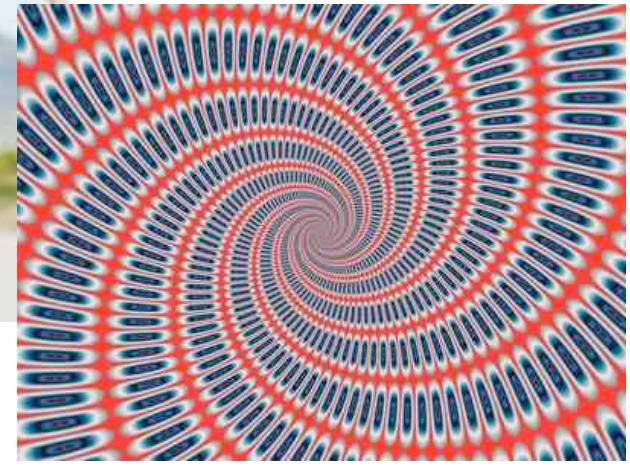
We All Get Older



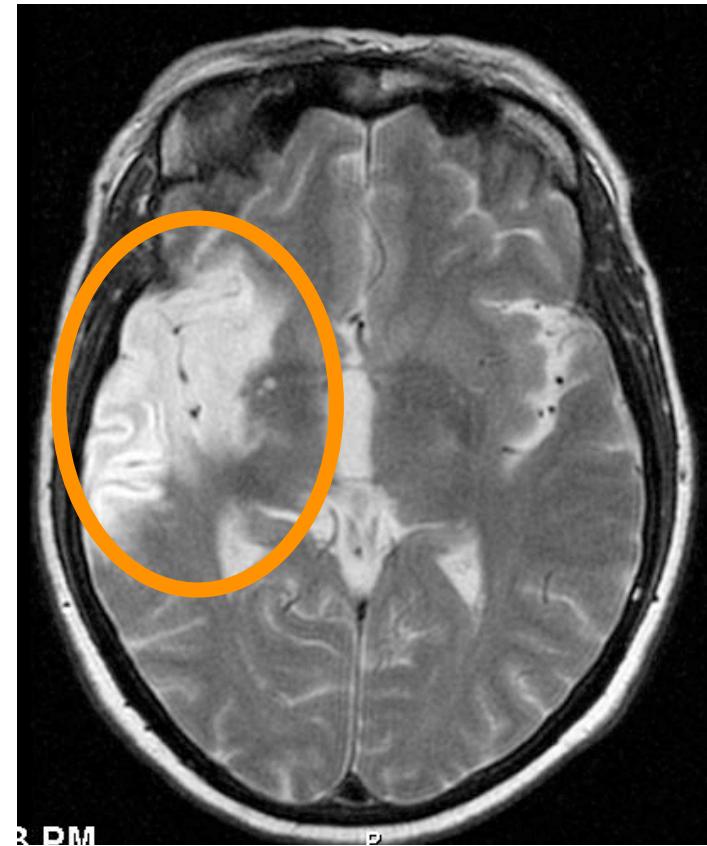
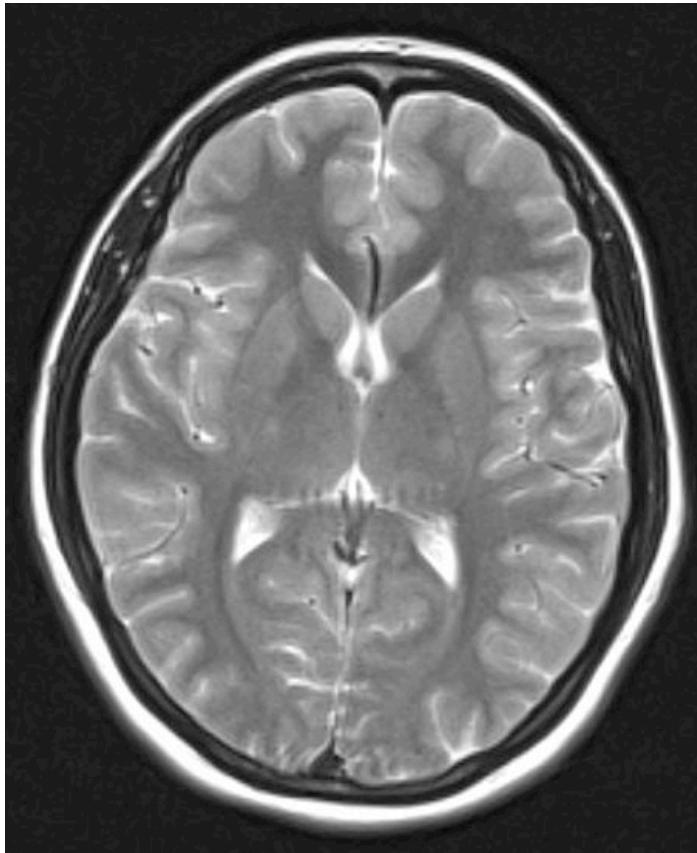
Go AS, et al. JAMA. 2001;285:2370-2375.



So What?



20% of Strokes



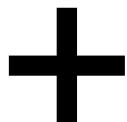
\$20 billion/year



What Causes AFib?



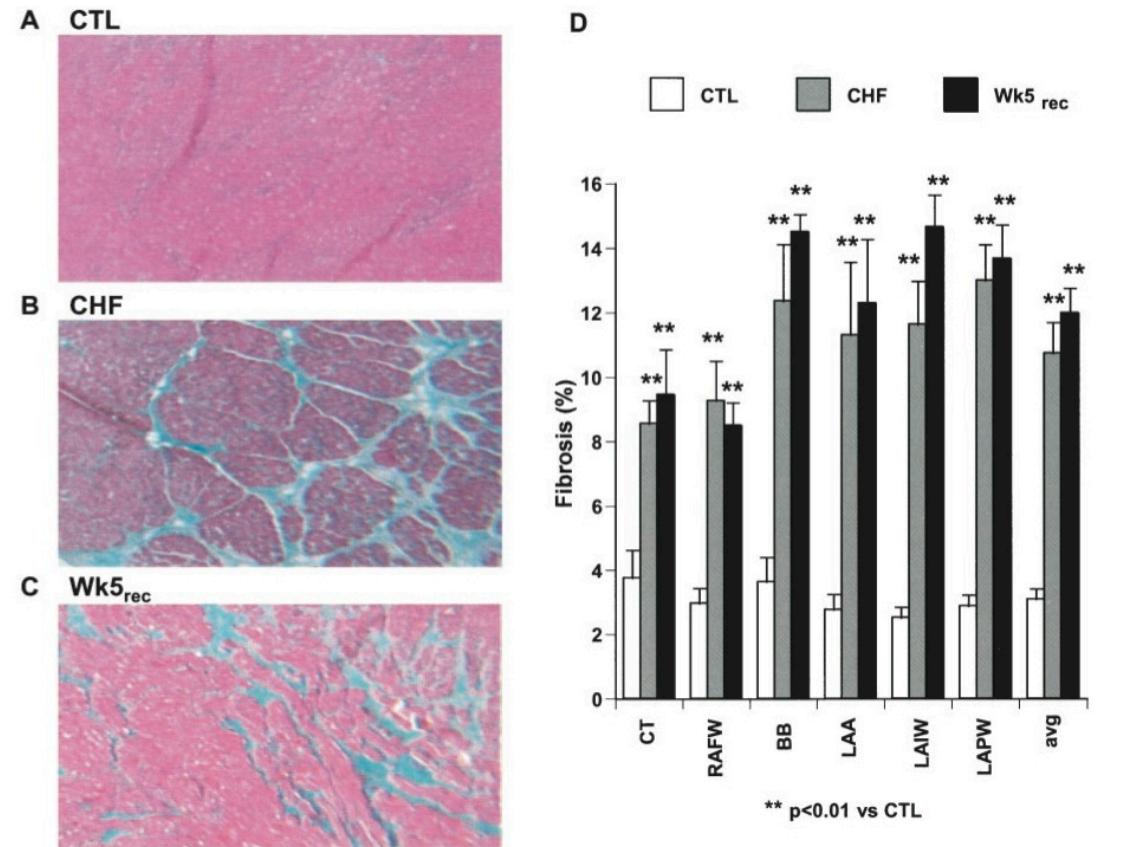
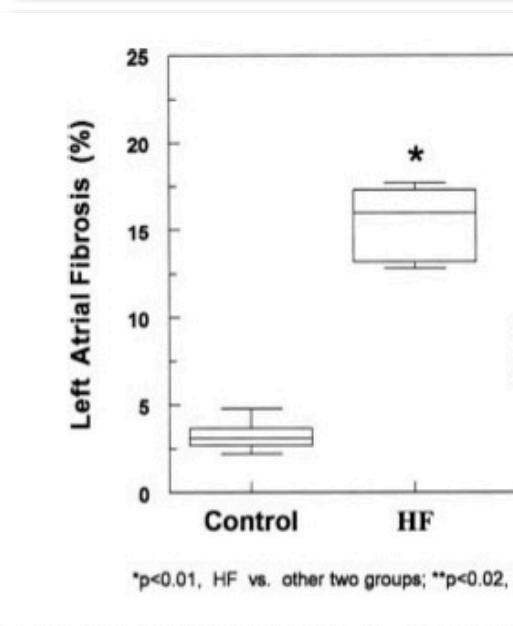
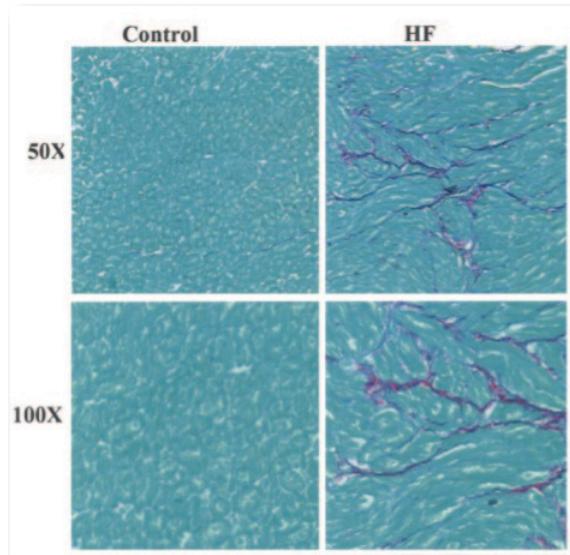
Substrate



Trigger



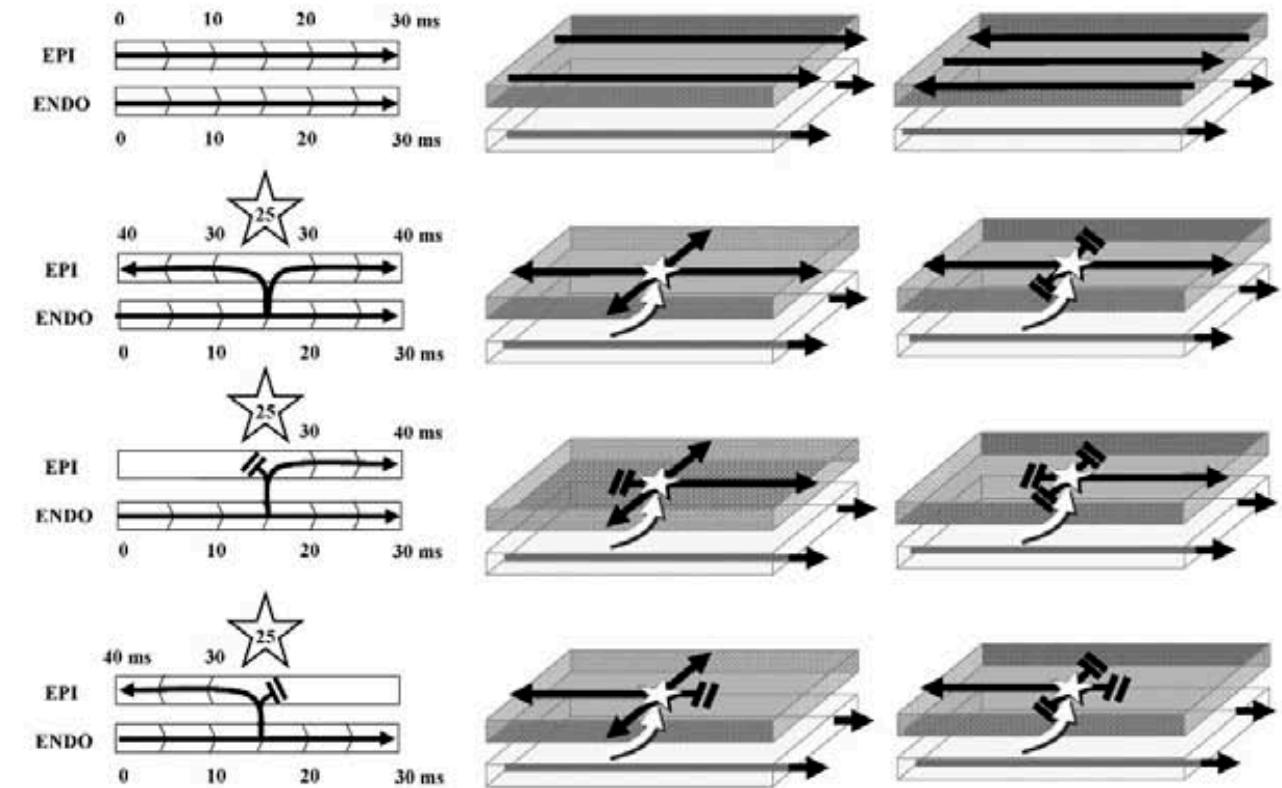
Substrate:Fibrosis



Lee KW, et al. Circ. 2006: 1703-1712.

