

Young Investigator's Award Competition (YIA)

Monday, June 15, 2015

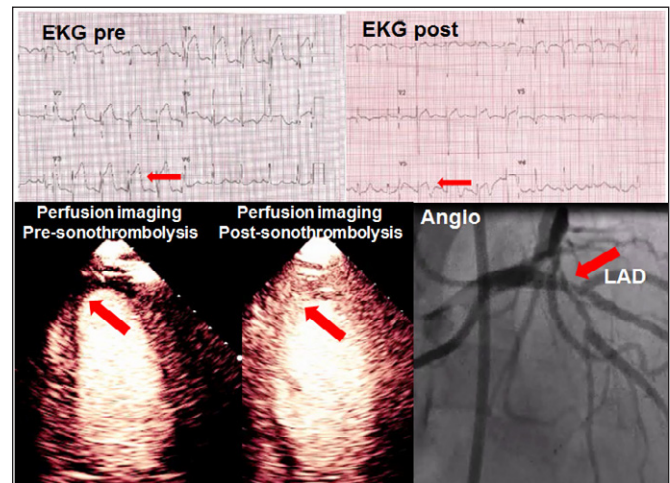
2015 ARTHUR E. WEYMAN
YOUNG INVESTIGATOR'S AWARD
COMPETITIONMonday, June 15, 2015
Presented 8:00 am-9:30 amEmerging Use of Echocardiography / Point of Care
Echocardiography
YIA-1 and YIA-3Ventricular Function / Myocardial Mechanics
YIA-2 and YIA-4

YIA-1

Safety and Feasibility of Diagnostic Ultrasound High Mechanical Index Impulses in Restoring Epicardial Flow in Acute ST Segment Elevation Myocardial Infarction in Humans

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Objective: Intravenous microbubbles (MB) and transthoracic ultrasound have been utilized to recanalize both the microvasculature and epicardial vessels in animal models of ST segment elevation myocardial infarction (STEMI). The feasibility, safety and efficacy of such an ultrasound guided approach in humans with STEMI have not been studied. **Methods:** Twenty four patients (18 males; 58±9 years) with acute STEMI (15 anterior) were randomized. Diagnostic ultrasound guided high mechanical index (MI) impulses were applied within and outside the risk area during a continuous infusion of intravenous 3% Definity®. Patients either received custom designed high MI impulses (1.7 MHz; 1.3 MI) at 4-20 usec pulse duration (GI, n=7), or repeated diagnostic high MI impulses <2 usec pulse duration at an MI=1.0 (GII, n=8) whenever very low MI perfusion imaging detected microbubbles within the microvasculature. A control group (GIII, n=9) received limited diagnostic high MI impulses (<5) just to analyze perfusion before and after percutaneous coronary intervention (PCI). All randomized ultrasound treatments were before and immediately after emergent PCI. Comparisons were made on door to dilation times, survival, angiographic recanalization rates (ARR) at initial angiography, and reduction in infarct size determined by the salvagability index (SI) at magnetic resonance imaging 72-96 hours post STEMI. **Results:** There were no deaths during the initial treatment period pre-PCI in any group. No delays in door to dilation time were observed in GI vs GII, GIII respectively, 76±35 vs 70±20 vs 81±13 minutes respectively, p=ns. ARR and SI were significantly higher in GII (75% ARR and 46±15% SI for GII compared to 23% ARR and 28±10% SI for GI and 0% ARR and 25±10% SI for GIII; p=0.005). Figure 1 shows a case with reduction of ST elevation in a patient of GII and open artery at initial angiography. **Conclusions:** Utilization of a standard diagnostic ultrasound transducer to apply high MI impulses to the microvasculature in acute STEMI is safe and feasible in a large emergency department setting. The acoustic radiation forces and cavitation generated by repeated diagnostic high MI impulses applied to the entire myocardium may be a method of achieving early recanalization in acute STEMI, and improving the salvagability index.

