Cardiology Research Committee Meeting

9.4.20

Agenda

- Introductions - all
- Purpose – Dr. Mounsey
- Process Overview – Dr. Al'Aref
- Current project review - Laura
- Upcoming projects
  - Dr. Sharma - Coronary artery calcium score as a predictor of peri-operative major adverse cardiac events in patients undergoing non-cardiac surgery
  - Dr. Al'Aref - Machine Learning and Deformable Model-based 4D Characterization of Cardiac Dyssynchrony from MRI

Current Projects

- Clinical/Commercial Trials
  - WARRIOR, Tricuspid Valve Regurgitation Survey, MINT
- Primary/Community Intervention
  - UAMS Lincoln, EPA crop burning
- Data Registries
  - Global Cardiology, Afib, AI, Death registration data
- Telemedicine
  - PCORi - Digital Platform to Manage Heart Failure, MyChart Adoption

Upcoming Projects

Coronary artery calcium score as a predictor of peri-operative major adverse cardiac events in patients undergoing non-cardiac surgery

Tanya Sharma

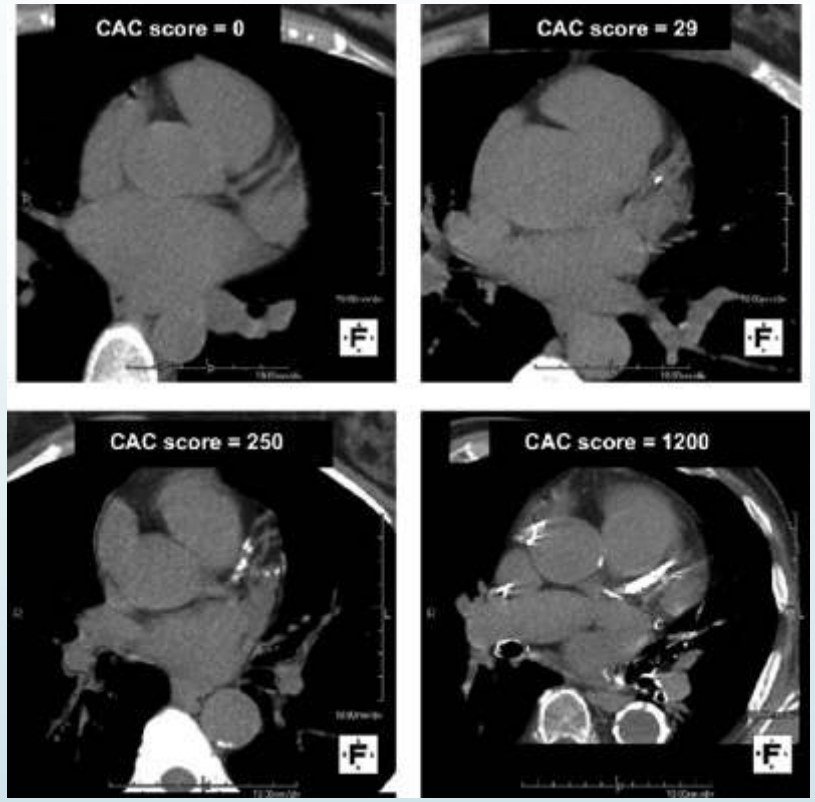
PGY2

Internal Medicine

Background

- Limitations in capacity to predict peri-operative Major Cardiac Adverse Events (MACE) in individual patients with existing pre-operative risk assessment strategies
- Current approach is restricted to identifying highest risk patients (through RCRI and traditional scores) and patients with ischemia (through stress testing)
- Peri-operative MI and mortality is often a consequence of plaque rupture, an anatomic evaluation of the coronary vasculature may offer an advantage
- Coronary artery calcium (CAC) score uses non-contrast CT scan to quantify calcium plaque burden
- Different methods of calculation: Agatston method, calcium volume score, relative calcium mass score

Coronary artery calcium score



ACCF/AHA 2007 clinical expert consensus document on coronary artery calcium scoring:

- CAC score of 100–400—relative risk of 4.3 (95% CI: 3.1–6.1);
- CAC score of 401–999—relative risk of 7.2 (95% CI: 5.2–9.9);
- CAC score = 1000—relative risk of 10.8 (95% CI: 4.2–27.7).