Shinagawa K, Nattel S. Circ. 2002: 2672-2678.

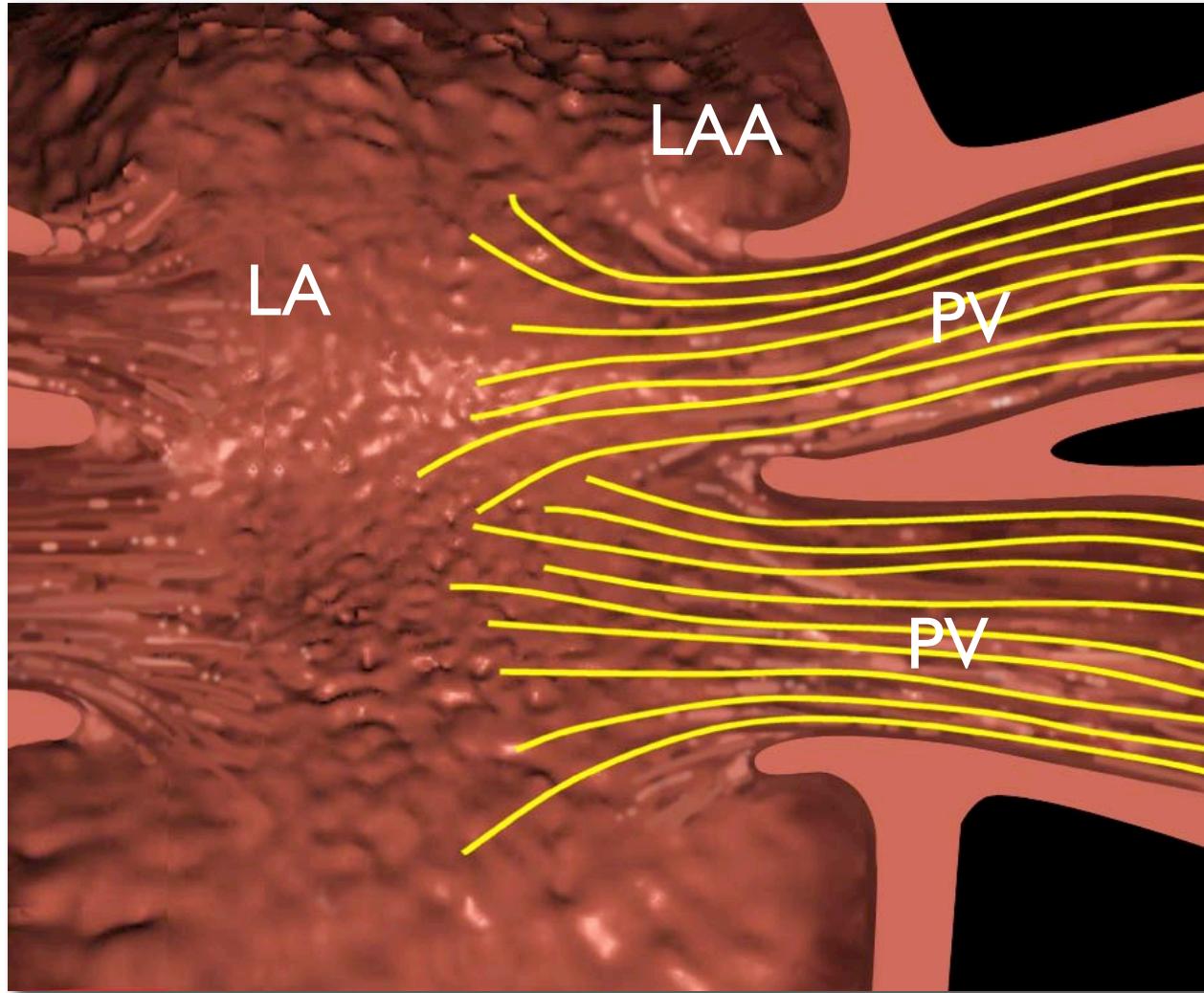
Complex Propagation



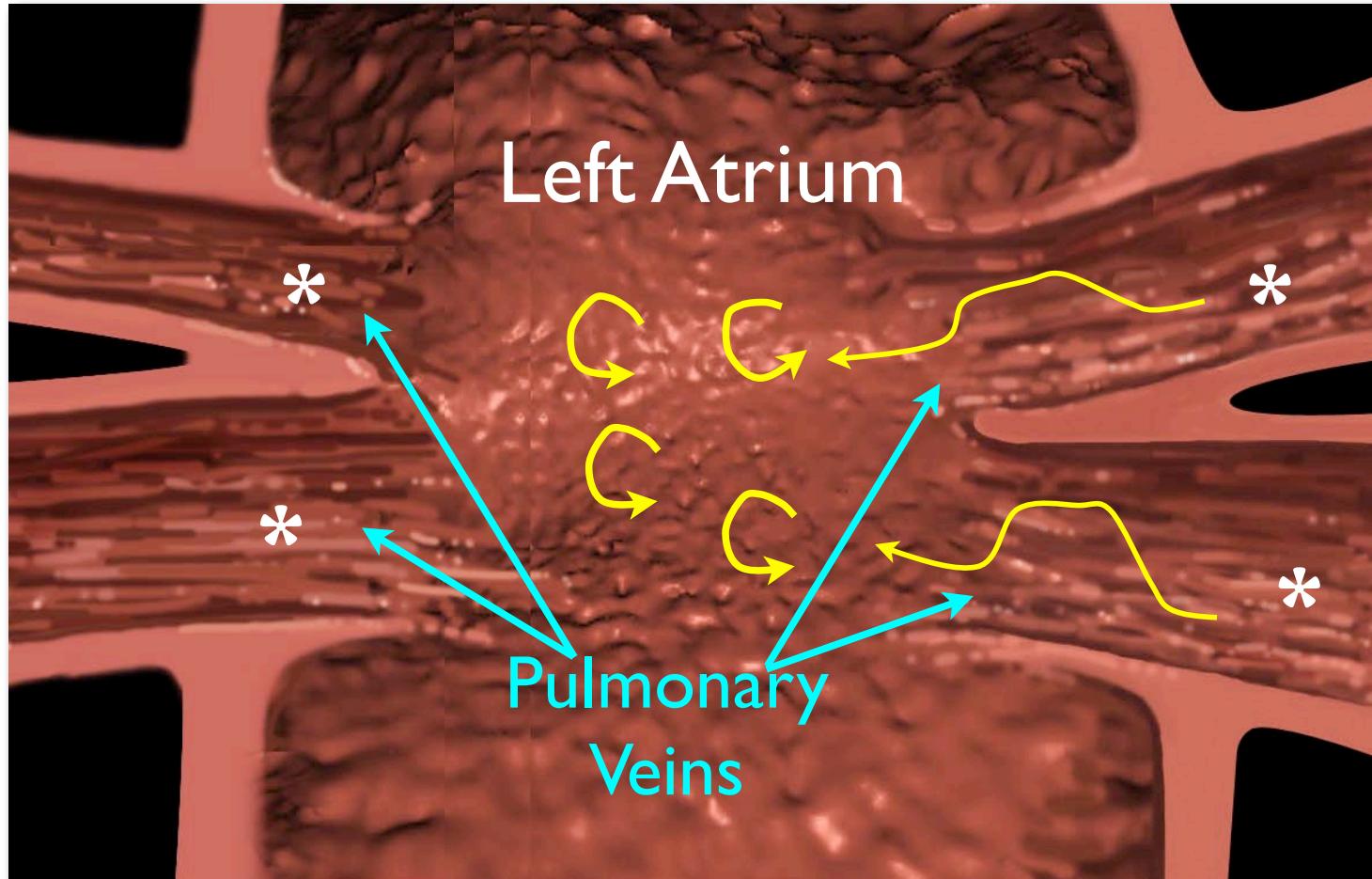
de Groot, Allessie MA. Circ. 2010: 1674-1682.



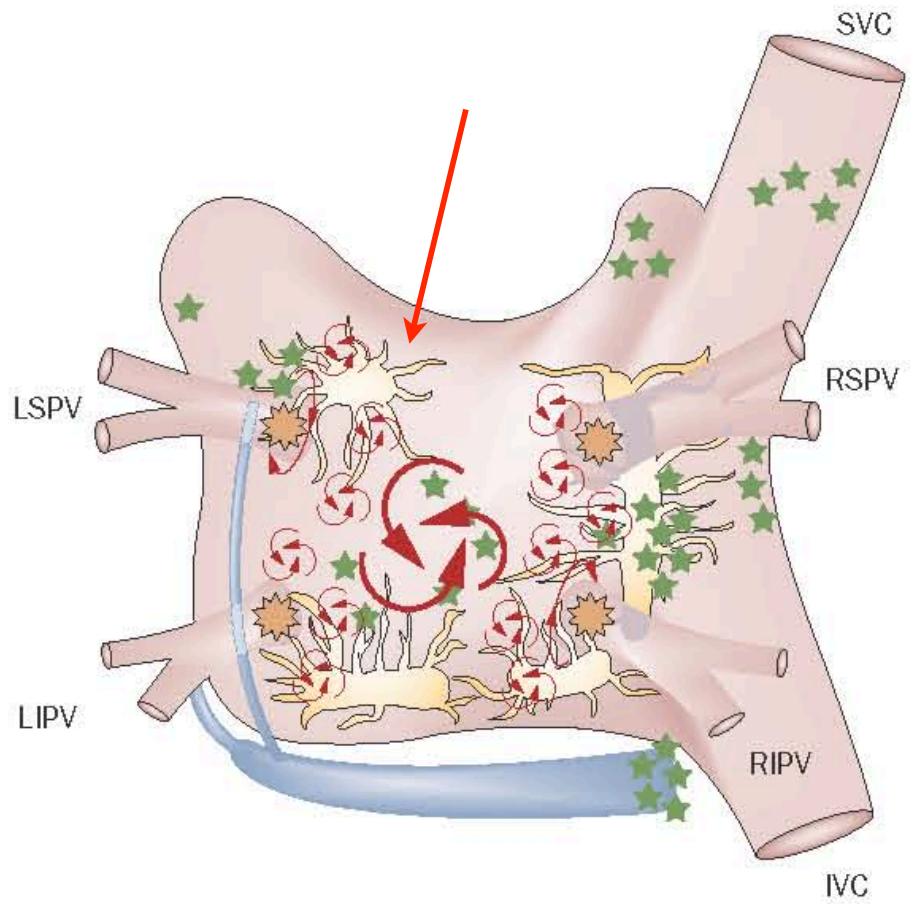
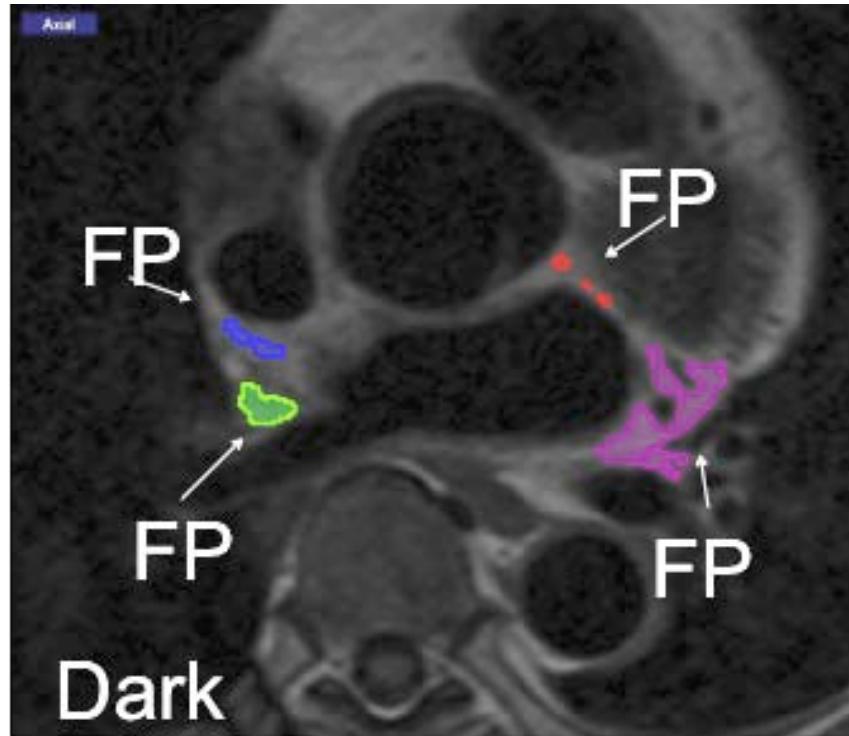
Substrate: Extension of muscle sleeves