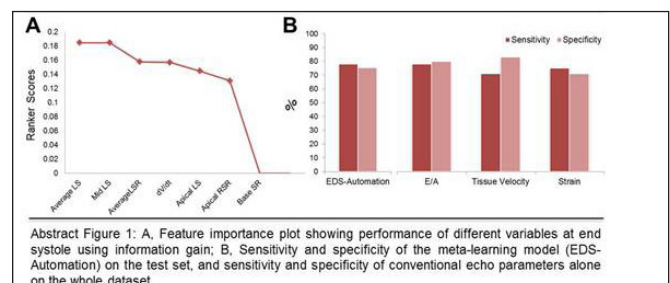


YIA-2

Automated Morphological and Functional Phenotyping of Human Heart with Feature Tracking of 2D Echocardiographic Images Using Machine Learning Algorithms

Sukrit Narula, Shameer Khader, Sharath Vallabhajosyula, Alaa M. Omar, Joel T. Dudley, Partho P. Sengupta. Icahn School of Medicine at Mount Sinai, New York, NY

Background: Automated echocardiography decision system (EDS-automation) may aid new users of cardiac ultrasound for rapid and accurate assessment of echocardiographic images. This investigation presents the development and validation of a machine learning framework that incorporates speckle tracking echocardiographic data for fully automated discrimination of pathological remodeling seen in hypertrophic cardiomyopathy (HCM) from physiological hypertrophy seen in athletes (ATH). **Methods:** Speckle tracking echocardiography (STE) was performed on expert annotated image data sets obtained from a cohort of 121 subjects (77 ATH and 44 HCM patients). Numerical data extracted from the images was used as input for EDS-automation. The model was designed by integrating predictions from three different algorithms (Artificial Neural Networks, Random Forests, Support Vector Machines) using a majority voting method to attain concurrency in prediction results. The model was tested on an exploratory dataset with 40 ATH and 40 HCM patients and tested on discovery cohort with 37 ATH and 4 HCM to find the most predictive time point in systole. Furthermore, the features that contributed to the classification task were determined using information gain algorithm. **Results:** The EDS-automation model derived from variables at end-systole provided optimal case classification (area under the curve for cross-validation and test samples, 0.75 and 0.77, respectively). Information gain algorithm revealed average longitudinal strain as the most predictive parameter (ranker score, 0.19; abstract Figure 1A). The diagnostic value of the EDS-automation model for differentiating HCM from ATH was comparable to expert derived conventional echocardiographic measurements namely early-to-late diastolic trans-mitral velocity ratio (E/A), average early diastolic tissue velocity, and average longitudinal strain (abstract Figure 1B). **Conclusion:** EDS-automation can aid in accurate morphological and functional discrimination of physiological versus pathological patterns of hypertrophic remodeling. This effort represents a step towards the development of a real-time guidance system for interpreting echocardiographic images, which is capable of full automation without human input.



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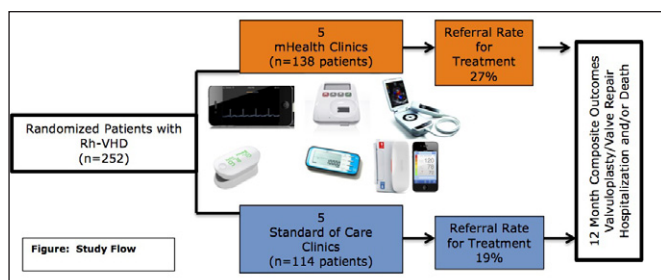
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YIA-3

A Randomized Trial Integrating Pocket Ultrasound with mHealth Diagnostics in Modern Structural Heart Disease Clinics