*Image courtesy https://my.cleavelandclinic.org

Current literature

Table 3 CAC score and risk of perioperative major adverse cardiovascular events

	OR	95% CI	P value
CAC score ≥100 *	5.08	2.15 to 11.99	<0.001
CAC score ≥400 *	3.93	2.06 to 7.50	<0.001
CAC score ≥1000 *	10.42	1.56 to 69.72	0.016

*CAC ≥100 compared with CAC <100; CAC ≥400 with <400, CAC ≥1000 with <1000.
CAC, coronary artery calcium.

Koshy AN, *et al*. *Heart* 2019;**105**:1335–1342. doi:10.1136/heartjnl-2018-314649

- 7 studies, 1341 patients
- Meta-analysis of 5 studies by Koshy et al.
- Most focused on specific populations/ surgeries
- 2 studies included all non cardiac surgeries in general population

Current literature (contd)

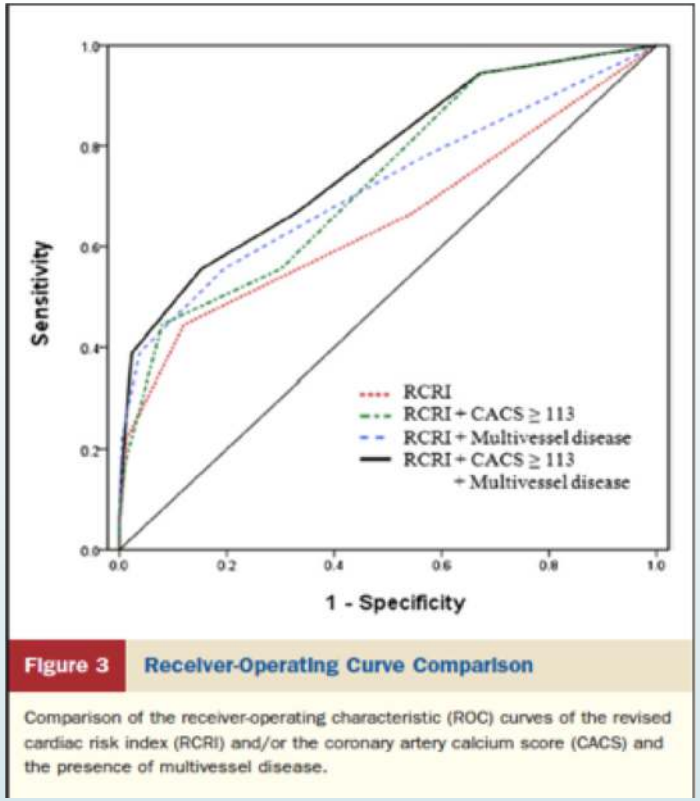


Figure 3 Receiver-Operating Curve Comparison

Comparison of the receiver-operating characteristic (ROC) curves of the revised cardiac risk index (RCRI) and/or the coronary artery calcium score (CACS) and the presence of multivessel disease.

Ahn JH, Park JR, Min JH, et al. Risk stratification using computed tomography coronary angiography in patients undergoing intermediate-risk noncardiac surgery. *J Am Coll Cardiol*. 2013