Triggers

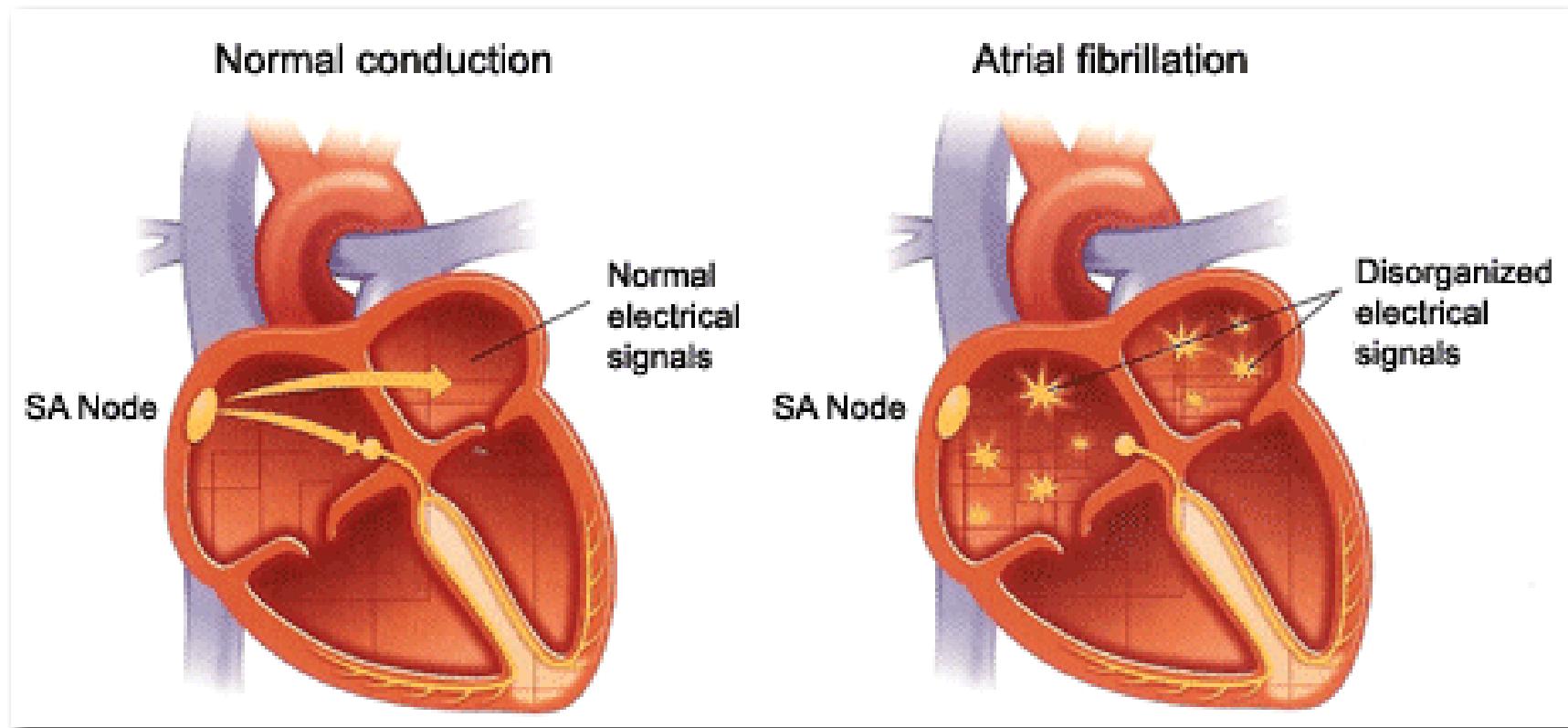


Nervous System

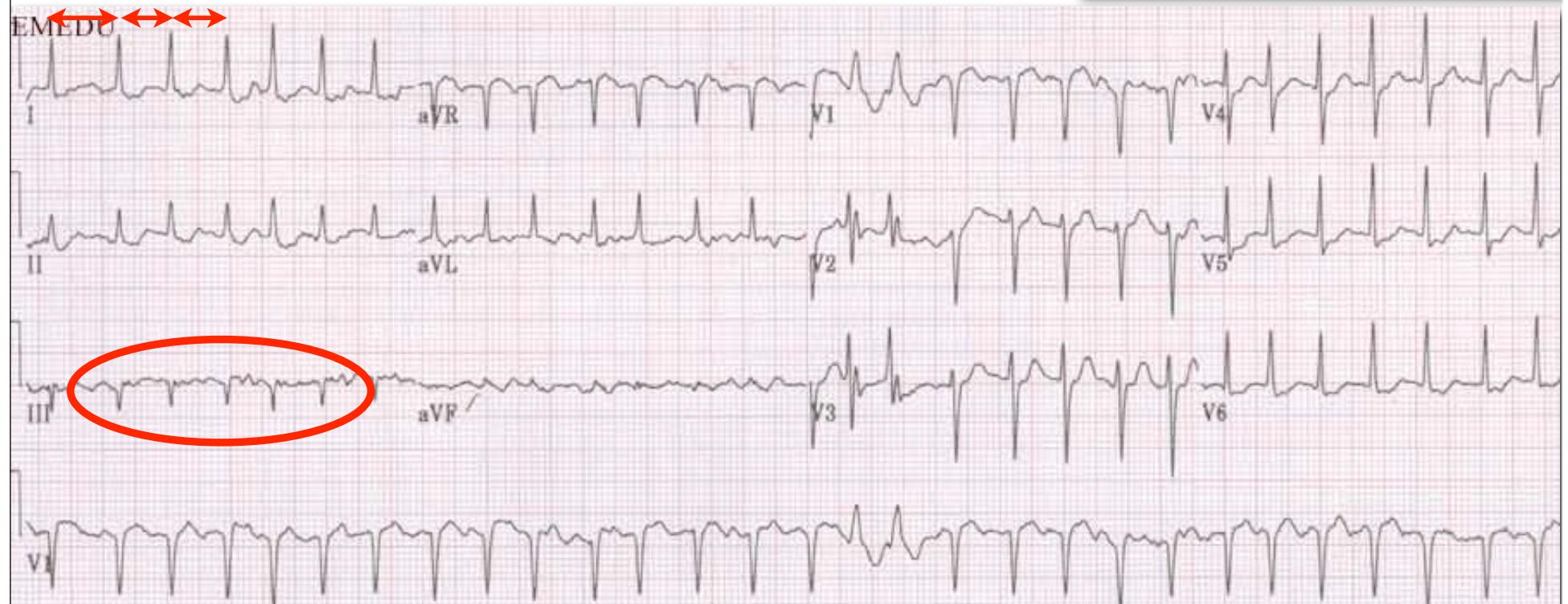
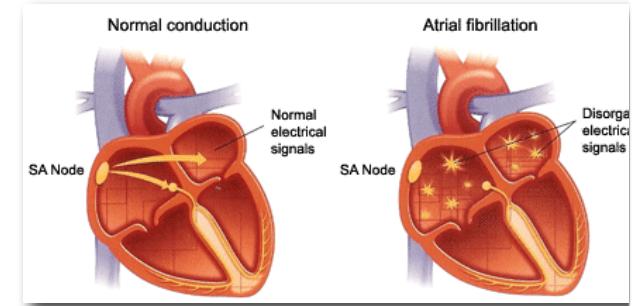


Dewire et. al. Nat. Rev. Cardiol., 2010: 129–138.

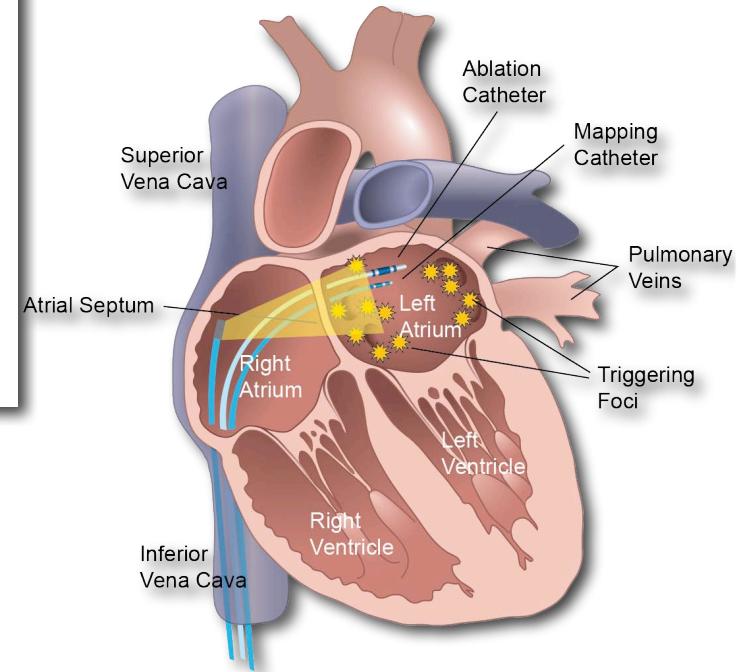
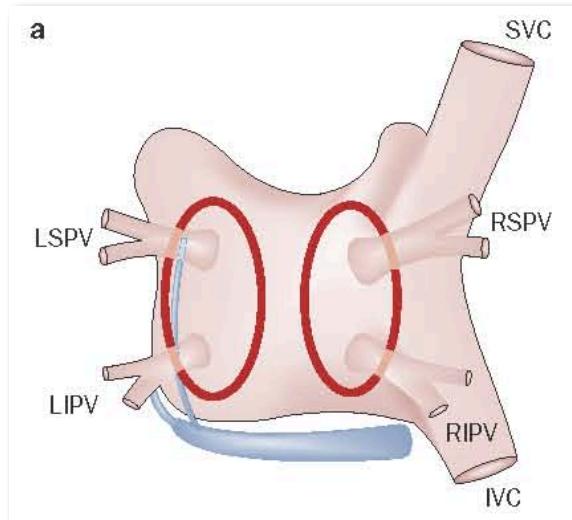
Clinical Result



