PO-639-06

PROCEED WITH CAUTION: STANDARD PROTOCOL EXERCISE STRESS TESTS DO NOT RECREATE THE DIAGNOSTIC UTILITY OF THE SUPINE-STAND TESTS FOR LONG QT SYNDROME
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Background: The treadmill exercise stress test (TEST) can unmask concealed long QT syndrome (LQTS), especially LQT1, by identifying a maladaptive QT response during the TEST’s recovery phase. Additionally, the supine-stand test may aid in LQTS diagnosis as patients fail to shorten their QT interval in response to standing up, and instead show a paradoxical increase of QT. However, as the supine-stand test protocol requires patients to be supine and then standing for ≥ 5 minutes, this often does not match the standard TEST protocols and as such, the clinical utility needs to be validated.

Objective: To evaluate the diagnostic accuracy of interpreting the supine-stand test from values obtained during a standard protocol TEST.

Methods: We performed a retrospective review of 478 TESTs from patients evaluated for LQTS in Mayo Clinic’s Windland Smith Rice Genetic Heart Rhythm Clinic. To negate the effect of beta blocker (BB) therapy on TEST results, patients on BB therapy at the time of their TEST were excluded. Patients referred for evaluation but dismissed as normal served as controls.

Results: Overall, 243 patients with LQTS [125 LQT1, 63 LQT2, 55 LQT3; 146 (60%) female, mean age 30±17 years] and 235 controls [142 (60%) female, mean age 24±15 years] were included. Both groups had similar increases in HR (ΔHR) during the position change from supine to standing. Among LQTS patients, the mean supine QTc was 465±32 ms and mean standing QTc was 460±34 ms compared to 425±26 ms and 423±28 ms for controls respectively. The paired ΔQTc was similar between LQTSs (-5±26) and controls (-2±25; p = 0.2). During position change, the QT interval shortened in only 33%, remained unchanged in 62%, and increased in 5% for LQTS patients, similar to controls (shortened by ≥20 ms in 40%, unchanged in 54%, and increased in 6%, p = 0.2). No difference in ΔQT between controls and LQT1, 2, and 3 was observed. Lastly receiver-operator curve analysis to test the diagnostic ability of ΔQT performed poorly in differentiating LQTS from control subjects with an of AUC 0.52 (p = 0.4).

Conclusion: The standard protocol TEST used in clinical exercise laboratories throughout the world fails to elicit the so-called ‘Viskin stretch’ in QT/QTc as demonstrated previously when using the official supine-stand test with proper times of patients being supine and standing.

PO-639-07

AUTOMATIC UNIPOLAR ELECTROGRAM MORPHOLOGY ANALYSIS USING A CONVOLUTED NEURAL NETWORK CLASSIFIER
Nathan A. Angel PhD; Pratik Shah PhD; Derrick Chou PhD and Min Zhu PhD

Background: Unipolar electrogram (EGM) morphology contains information of near-field cardiac substrate properties and the relative source-sink interactions of the wavefront as it approaches and leaves. S wave unipolar morphology indicates a region of electrical sink and may physiologically represent wavefronts propagating into an unexcitable obstacle such as an ablation line. An RS wavefront generally indicates normally conducting tissue with relatively balanced source-sink relationship. Finally, a fractionated/multi-component EGM, represents a region of complex source-sink relationships, and may physiologically represent a region of multiple wavefronts, wavefront turning, or slow conduction through an isthmus. EGM morphology may help determine arrhythmia mechanism. Automatically detecting and displaying regions with characteristic EGM morphologies may aid arrhythmia diagnosis and treatment.

Objective: Evaluate the accuracy of a CNN (convolutional neural network) classifier to classify unipolar electrogram morphology as compared to manual, human classification accuracy.

Methods: Charge density unipolar electrograms (n=44,622) were acquired from 15 AT/AFL/SR patients using the AccuMap mapping system (Acutus Medical). Training set EGMs (n=43,586, from 15 patients) were annotated as either RS, R, S, or multi-component/fractionated by an expert reviewer. Test set EGMs (n=1,036) were annotated from one patient by two expert reviewers. Labeled EGMs on which the reviewers agreed were used as the test set (n=836). A 1-dimensional CNN based classifier was developed, trained and evaluated.

Results: The CNN was able to achieve an accuracy of 0.82 for classifying EGM morphology. The accuracy of the CNN is comparable to human vs. human agreement between two experts who achieved an accuracy of 0.79.

Conclusion: CNN classifiers can classify unipolar EGM morphology with high accuracy that rivals human level accuracy. Automatic algorithms to classify unipolar EGM morphology may aid physicians in diagnosis and treatment of arrhythmia.

A) EGM Classes

| RS | R | S | Frac |

B) Input into Network

![Figure 1](image-url)
IDENTIFICATION OF CONDUCTION PATTERNS DURING ATRIAL FIBRILLATION USING ARTIFICIAL INTELLIGENCE: HOLISTIC FULL CHAMBER VIEW

Nathan A. Angel PhD; Pratik Shah PhD; Derrick Chou PhD and Min Zhu PhD

Background: Atrial fibrillation (AF) is thought to be maintained by reentrant and focal driver regions that may have some spatial-temporal stability. Recently, several cardiac mapping systems have implemented algorithms for automatic detection of these arrhythmogenic conduction patterns (CPs) during AF. Many of these algorithms divide the atrium into overlapping patches, sequentially analyzing each patch with the driver identification algorithms. Patch-based analyses may misrepresent local CPs as the number and trajectory of wavefronts entering and leaving the analyzed patch are uncertain. However, when a holistic view of chamber-wide activation is used, machine learning algorithms can ubiquitously identify arrhythmogenic CPs.

Objective: Develop and evaluate a machine learning approach that can automatically identify and locate arrhythmogenic CPs.

Methods: Propagation maps of clinical AF from nine patients were transformed into a 2D image space using conformal mapping, and these images were used to train and evaluate a UNet architecture model. Rotational and focal CPs were identified by the AcQTrack algorithm (Acutus Medical) and manually confirmed. The clinical dataset was supplemented with eikonal simulations of focally (n = 400) and rotationally (n = 200) driven AF, where the time and location of the rotational and focal drivers were randomized and known. The UNet architecture was trained using five of the clinical AF cases (n = 7,880 frames) and simulated AF (200 focal and 100 rotational simulations, n = 14,380 frames). A test set, consisting of five clinical AF cases (n = 6,172 frames) and simulated AF (200 focal and 100 rotational simulations, n = 14,382 frames), were independently used to evaluate the model performance.

Results: The UNet model accurately detected the time and location of arrhythmogenic CPs in the atrium - Clinical AF DICE 0.91 and Simulated AF DICE 0.98.

Conclusion: The presented machine learning approach can accurately identify and locate arrhythmogenic targets. It has potential to overcome limited problem in detecting arrhythmogenic targets that is inherent problem of patch-based heuristic algorithms.

CHARACTERISTICS AND OUTCOMES OF FIRST HOSPITALIZATION FOR CARDIAC ARREST IN PATIENTS WITH KNOWN CARDIOMYOPATHY

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Background: Patients with reduced ejection fraction (LVEF ≤ 50%) are at increased risk of cardiac arrest (CA) due to shockable [polymorphic (PVT) and monomorphic (MVT) ventricular tachycardia; ventricular fibrillation (VF)] or non-shockable [pulseless electrical activity (PEA); and Asystole] rhythms.

Objective: To examine the characteristics and mortality of cardiomyopathy patients admitted with CA by type of arrhythmia.