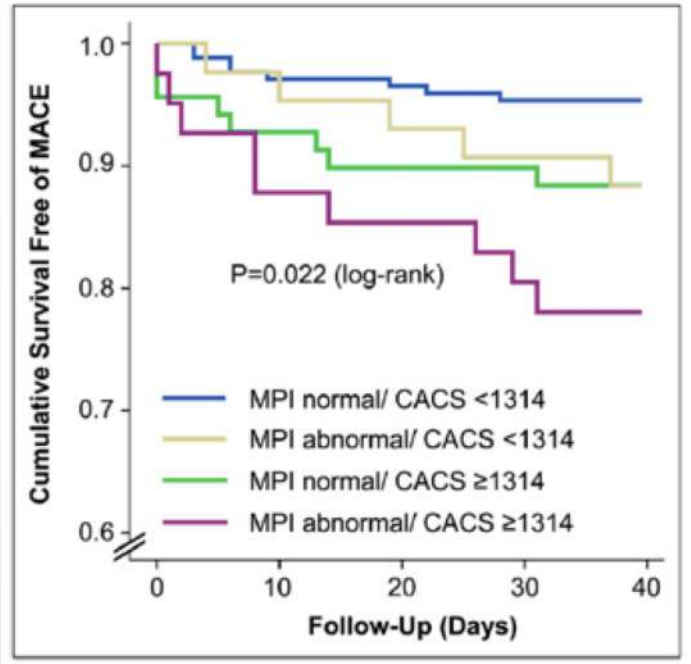


FIGURE 2. Kaplan–Meier survival curves for cumulative survival free of MACE according to subgroups of normal or abnormal SPECT MPI findings and CACS above or below 1,314 ($P < 0.05$, log-rank test).

Ghadri JR, Fiechter M, Veraguth K, et al. Coronary calcium score as an adjunct to nuclear myocardial perfusion imaging for risk stratification before noncardiac surgery. *J Nucl Med*. 2012

Aim

- To study the utility of CAC score in predicting peri-operative MACE
- Comparing it to the predictive value of pre-operative functional scales (RCRI, Gupta score) and stress-testing

Study design

- Retrospective observational study
- Study period: May 2014- August 2020
- Timeline: 6 months-1 year
- Data collection: Preliminary dataset, EPIC chart review
- Inclusion
  - All patients between ages 18-99 years undergoing non-cardiac surgery at UAMS
  - Have a SPECT within a year preceding surgery
- Exclusion
  - Known coronary artery disease

Study design (contd.)

- Method

  - Calculating CAC score by Agatston method using CT scan done for attenuation correction during SPECT, calculating RCRI for all patient

- Outcome

  - In-hospital MI (troponin elevation with significant ischemic changes on ECG), new-onset heart failure, hemodynamically significant arrhythmias, and death from cardiovascular causes

- Other data-points

  - Demographics
  - Data points to calculate RCRI

References

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- Shalaeva EV, Saner H, Janabaev BB, Shalaeva AV. Coronary artery calcium score and coronary computed tomographic angiography for major perioperative cardiovascular complications in symptomatic diabetic patients undergoing trans-femoral amputation. Int J Cardiol. 2016;221:806-811. doi:10.1016/j.ijcard.2016.06.165

Machine Learning and Deformable Model-based 4D Characterization of Cardiac Dyssynchrony from MRI

Background

- In the US, the number of heart failure (HF) related deaths is on the rise, with more than 1:8 death certificates currently listing the disease and about 50% of people diagnosed with HF dying within 5 years.

- HF patients often develop impaired interventricular conduction. This results in dys-synchrony of ventricular contraction, which leads to progressive deterioration in cardiac output and worsening HF.

- Dys-synchrony can be treated via cardiac resynchronization therapy (CRT) however, based on our current over- and under-conclusive selection criteria, the success rate of CRT is only 2/3, which is quite low based on the invasiveness and cost of this treatment.

- Given the limited reliability of the conventional criteria to predict response to CRT, one would expect that using imaging of cardiac mechanics to select patients would improve the response ratio of CRT.

Background

- High resolution tomographic dynamic images, such as acquired with cine cardiovascular magnetic resonance (CMR), have the potential of improving this response ratio, as they can capture morphometry and cardiac mechanics with much higher spatial resolution than echocardiography.

- The goal of this proposal is to develop machine learning based technology that more accurately quantifies local and global characteristics of the LV motion and strain, based on CMR, with the expectation that this will be useful for selecting candidates for CRT, as well as other applications.