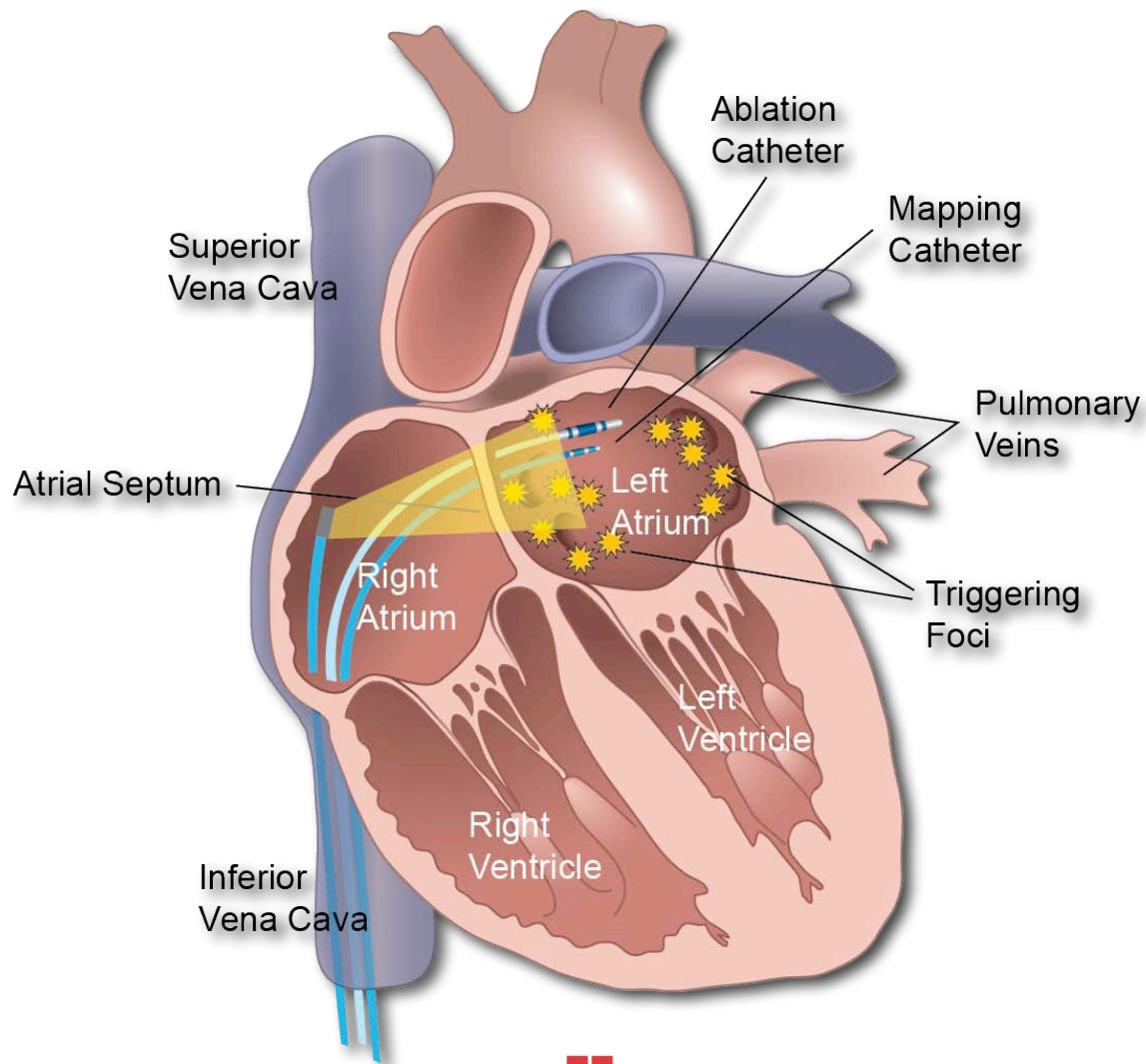
Clinical Result



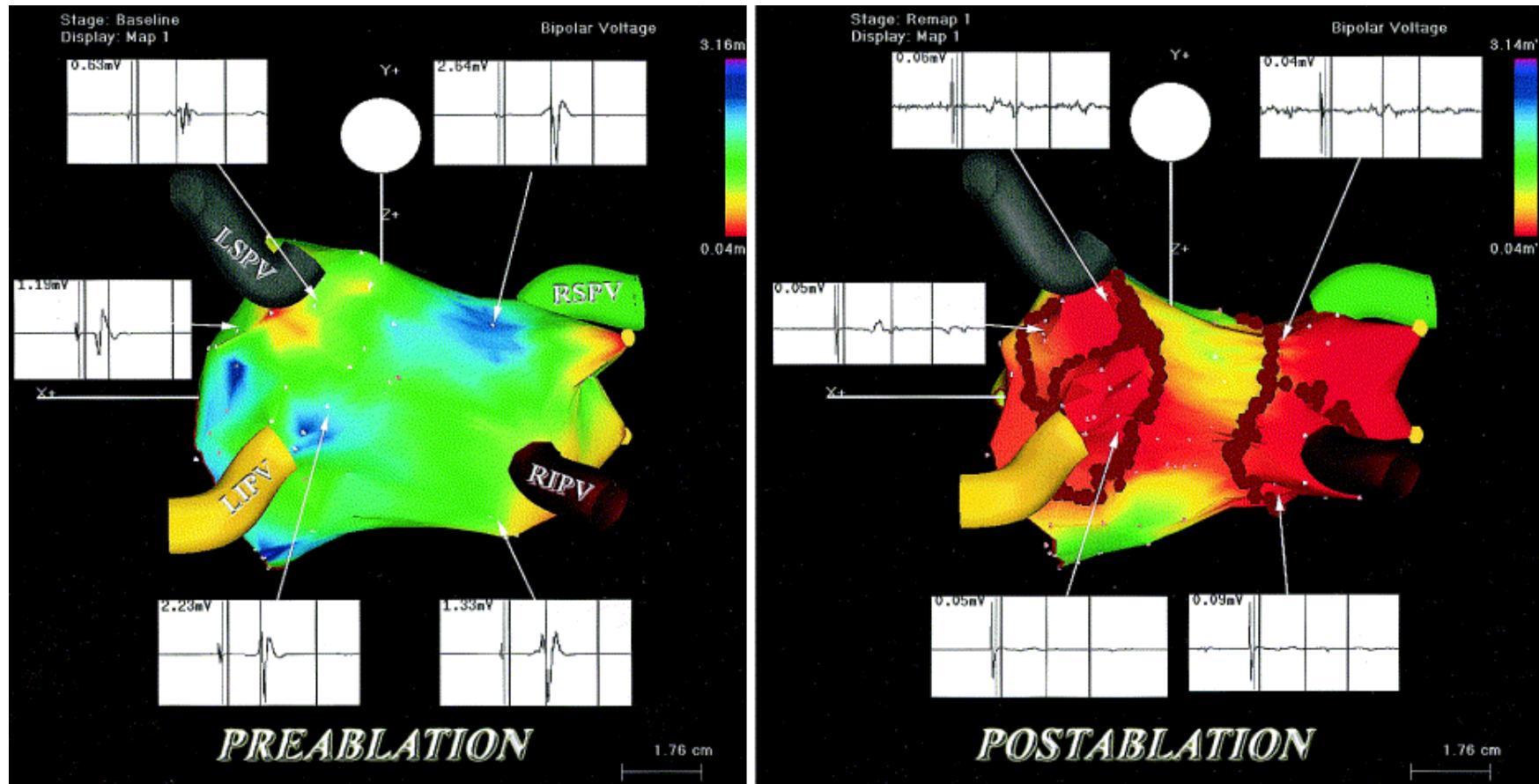
Treatment?



Catheter Ablation



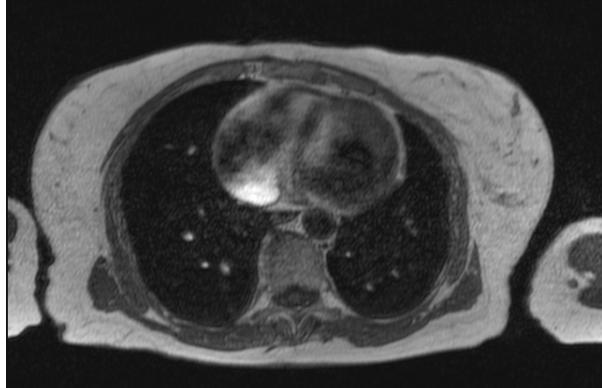
Electroanatomical Mapping



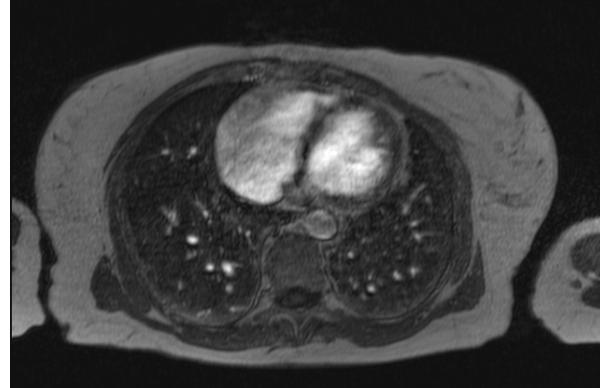
Imaging?