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Background: Modern advances in miniaturized ultrasound and wireless mobile health (mHealth) technologies represent promising methods to diagnose the severity of structural heart disease (SHD) at the point-of-care (POC). The current study assessed the integration of smartphone-based mHealth devices with handheld echocardiography (handheld-echo) for characterizing the severity of disease in patients with rheumatic valvular heart disease (Rh-VHD). **Methods:** We prospectively randomized 252 Rh-VHD patients referred to a tertiary care out patient clinic to assessments at 5 mHealth clinics (n=138 patients) or 5 standard of care clinics (Standard-care, n=114 patients). The mHealth clinics were equipped with a handheld-echo, the smartphone connected iECG, and blood pressure monitor, wearable activity trackers and POC-BNP levels for functional assessments. The Standard-care clinics included physical assessments and diagnostic testing as clinically indicated. All patients underwent echocardiography for assessing the severity of Rh-VHD. We compared the integration of mHealth devices with standard-care for predicting the need for valvuloplasty, valve replacement, hospitalization or death over 1 year in a non-inferiority design (figure). **Results:** Overall, the mHealth and the Standard-care groups demonstrated a similar incidence of Rh-VHD (68% vs. 64%, p=0.68) and a similar incidence of severe mitral (26% vs. 26%, p=0.92) or aortic valvular abnormalities (10% vs. 11%, p=0.24). Handheld-echo diagnosed mitral or aortic valve disease in 66% and 36% of mHealth patients, respectively. mHealth diagnostics further revealed abnormal cardiac rhythm in 27%, functional impairment on activity monitoring in 88% and a mean BNP of 85 ± 25 pg/mL. The referral rate for treatment was higher in the mHealth group as compared to the Standard-care group, 27% vs. 19%, p=0.001. During a median follow up of 6-months, the composite outcome for treatment was seen in 49 patients in the mHealth group and 38 patients in the Standard-care group (hazard ratio for the mHealth group 1.24 (95% CI 0.9 - 1.42, p= 0.13 for non-inferiority). **Conclusion:** This study demonstrates that integration of mHealth devices to handheld-echo provides improved assessment and can be readily integrated at the POC for evaluation of patients with structural heart diseases.



YIA-4

Evaluation of Myocardial Function According to Early Diastolic Intraventricular Pressure Difference in Fetuses

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Background: Early diastolic intraventricular pressure difference (IVPD) has been known to be a useful marker to evaluate myocardial function in adult and children. IVPD is a diastolic suction generated between the apex and the base during early diastole, which induces an efficient filling. There have been no studies to know fetal IVPD. The purpose of this study was to determine whether IVPD existed during the fetal stage and whether IVPD correlated with preexisting parameters for evaluating cardiac function in the fetuses. **Methods:** Ninety-six healthy pregnant women at 17 to 36 weeks of gestation were prospectively recruited from Juntendo University Hospital. After routine echocardiography, we collected velocity time integral (VTI) and valve diameters to get fetal cardiac output (CO). E/A ratio, myocardial performance index (MPI) and global strain rate using VVI were evaluated. Color M-mode was performed, then IVPD was calculated with MATLAB. **Results:** The IVPD in the right (RV) and left (LV) ventricle significantly increased toward term (RV/LV: $r = 0.63, 0.71$, $p < 0.001$, respectively). Both VTIs were well correlated with the IVPD (RV/LV: $r = 0.68, 0.59$, $p < 0.001$, respectively), which induced a linear correlation between the CO and the IVPD (RV/LV: $r = 0.67, 0.59$, $p < 0.001$, respectively). Combined CO in both ventricles showed a good correlation with the IVPD in the both ventricle (RV/LV: $r = 0.67, 0.63$, $p < 0.001$, respectively). Left MPI did not show a significant correlation with the IVPD. E/A ratio also had a good correlation with the IVPD (RV/LV: $r = 0.33, 0.27$, $p < 0.05$, respectively). In the VVI analysis, the global strain rate linearly decreased with gestational age (RV/LV: $r = 0.44, 0.38$, $p < 0.001$). However, no significant relationship was found between global strain rate and IVPD in either ventricle. **Conclusion:** IVPD has been proven to exist in both ventricles during fetal stage. In addition, IVPD increased with gestation in the both ventricles. Furthermore, the IVPD in the both ventricles was well correlated with the VTI and accordingly CO. IVPD might play an important role in the evaluation of fetal myocardial function.

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