Collaborators

- **UAMS**
  - Subhi J. Al'Aref - Assistant Professor & Director of Research at the Division of Cardiology
- **Rutgers University**
  - Dimitris N. Metaxas - Distinguished Professor and the Chair of the Computer Science Department at Rutgers university
- **NYU**
  - Leon Axel - Professor, Department of Radiology at NYU Grossman School of Medicine

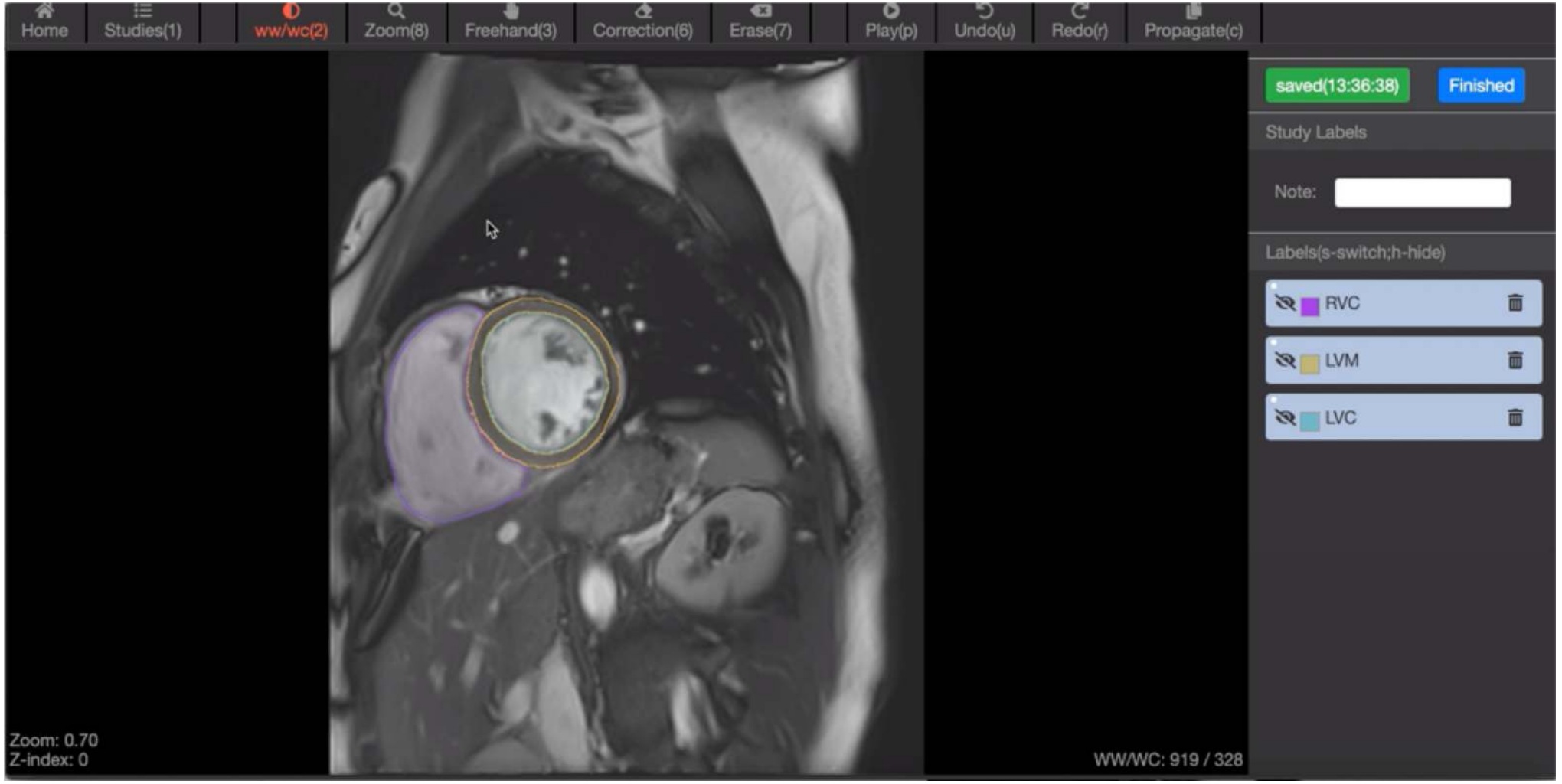
Objectives

Aim 1: Develop novel end-to-end ML-based cardiac MRI analysis tools, that will: a) detect and classify cardiac regional dysfunction for cardiac dyssynchrony, and b) provide information that will clarify how those decisions were arrived at, for better clinical utility.