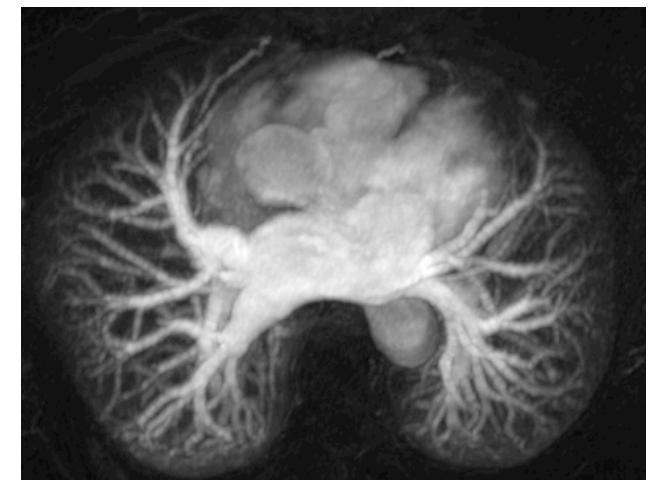
MR Angiography



Pre

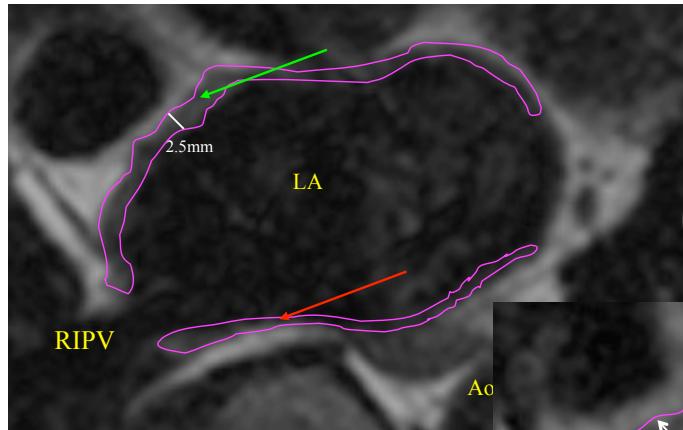


First Pass

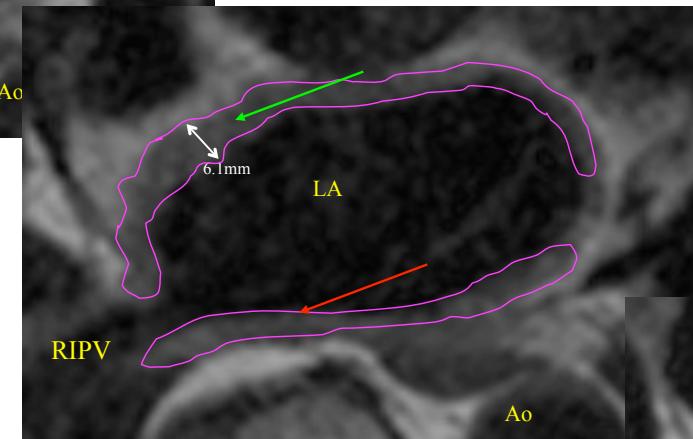


Subtraction

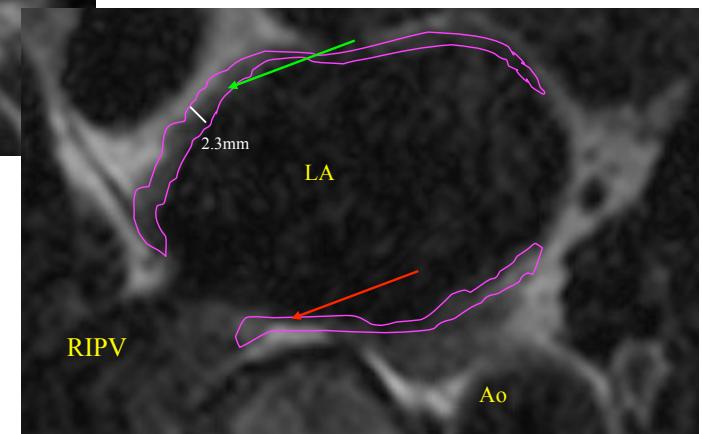
Dark Blood MRI



Pre-treatment



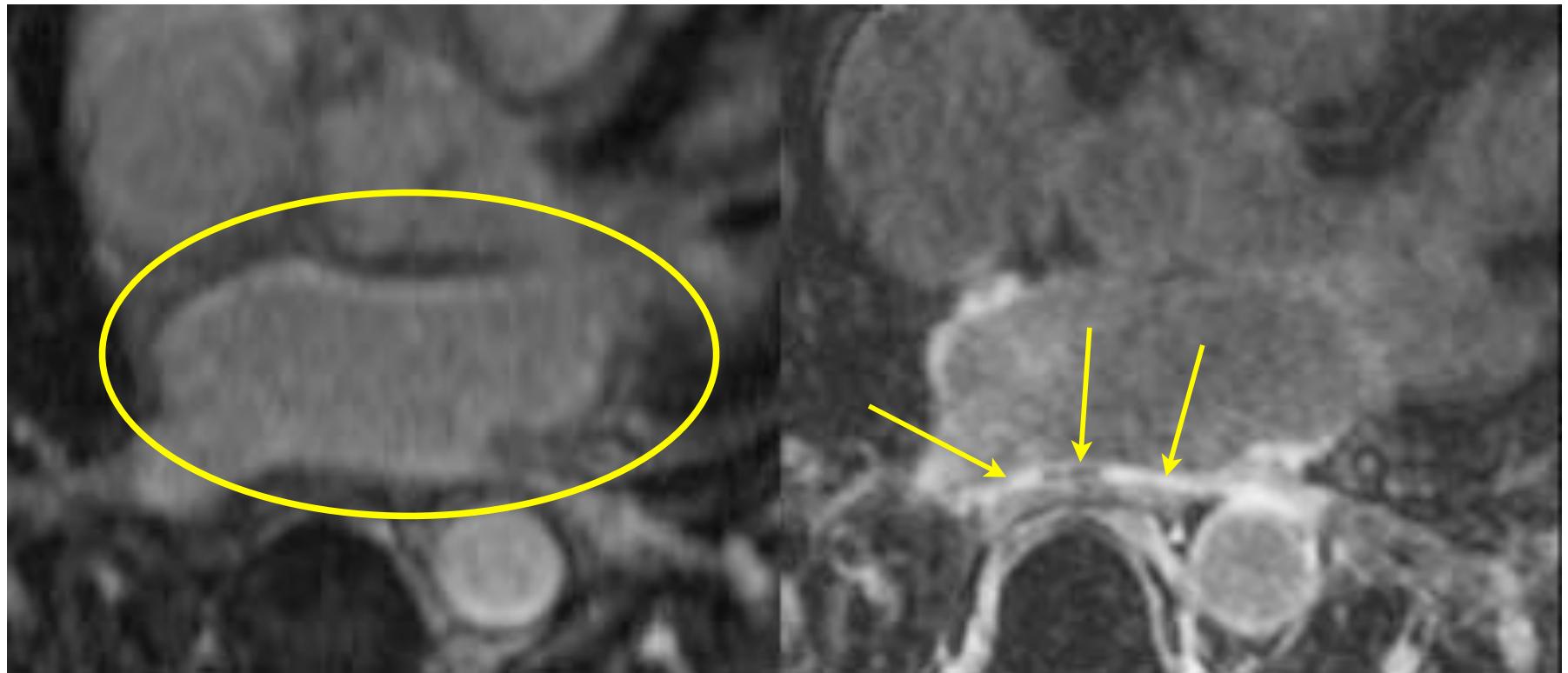
24 Hrs Post



3 Months Post



Late Gadolinium Enhancement



Pre-treatment

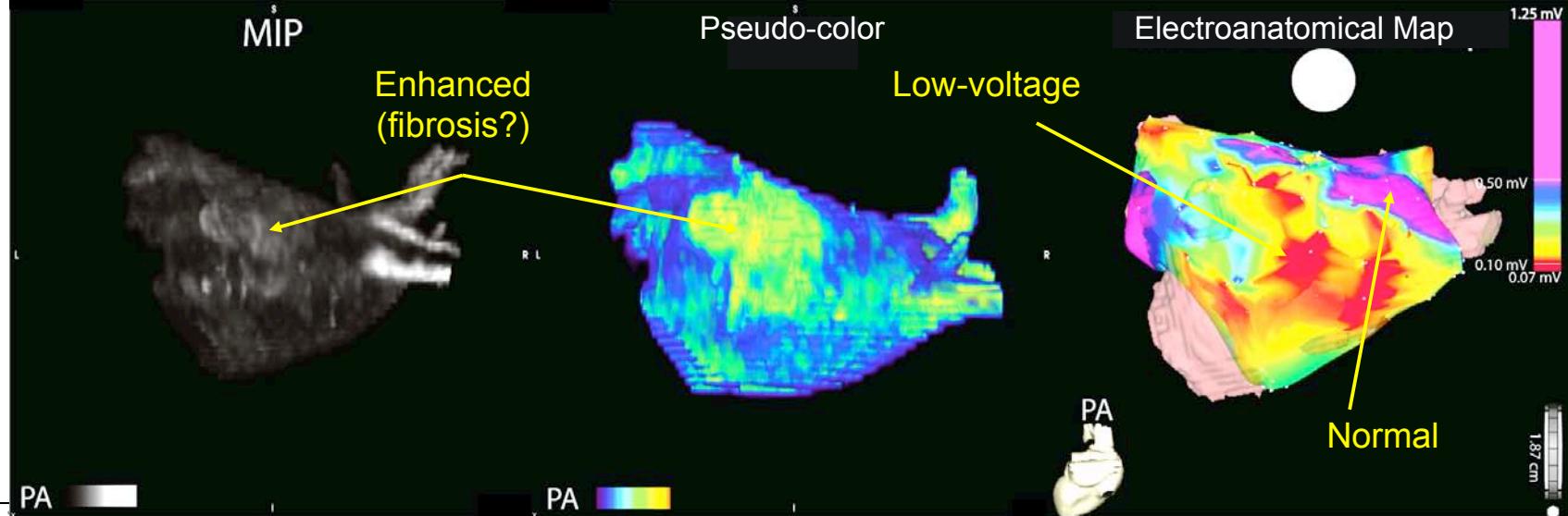
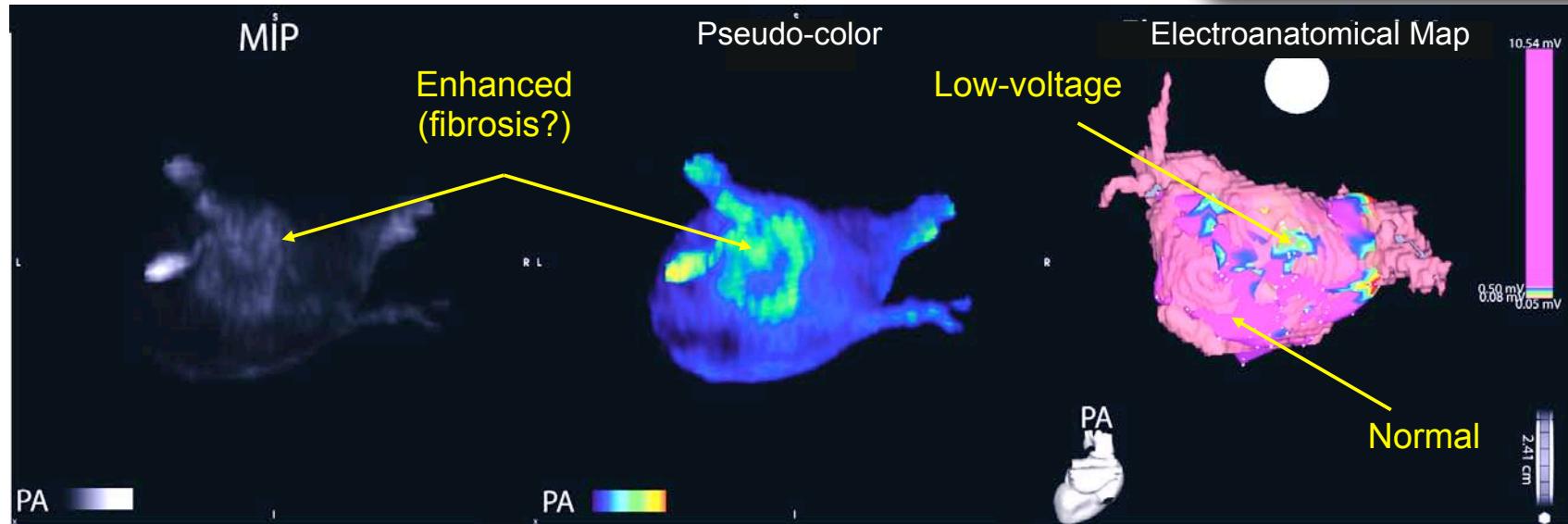
3 month Post

Patient Workflow



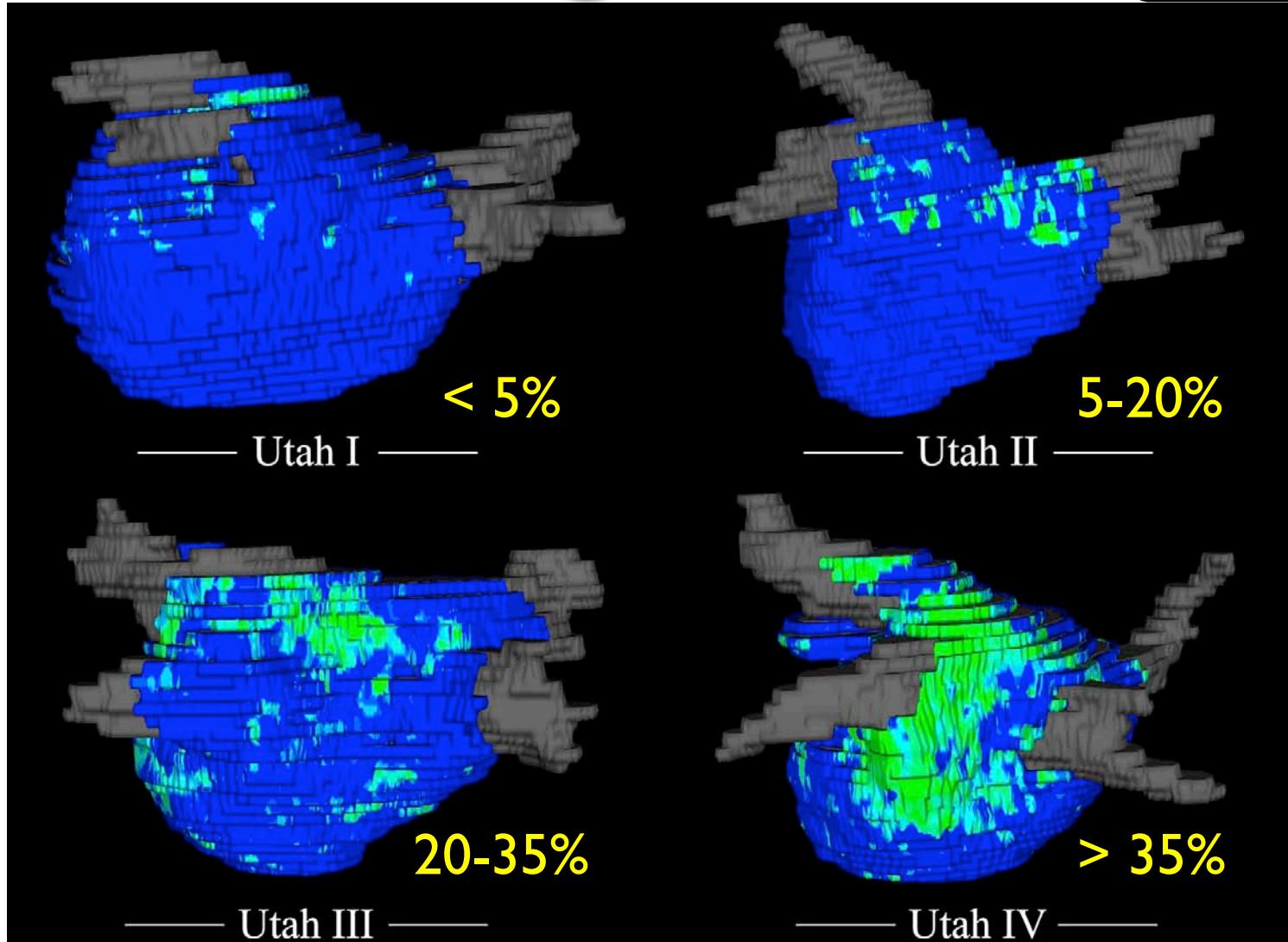
Fibrosis and Outcome

Evaluation



Utah Scoring Scheme

Evaluation

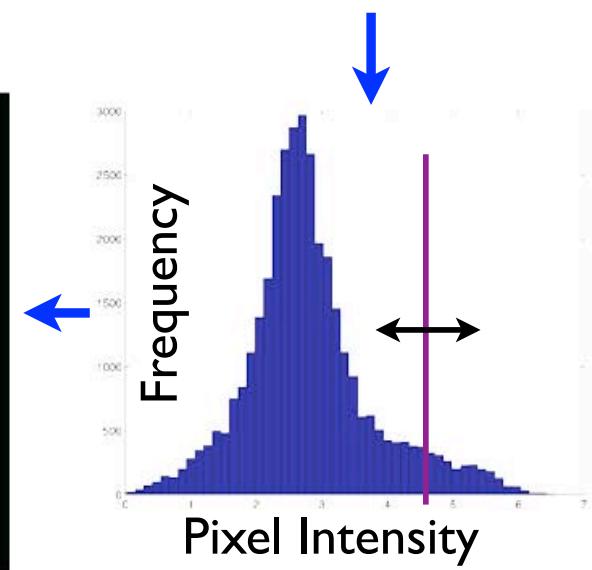
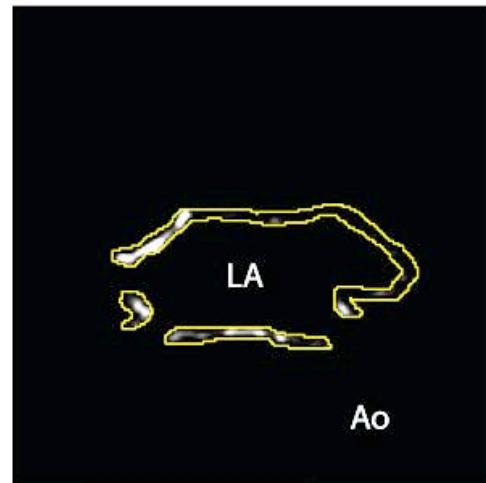
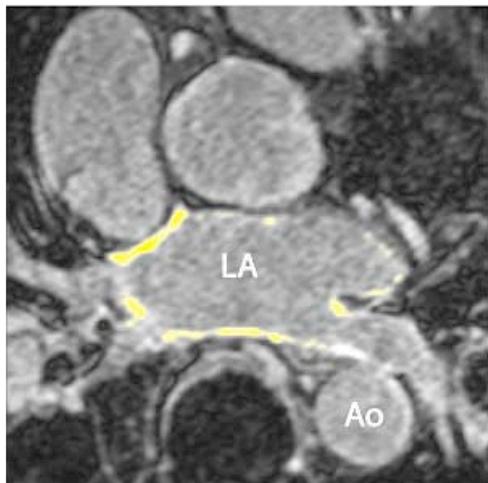
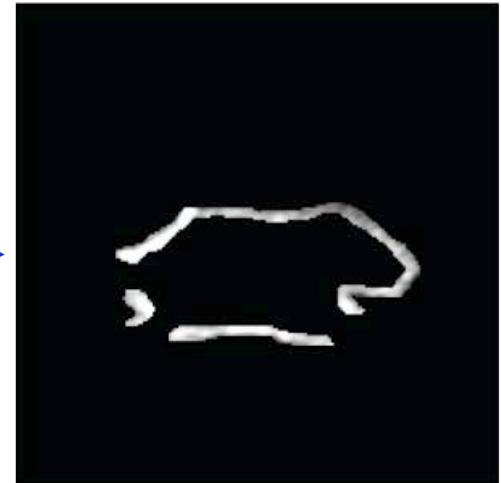
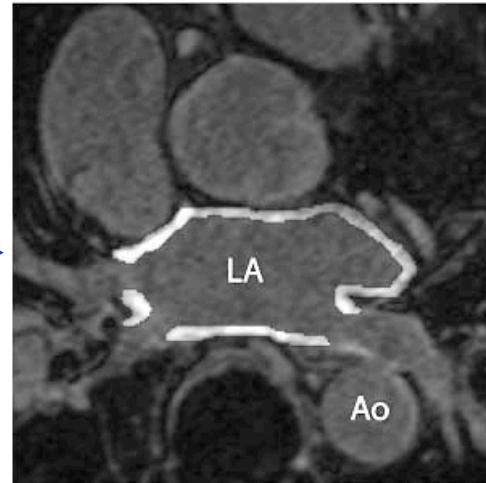
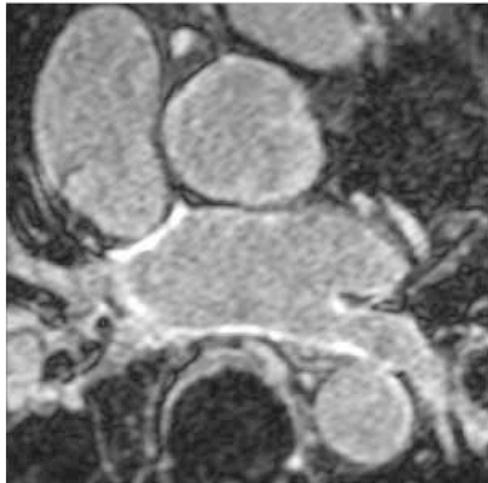


