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

Alexa Pinsky B.A.; Veda Kulikarni; Johan Martijn Bos MD, PhD; Raquel Almeida Lopes Neves MD; Thomas Allison and Michael John Ackerman MD, PhD

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 LQTS (-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 source and may physiologically represent a site of focal activation or the rapid spread of activation from activity leaving a conducting isthmus. An R 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 AcQMap mapping system (Acutus Medical). Training set EGMs (n = 43,586, from 15 patients) were annotated 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 B) Input into Network

Figure 1: Methods for the CNN. All EGM classes include: RS morphology defined as greater than 90% of signal energy balanced around the isoelectric line. R morphology defined as greater than 90% of signal energy above the isoelectric. S wave defined as greater than 40% of the signal energy below the isoelectric line. Multi-component defined as a multi-component EGM that was manually identified. EGM Segments were subsampled to 50 discrete equally spaced points and were used as the input to a CNN machine learning model.