Image Analysis for Atrial Fibrillation

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CVRTI, CARMA
Normal Contraction  Atrial Fibrillation
AF Prevalence Is Increasing Rapidly

Projected Number of Persons With AF (millions)

Year

0  2  4  6  8  10  12  14  16

Current age-adjusted AF incidence
Increased age-adjusted AF incidence

AF Prevalence Is Increasing Rapidly

20% of Strokes

$20 billion/year
Clinical Imaging at CARMA

- Evaluation
- Treatment
- Followup
The CARMA Mantra

“Cardiac Arrhythmia is a substrate disease”

Ausma J, .... Allessie M ... J mol Cell Cardiol. 2001: 2083.
Evaluation → Treatment → Followup
Utah Scoring Scheme

Fibrosis Predicts Outcome

Recurrence by Pre-Ablation Delayed Enhancement

Proportion of Patients in Sinus Rhythm

Days since Ablation

- Utah I
- Utah II
- Utah III
- Utah IV

<5% SRM
5-20% SRM
20-35% SRM
>35% SRM
Blue is Normal

epi

endo
Green is Fibrosis
Imaging Modalities in AF Management

Fluoroscopy

Dyna CT

MR Angiography

Ultrasound

Real-time

Electroanatomical
Ablation Guidance
Real Time MRI
Post Ablation Scar Mapping

Incomplete Isolation

First PVAI - Posterior Left

Complete Isolation

Second PVAI - Posterior Left

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

Lesion

LGE (pre)  T2w (<1 hr)  LGE (<1 hr)  LGE (3 mo)

Time
The CARMA Questions

“Cardiac Arrhythmia is a substrate disease”

“How can we evaluate substrate?”

“How can we track substrate progression?”

“How can we ablate less?”
Image Analysis

The Engineering
Segmentation Goals
Segmentation Status

WALL: Easier, manual, TIME < 10mins.

Multi-Atlas Method (Yi Gao)

Automated Scar Segmentation

SPIE 2012
New Approaches

From this Meeting!

Nonparametric Approaches, Label Fusion (Golland)

Graph based segmentation (Whitaker)

Interactive segmentation (Tannenbaum)
CALL FOR PARTICIPATION

ISBI 2012 Challenge Workshop

Cardiac Delayed Enhancement Magnetic Resonance Image Segmentation
cDEMRRIS
**ISBI Challenge**

**CALL FOR PARTICIPATION**

**ISBI 2012 Challenge Workshop**

**Cardiac Delayed Enhancement Magnetic Resonance Image Segmentation (cDEMRIS)**

**cDEMRIS Challenge**: Delayed-enhancement magnetic resonance imaging (DE-MRI) is a powerful tool for detecting myocardial fibrosis and scarring in both the ventricles and atria. The figure shows three examples of DE-MRI slices of the left atrium (LA) where scar (see arrows) appears as brighter signal in locations of myocardium. Recently there has been much interest in the quantification of DE-MRI for a variety of applications. The quantification of DE-MRI in the LA of patients with atrial fibrillation has been shown to be potentially useful for selecting suitable candidates for ablation therapy and the subsequent monitoring of this therapy. This quantification is particularly challenging due to the thin myocardium of the atrium, the variable geometry of the LA, and the difficulties in imaging these patients at sufficient resolution and signal-to-noise ratio. This challenge-workshop will make available 60 DE-MRI clinical data sets to challengers for segmentation of enhanced regions from patients with atrial fibrillation. 30 data sets will be from patients prior to ablation therapy for fibrosis segmentation and 30 will be at least 3-months post-ablation therapy for ablation-related scar segmentation. Data provided will include the DE-MRI scans and a segmentation of LA cavity from an anatomical MRI, which is a guide to the LA wall, within which the enhanced regions are found. Ground truth will be established by using manual segmentations from clinical experts.

The cDEMRIS challenge workshop will be run as a collaboration between researchers, rather than a competition. There will be no “winner” and comparative results will be presented without rankings. We encourage participation by a broad selection of researchers using a range of methods, both complex and simple. Groups are encouraged to provide results from algorithms in preliminary stages of development. Each participant commits to submitting an abstract to the CDEMRIS’12 workshop summarizing the method used and results of the test dataset.

**CVRTI**

**SCI Institute**

**CARMA**
MICCAI Challenge

2012 Update: Ventricular Segmentation
Quantification

Pixel Intensity

Frequency

Pixel Intensity
CARMA Workflow
CARMA Workflow
Registration

Pre-Ablation (FIBROSIS)

Post-Ablation (SCAR)

How does the GREEN overlap with the RED?
Current Status
New Approaches

Landmark based registration (CARMA)
New Approaches

Segmentation driven registration (Gao)

Pre-Endocardium on Pre-op MRI
Some New Ideas
Image Merging

+ = ?

<table>
<thead>
<tr>
<th>Posterior Wall</th>
<th>Left Pulmonary Veins</th>
<th>Right Pulmonary Veins</th>
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<tbody>
<tr>
<td>11.9% Scar</td>
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Fluoroscopy
The Link

DynaCT
Some Results
Some Results
Some Goals
Some Goals

Biplanar

Monoplanar
Realtime MRI Guided Ablation
Real Time MRI

March, 2011
Current Status

Lesion Before

Lesion After
Challenges