Akoum et al. J Cardiovasc Electrophysiol, 22:16-22, 2011



Fibrosis Imaging

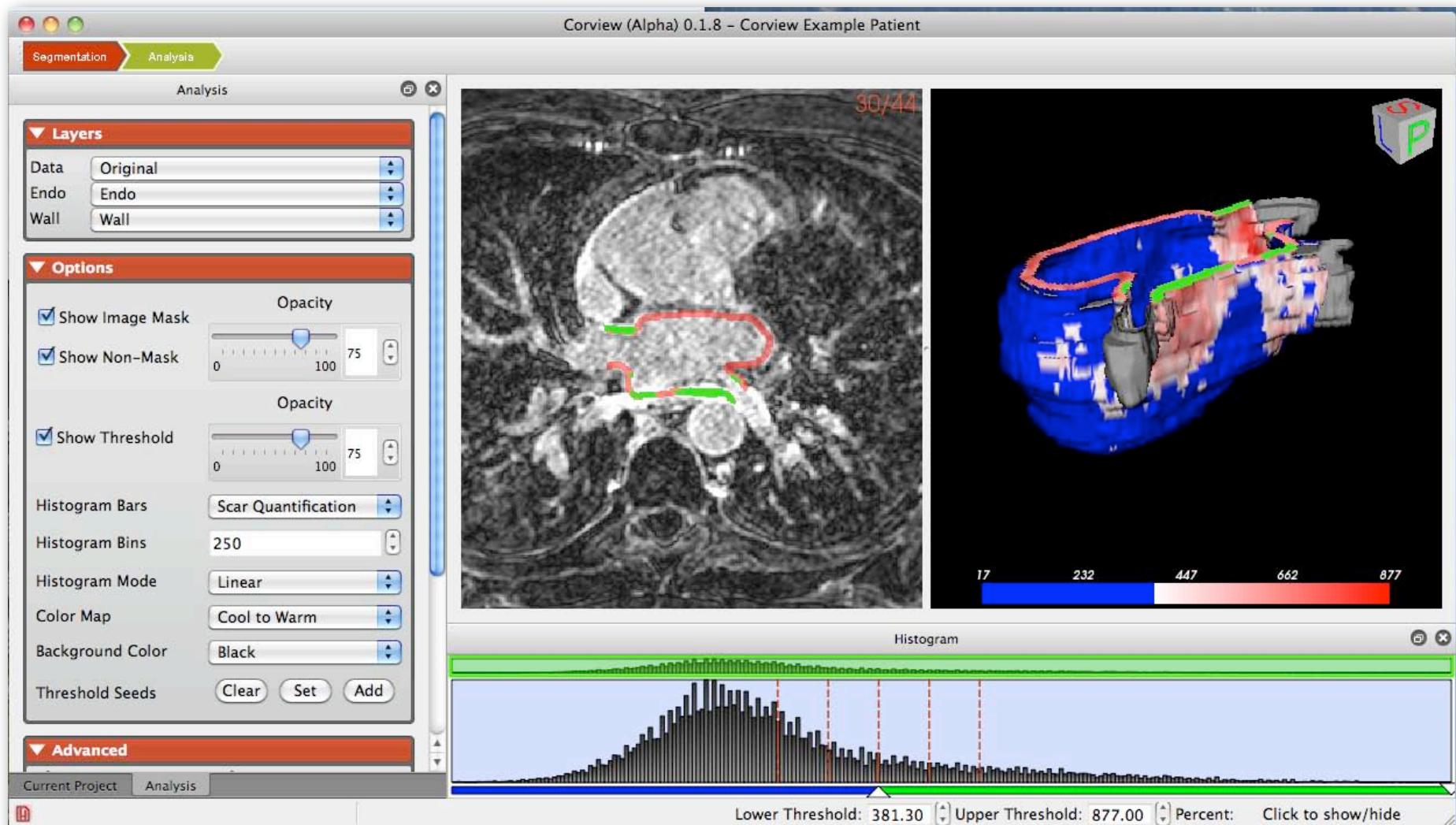
Evaluation





Corview

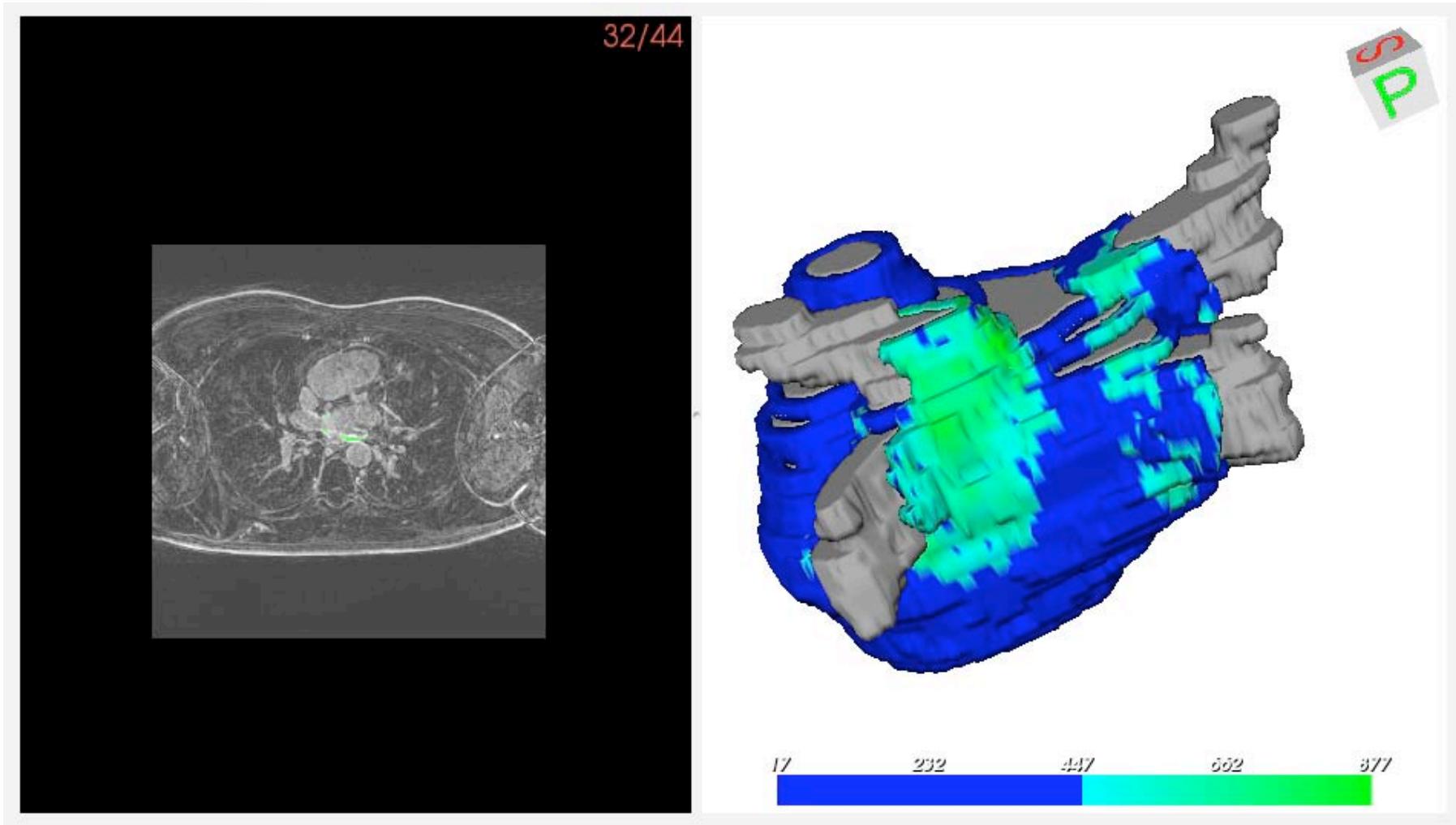
Evaluation





Corview

Evaluation

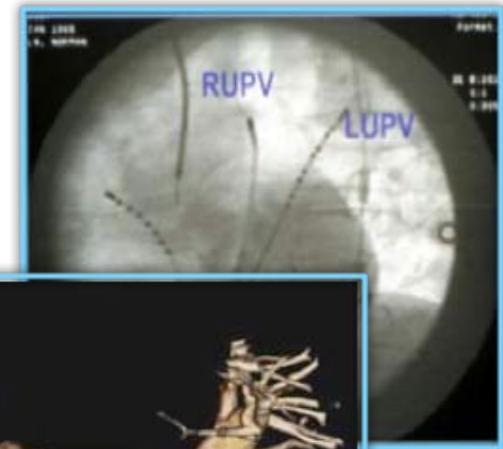
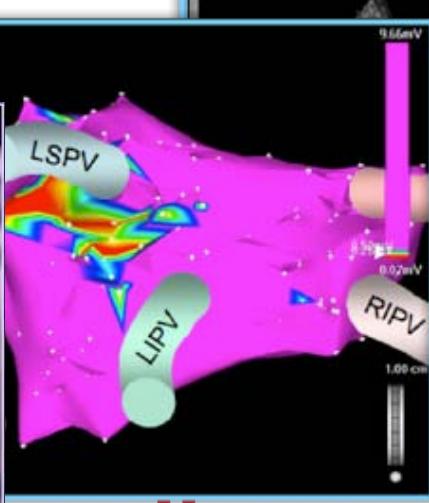
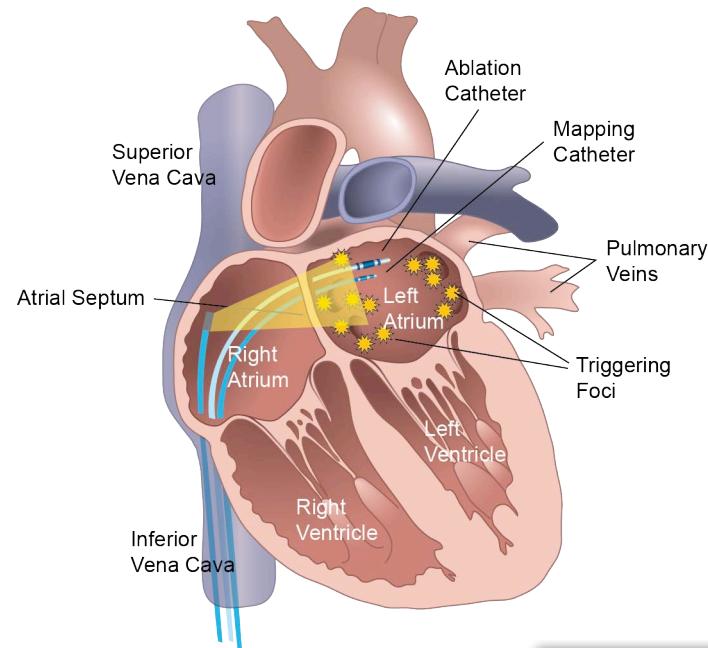


Patient Workflow



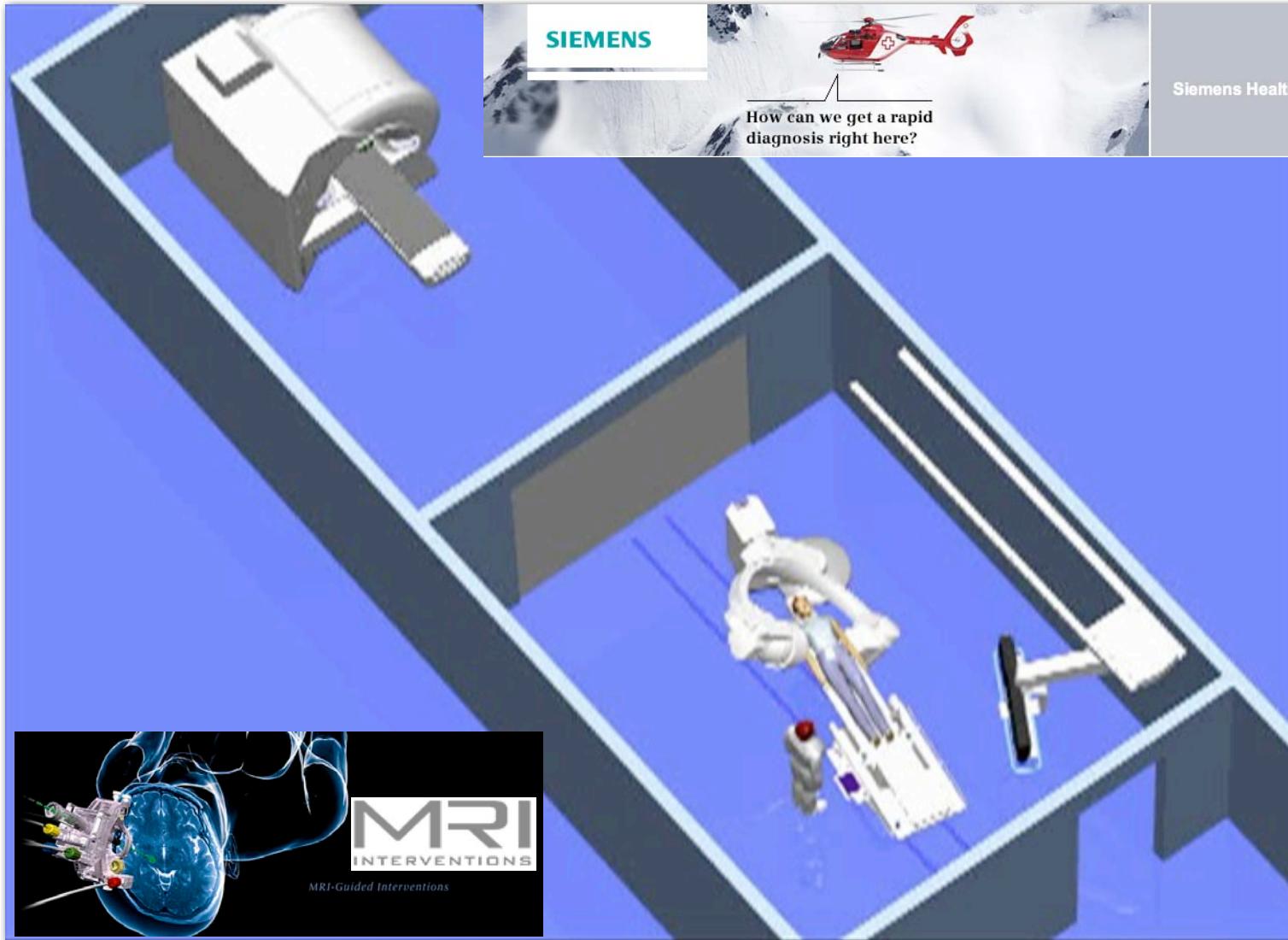
Ablation Guidance

Treatment



Treatment

Real Time MRI



Treatment

Real Time MRI

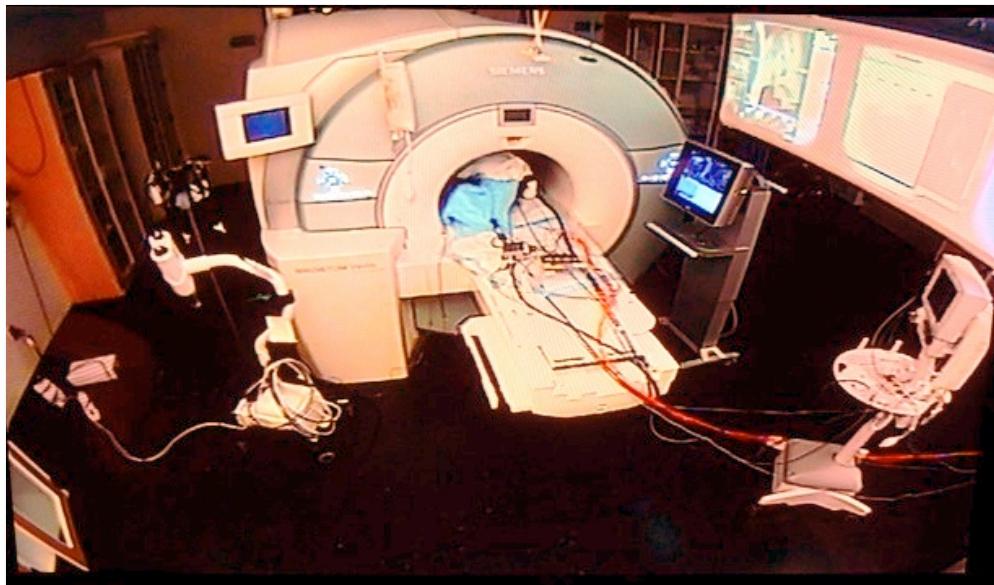


Experiments!

