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Moving Beyond QRS Duration: QRS Voltage-Time-Integral (Area) is a Superior Predictor of Clinical Response to Cardiac Resynchronization Therapy Part 1

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Background

- Cardiac resynchronization therapy (CRT) can alleviate left ventricular (LV) electrical dyssynchrony mediated systolic heart failure (HF). Prolonged baseline QRS duration (QRSd) is the only conventional quantitative ECG criteria to assess left ventricular electrical dyssynchrony.

Objective

Evaluate the baseline QRS voltage-time-integral (VTI), along with QRSd, and their reduction effect after CRT as predictors of future HF events.

Methods and Materials

- We included 595 patients (68.1±11.5 yr., 32.6% women, 43.9% ischemic cardiomyopathy, baseline LV ejection fraction 25.8±8.3%) who underwent CRT-defibrillator implant for clinical indications 2012-2019 and analyzed their ECGs before and after CRT. Orthogonal X, Y, Z leads were reconstructed from 12-lead ECG using Kors's matrix. VTIQRS-X, Y ,Z and VTIQRS-3D were obtained from integration over the duration of QRS in X, Y, Z and root-mean-squared (3D) ECGs respectively.

Follow-up clinical data including heart failure hospitalization, death, LV assist device (LVAD) implant, and orthotopic heart transplantation (OHT) were obtained from retrospective chart review. We used proportional hazard models to evaluate ECG variables as predictors of time to (a) composite death/LVAD/OHT and (b) first HF hospitalization over follow-up of 48.7±26.2 months. Models were adjusted for confounding by age, sex, ischemic cardiomyopathy and LV ejection fraction

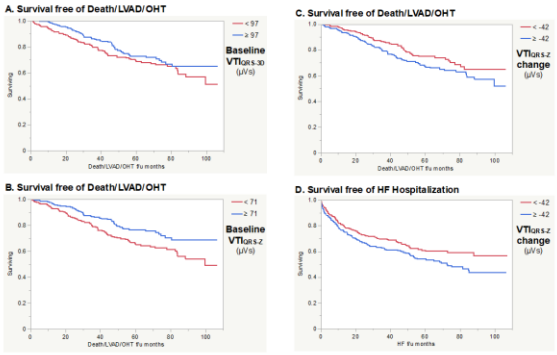

Figure 1. Unadjusted Kaplan-Meier curves categorized by median ECG values. Panels A, B and C plot survival free of death, left ventricular assist device or orthotopic heart transplant, while D plots survival free of heart failure hospitalization. Panel A depicts categorization by baseline VTIQRS-3D, B shows baseline VTIQRS-Z, and C and D portray Δ VTIQRS-Z. Shaded areas depict 95% confidence intervals.

Results

- QRSd reduced from 153±26 to 137±22 ms with CRT but neither baseline QRSd nor Δ QRSd predicted clinical outcomes. VTIQRS-3D and VTIQRS-Z of 104±49 and 75±44 respectively improved to 67±34 and 33±24 μVs. Significant unadjusted predictors of death/LVAD/OHT included VTIQRS-3D (p=0.047) and VTIQRS-Z (p=0.002) at baseline, and Δ VTIQRS-Z (p=0.01). On multivariable adjustment, VTIQRS-Z (p=0.005) and Δ VTIQRS-Z (p=0.02) remained significant. Δ VTIQRS-Z was the only significant predictor of HF hospitalizations (unadjusted p=0.02 and adjusted p=0.047).

Conclusion

In patients undergoing CRT, a larger baseline QRS VTI from Z (anteroposterior) axis ECG predicted reduced death/LVAD/OHT. Further, a larger reduction in Z axis QRS VTI was associated with reduced death/LVAD/OHT and HF hospitalizations. VTIQRS-Z should replace QRSd for CRT patient selection and prognostication.

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