DBP: Image Analysis for Atrial Arrhythmias

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Driven (Crazy?) by Doctors
The CARMA Team

CARMA = Comprehensive Arrhythmia Research and Management
Normal Contraction

Atrial Fibrillation

What We Know About AF

Substrate

Triggers
What We Know About AF

AF Triggers

Left Atrium
Pulmonary Veins

AF

AF Prevalence

Projected Number of Persons With AF (millions)

Year

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

20% of Strokes

$20$ billion/year

What We Do Not Know about AF: Everything Else

Mechanisms  Time Course  Environmental Factors  Genetics
The CARMA Mantra

“AF is a heart tissue disease”

Normal Early stage Mid stage Late stage


Structure Matters
Effective Treatment of AF Eventually Involves Intervention

CARMA Started Here
Utah Scoring Scheme: 2011

Utah Score Predicts Outcome

Utah Score Predicts Outcome

Recurrence Free Proportion

Follow up (days)

1200 Days

Log rank test p< 0.01

Utah I
Utah II
Utah III
Utah IV

MRI & Fibrosis: Blue is Normal

Chris McGann
Amit Patel
Histology Summary

Control  AF-mix  AF-fibrosis

1a  2a  3a

1b  2b  3b

1c  2c  3c
Treatment Option: Ablation
Not All Lesions Can Be Effective

Likely Effective

Potentially Effective

Epicardial Not Effective

DE-MRI Determinant of Successful Catheter Ablation of Atrial Fibrillation (DECAAF)
Results Support Utah Reports

Cumulative Incidence of AFib Recurrence
Recurrence Censored after 325 days

Fibrosis Analysis
Ablation Scar Analysis

Pre-treatment 3 month Post

The CARMA AF Workflow
The Corview Workflow

The Slicer Workflow

Inputs

Visualization

2D Dilation

Segment Wall

PV Antrum Cut

Scar Detection
CARMA Modules

Activities

Slicer Modules

- CMR Toolkit Wizard
- Automatic Cardiac MRI Inhomogeneity Correction Filter
- Automatic Left Atrial (Post-ablation) Scar Detection
- Cardiac MRI Registration
- Cardiac MRI Registration Using BRAINSFit
- PV Antrum Cut Filter
- Axial Dilate Filter
- Boolean REMOVE Filter
- Threshold Model
- Isolated Connected Image Filter
- Connected Threshold Image Filter
- Automated Graph Cut LA Segmentation

Slicer: Intensity Correction
Slicer: Pulmonary Vein Removal

Tutorials

- Automatic Cardiac MRI Inhomogeneity Correction Filter Tutorial
- Automatic Left Atrial Scar Tutorial
- Cardiac MRI Registration Tutorial
- Cardiac MRI Registration Using BRAINSFit Tutorial
- PV Antrum Cut Filter Tutorial
- Axial Dilate Filter Tutorial
- Boolean REMOVE Filter Tutorial
- Threshold Model Tutorial
- Isolated Connected Filter Tutorial
- Connected Threshold Filter Tutorial
- Slicer Workflow Tutorial
Good Tutorials

Events: Tutorial Contest June 2013

Congratulations to the winner of the Summer 2013 NAMIC Tutorial Contest!
- Tutorial: Cardiac MRI Toolkit
- Authors: Salma Bengali, Josh Cates, SCI, Utah

$250 Prize sponsored by Steve Pieper, Ph.D., Isomics (many thanks!)

Isomics, Inc.

2013 Slicer Demo

2013 ISMRM Cardiac Study Group CARMA

ISMRM 21st Annual Meeting & Exhibition
Salt Lake City, Utah, USA
20-26 April 2013
“Discovery, Innovation & Application – Advancing MRI for Improved Health”

CARMA

The University of Utah
Collaborative Projects

Other Projects
- Image registration capabilities for longitudinal analysis: Registration & Segmentation pipeline pilots & workflow development (Dominik Meier, Alex Zaitsev)
- Evaluation of BRAINSFit and fiducial-based registration tools for LA wall alignment and longitudinal registration of PV: BRAINSFit Registration of PVs
- Collaboration with GA Tech -
  - Test and evaluate Behnood’s wall segmentation - results and analysis are here: Automatic Wall Segmentation
  - Test and evaluate Yi Gao’s atlas-based endocardial segmentation algorithm: Automatic Endocardial Segmentation
  - Test and evaluate Yi Gao’s image and segmentation-driven registration algorithm: Image and Segmentation-Driven Registration

Open Data

Sample Data
- Sixty anonymized datasets containing LGE-MRI image data and segmentations of the left atrium from patients with atrial fibrillation: Pre and Post Radiofrequency Ablation LGE-MRI Collection
- Sixty segmentation datasets of the left atrium from patients with atrial fibrillation who have undergone radiofrequency catheter ablation for treatment: CARMA Longitudinal Left Atrial Shape Data
- Two subjects, two time points: CardiacMRIs.

http://www.insight-journal.org/midas
What Has CARMA Brought to NA-MIC?

Access to Image Based Medicine
Access to Data

Real World Testing
Dissemination

What Next?
Improved Segmentation

Segmentation Performance

Case 1  Case 2  Case 3

2 mm

4 mm

8 mm
Segmentation Performance

Mean Deformation [mm]

Fibrosis Change [%]

Patient 1  Patient 2  Patient 3  Patient 4  Patient 5

Image Guided Ablation
RF Ablation

Not All Lesions Can Be Effective

Likely Effective
Potentially Effective
Epicardial Not Effective
Image Merging

+ 

= ?

Fluoroscopy Results
EAM (Carto) Results

Shape
**Shape Analysis**

LA Shape and Outcome

- 152 AF Patients
- 6 Shape Parameters
LA Shape and Outcome

Joint Shape and Image Prediction of Outcome


Yi Gao, Liangjia Zhu, Rob MacLeod, Josh Cates, Allen Tannenbeum
Shape Based Registration

Greg Gardner
Koji Higuchi
Alan Morris
Josh Cates

Seventh Annual Western Atrial Fibrillation Symposium

http://healthsciences.utah.edu/carma/education/waf
Visionaries

Steve — You Inspire Me

Thanks Ron!

Visionaries

Ron — You Inspire Me

Thanks Ron!