Treatment



Experiments!

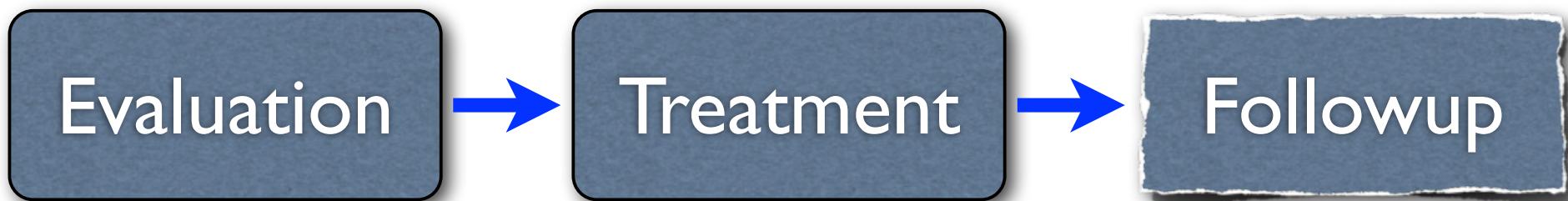


Treatment

Real Time MRI

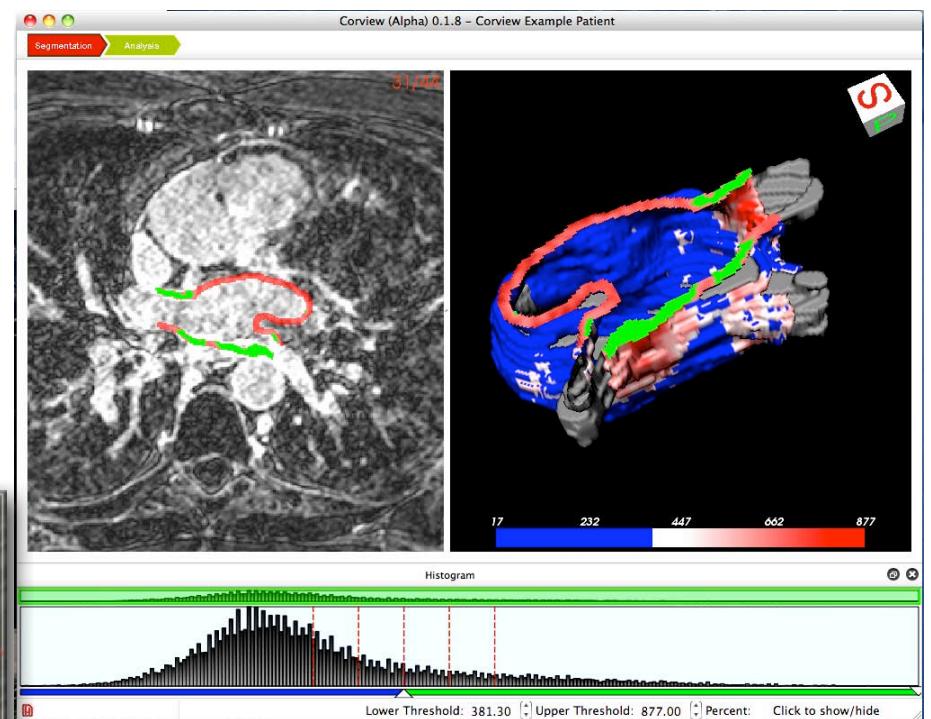
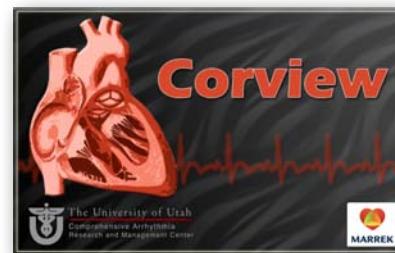
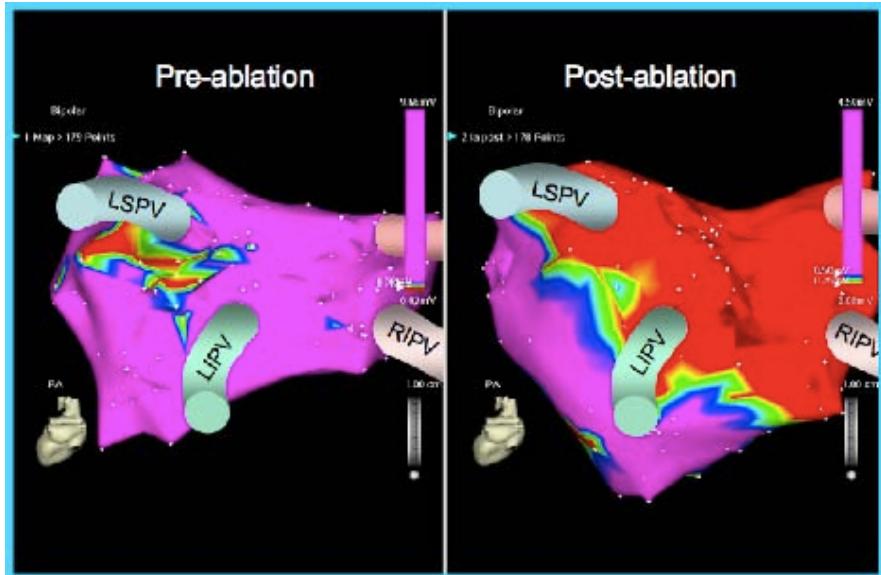


Patient Workflow



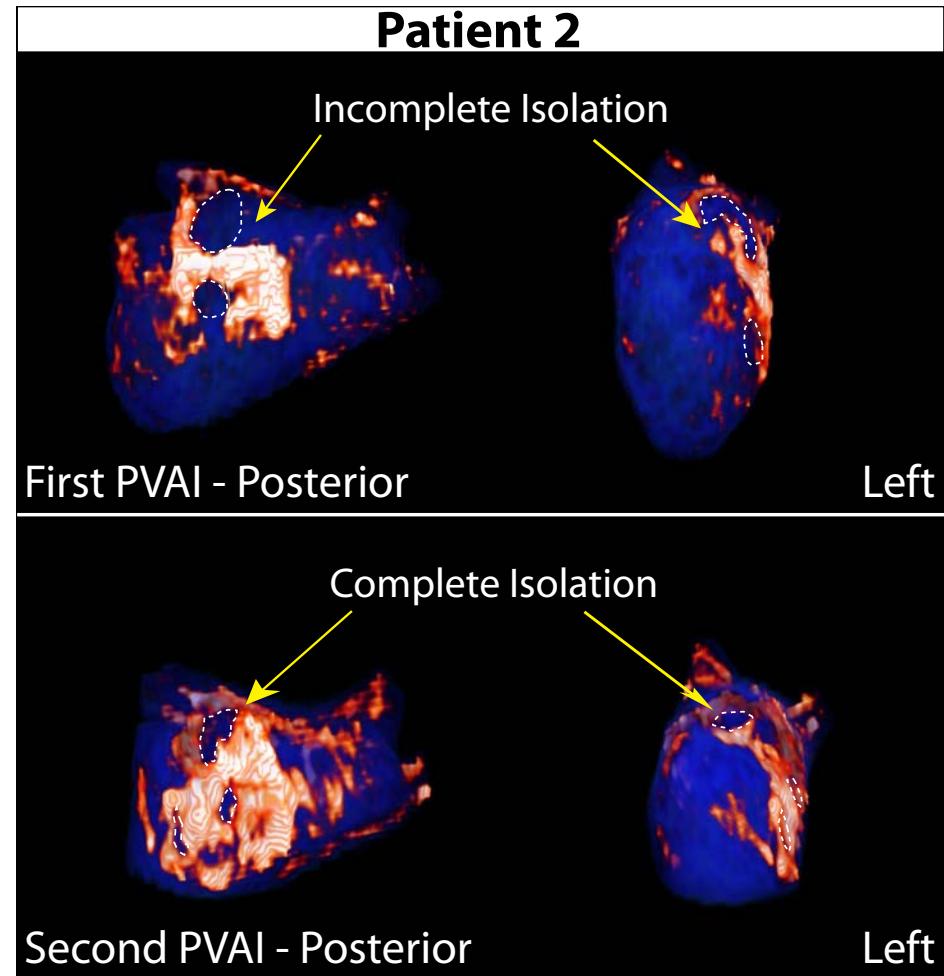
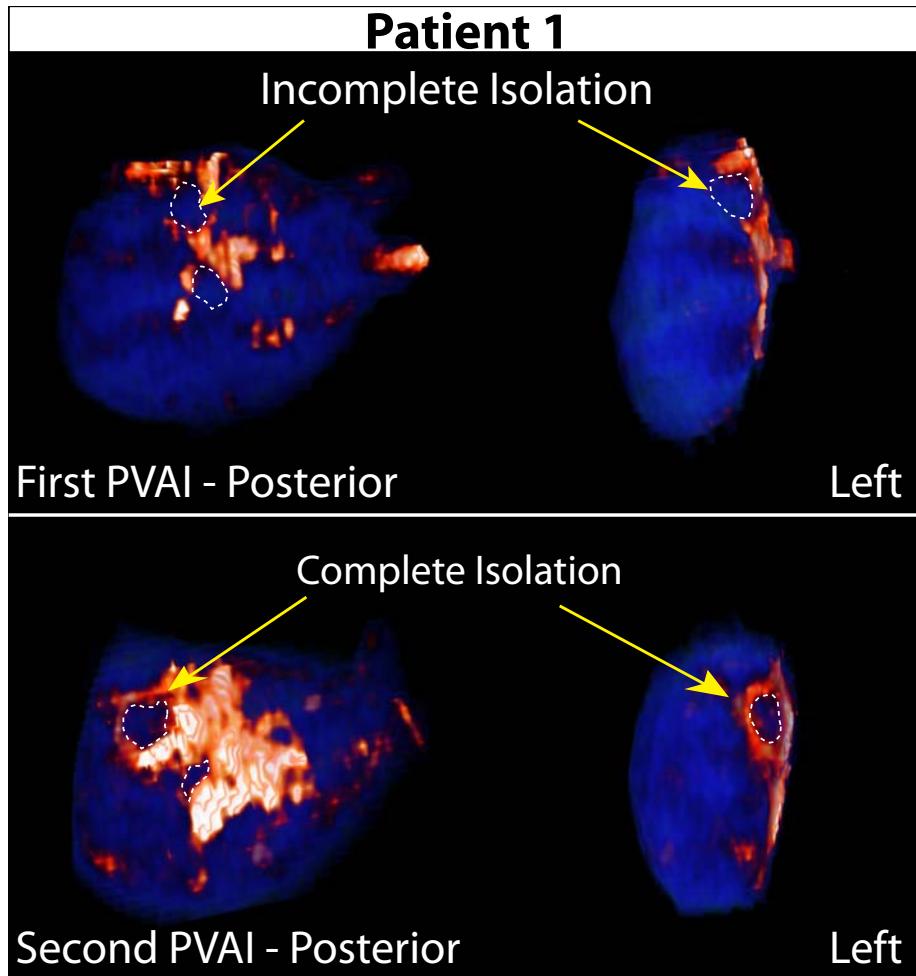
EAM vs. MRI