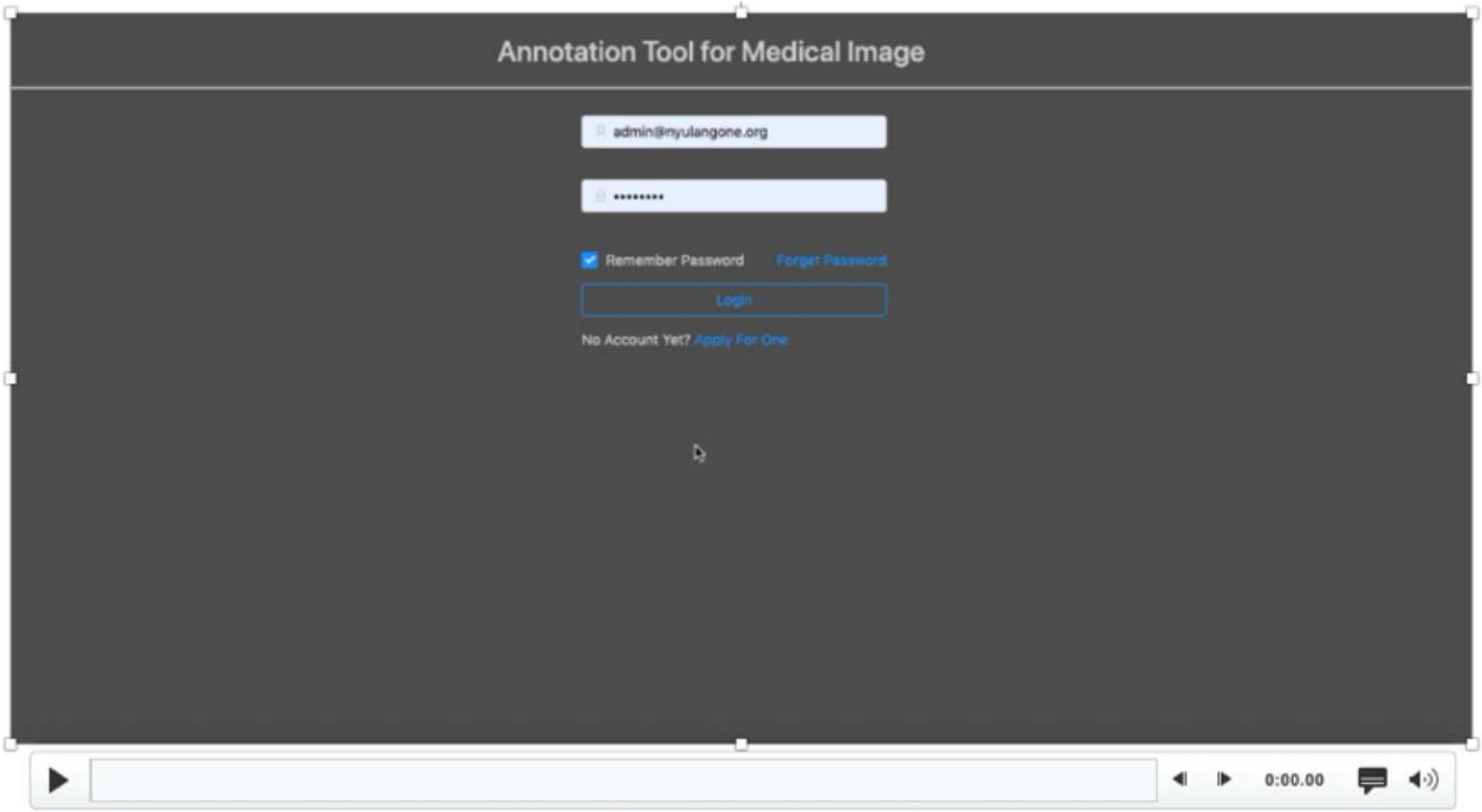
Aim 2: Use of novel ML methods to characterize different types dyssynchrony.

Aim 3: Validate the performance of these ML-based cardiac MRI models within the clinical realm, specifically for the determination of response to cardiac resynchronization therapy (CRT).