Followup



Followup

Repeat Ablation

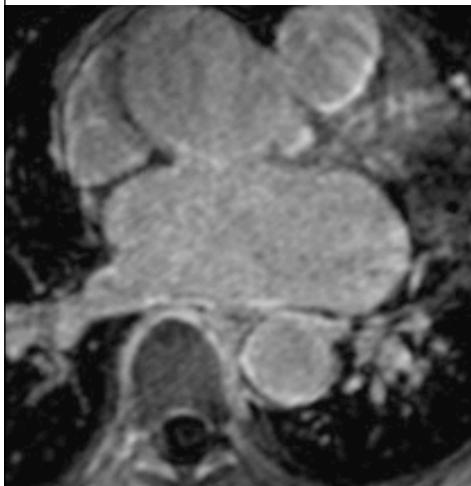


McGann et al. JACC, 52(15): 1263-1272, 2008

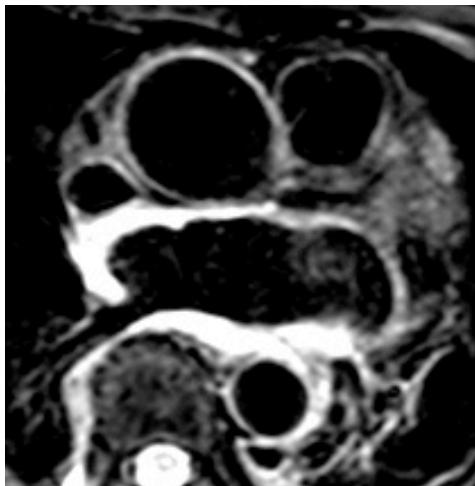


Predicting Success

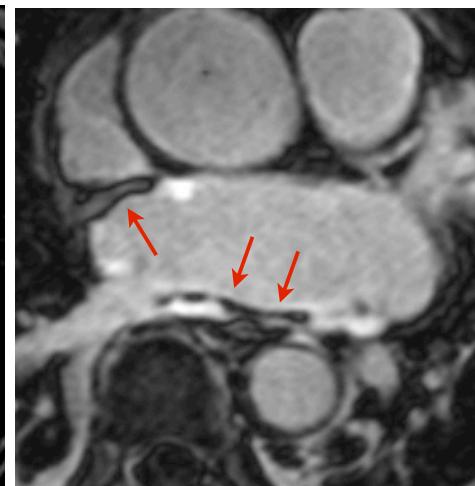
Followup



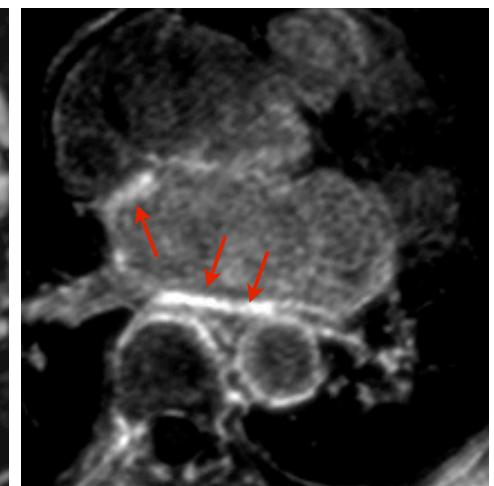
LGE (pre)



T2w (<1hr)

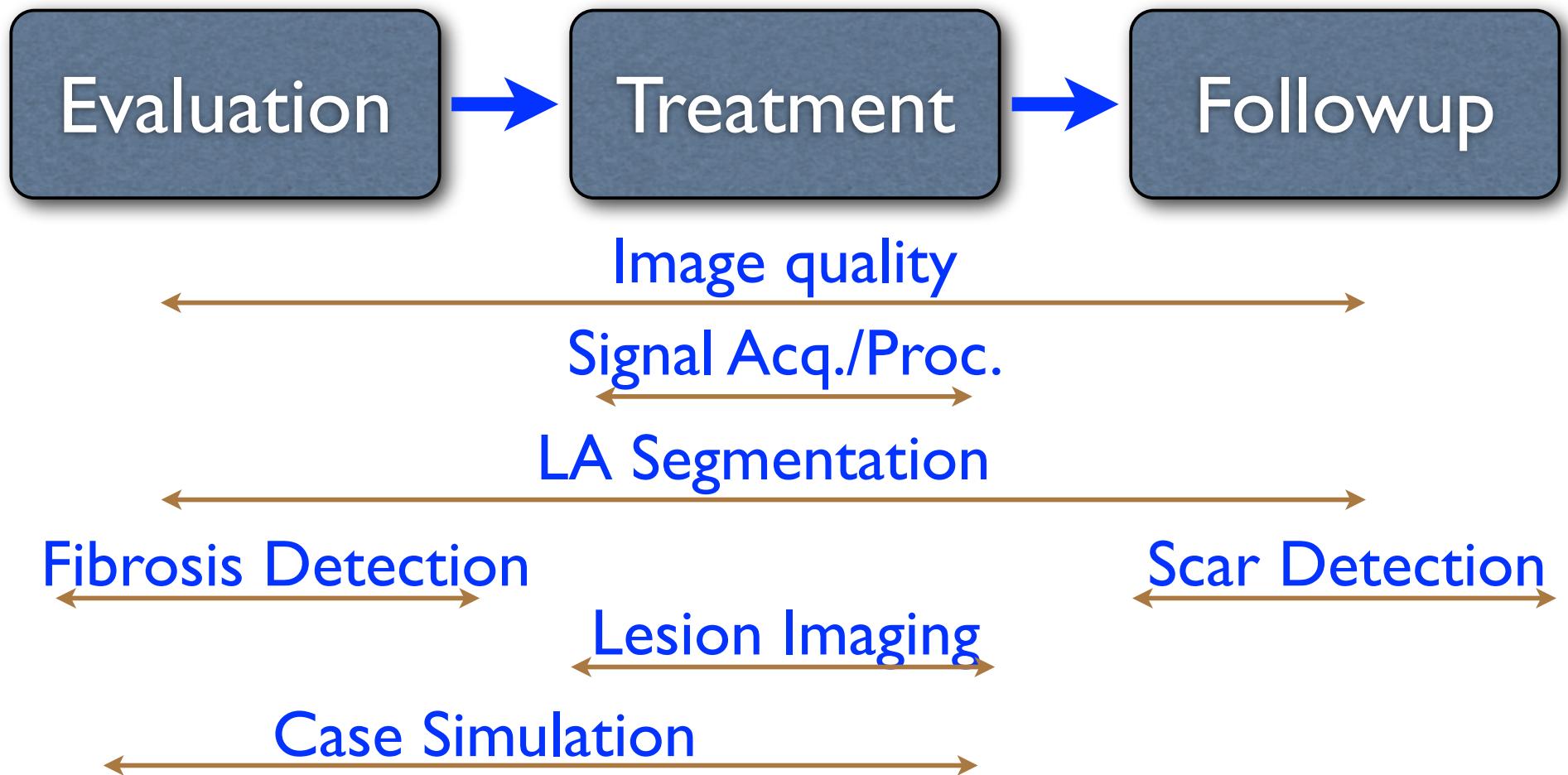


LGE (<1 hr)



LGE (3 mo)

Open Challenges



Animal Models of AFib



Utah Cooperative Arrhythmia Program

Hematology

Development
of chronic AF
animal model

Utah State University

Serum
markers of
inflammation

UCAIR,
Radiology

Pathology

Pathology and
histology of
fibrosis

UCAP

SCI

MRI analysis
and fibrosis
quantification

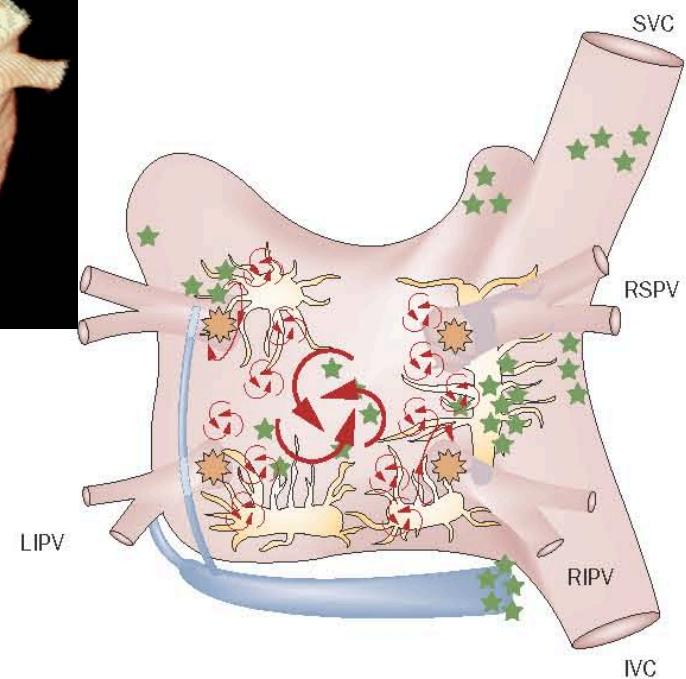
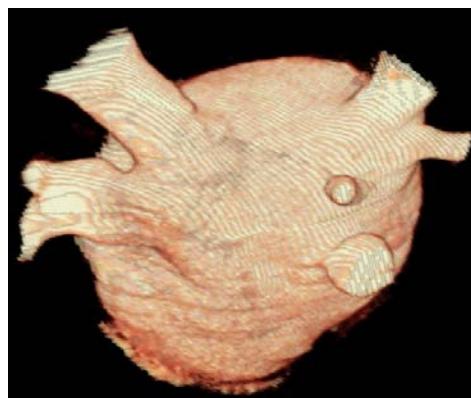
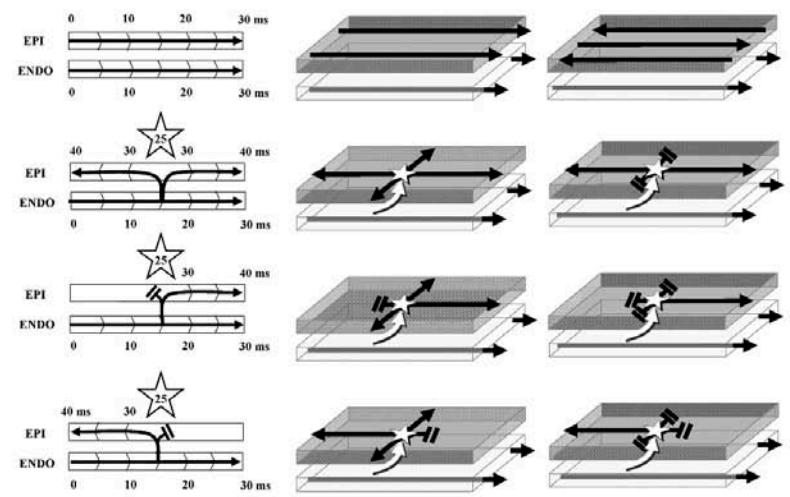
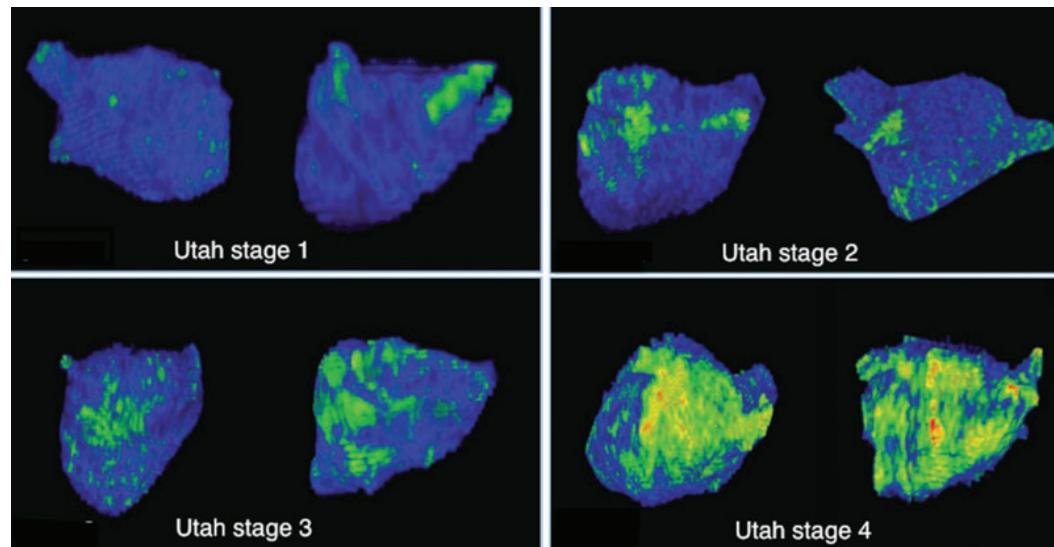
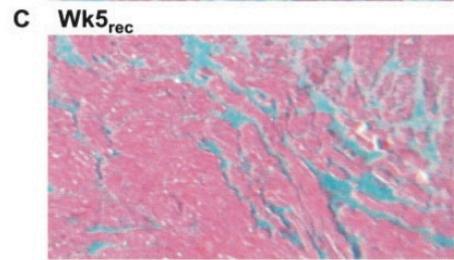
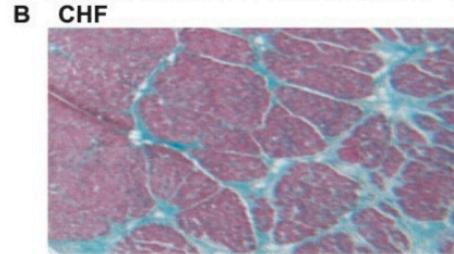
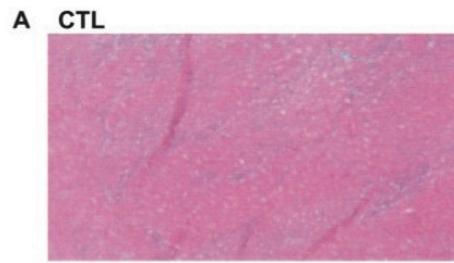
Clinical EP, Cardiology

Electro-
physiological
studies



Modeling and Simulations





Be Brave!!!



The ATRIA

Fibrillation



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