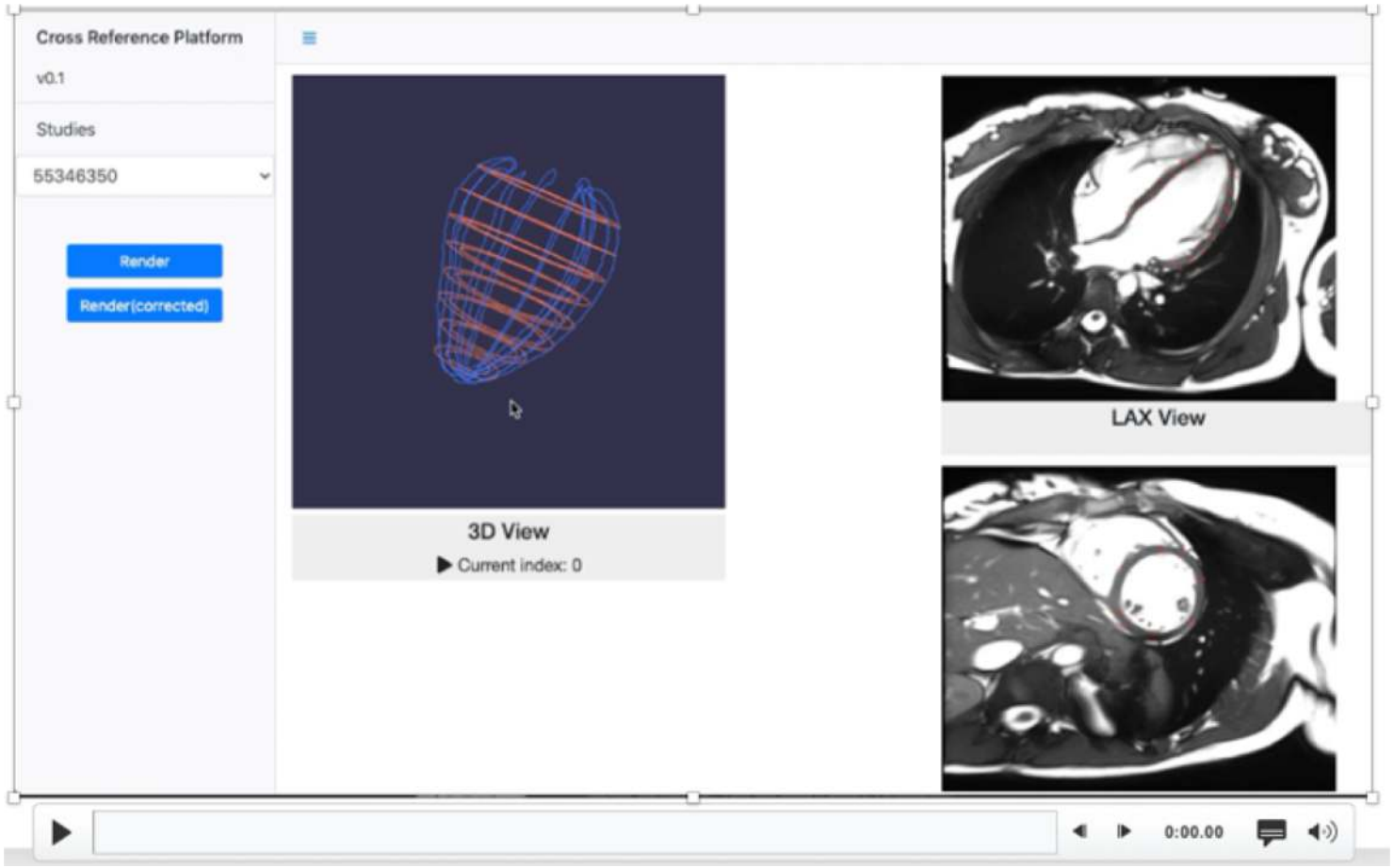
Annotation Platform



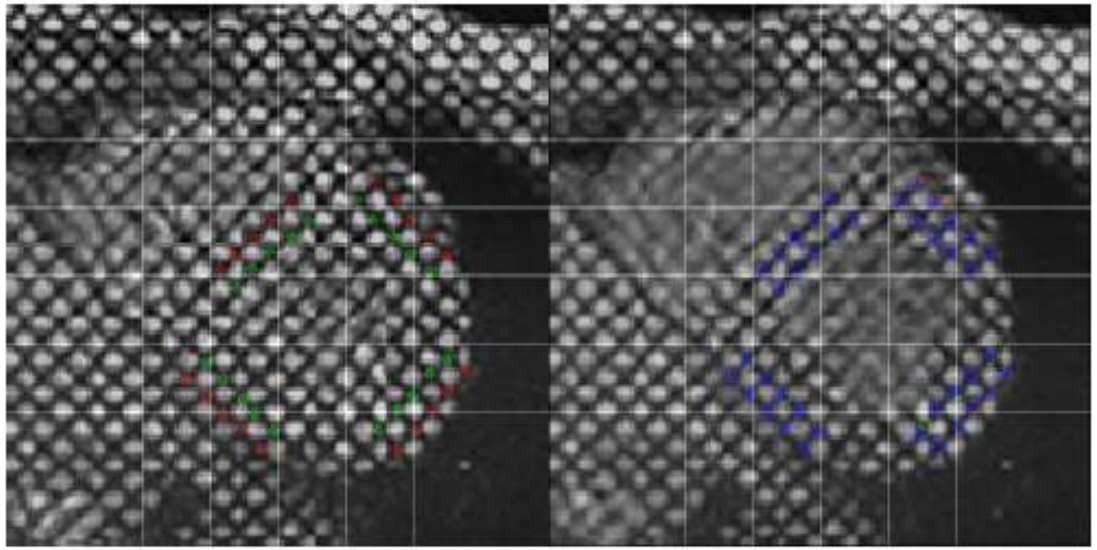
Annotation Platform

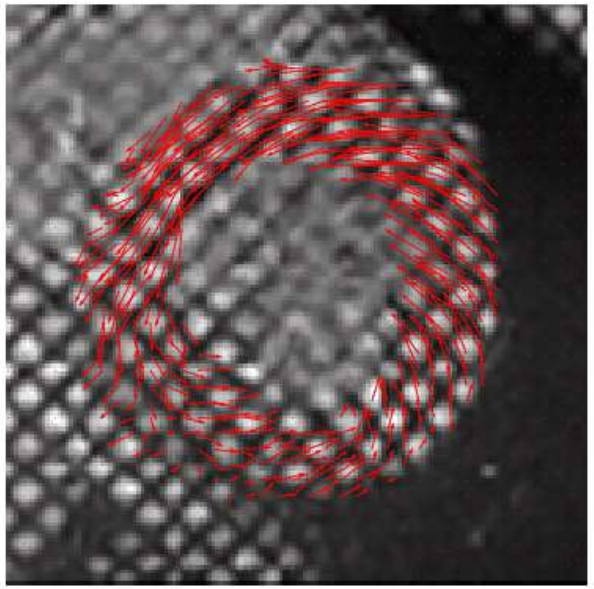


3D analysis platform



Tagging image strain analysis





Study Design

Patients meeting criteria for CRT and have had a CMR for clinical indications within 6 months

Consent and evaluate at baseline

Evaluate at 6-months follow-up

Data will be used to prospectively validate model performance for predicting response to CRT

Patient Recruitment

Inclusion criteria:

A. Patients with cardiac MRI study within 6 months of planned CRT procedure.

B. Patients meeting criteria for CRT implantation:

1. LVEF ≤35 percent + QRS ≥150 ms with LBBB, and NYHA class II-VI.
2. LVEF ≤35 percent + QRS ≥150 ms with non-LBBB, and NYHA class III-IV.
3. LVEF ≤35 percent + QRS <150 ms and NYHA class II-IV.
4. LVEF 35-50% who require a pacemaker and are expected to be paced >40% of the time.

C. Patients willing and able to sign the consent form.

Exclusion criteria:

A. Irregular heart rate or other sources of significant degradation of the MRI images.

B. The existence of a concomitant medical condition that limits life expectancy to less than 6 months.

Prospective recruitment of patients with evaluation of clinical status (NYHA class, heart failure medications, 6-min walk test, serum blood testing including NT-proB-type Natriuretic Peptide (BNP) level, EKG and Echocardiography parameters) at baseline and 6-months follow-up after CRT placement.