KU MEDICAL CENTER
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Only Z-Axis of QRS 3D-Voltage-Time-Integral Predicts CRT Benefit

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Background

- In patients with left ventricular (LV) electrical dyssynchrony, cardiac resynchronization therapy (CRT) reduces heart failure symptoms, hospitalization and death.
- QRS 3D-voltage-time-integral (VTI_{QRS-3D}) or 3D QRS area is a summary marker of LV electrical dyssynchrony and potential for CRT benefit.
- The individual contributions of orthogonal X, Y, and Z axes in VTI_{QRS-3D} is unknown.

Research Question

Which baseline ECG parameter is the strongest predictor of response to CRT?

Methods and Materials

- 225 patients who received CRT between 2014 and 2016 at KUMC, who had baseline and post CRT ECG, and baseline and 3-12 months follow-up echocardiograms.
- ECGs were converted to orthogonal X, Y, Z leads using Kors matrix.
- $VTI_{QRS-X, Y, Z}$ and VTI_{QRS-3D} were obtained by voltage-time-integral from the orthogonal leads and root-mean-squared 3D ECG, respectively.
- Linear regression models were used to evaluate baseline ECG parameters as predictors of 3-12 month post-CRT change in LV ejection fraction (LVEF).

Table. Baseline characteristics and their correlation with change in LVEF after CRT

Variable	Baseline distribution (N=225)	Δ LVEF, % (Overall 10.2 ± 10.7) Univariate models		Δ LVEF, % Multivariate models †
	Mean ± S.D. or %	β-coefficient	p-value	p-value
Age, years	68.1 ± 12.0	-0.27/10-yr	0.66	
Female	35%	0.95	0.21	
Baseline LVEF, %	26.2 ± 8.6	-2.55/10%	**0.002**	
QRS morphology			**0.0009**	
Left bundle branch block	46%	10.8 ± 10.9		
Right ventricular paced	13%	16.3 ± 10.3		
Other	41%	7.5 ± 9.7		
QRS frontal plane axis, °	-12 ± 68	-0.14/10°	0.17	
QRS duration, ms	151 ± 25	0.57/10-ms	**0.04**	0.36
QRS voltage-time-integral, □'s				
V4*	-64 ± 67	0.31/10-□'s	**0.003**	0.07
X	7 ± 41	0.17/10-□'s	0.32	
Y	-8 ± 48	0.21/10-□'s	0.15	
Z	67 ± 49	0.49/10-□'s	**0.0008**	**0.02**
3D	106 ± 48	0.50/10-□'s	**0.0007**	**0.02**

LVEF, left ventricular ejection fraction; VTI, voltage-time-integral
* Best performing of the standard 12 ECG leads
† Adjusted for age, sex, baseline LVEF, QRS morphology

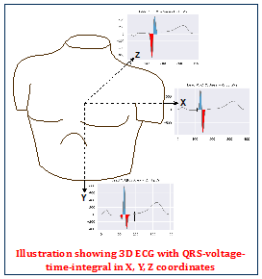
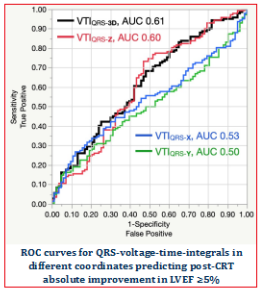


Illustration showing 3D ECG with QRS-voltage-time-integral in X, Y, Z coordinates



ROC curves for QRS-voltage-time-integrals in different coordinates predicting post-CRT absolute improvement in LVEF ≥5%

Results

- In addition to baseline LVEF and QRS morphology, the following baseline ECG parameters were significant predictors of improvement in LVEF: QRS duration, 3D QRS amplitude, VTI_{QRS-Z}, and VTI_{QRS-3D}.
- Only Z-axis and 3D voltage-time-integrals remained significant after multivariable adjustment for age, sex, baseline LVEF, and QRS morphology.

Conclusions

A larger baseline QRS 3D-voltage-time-integral independently predicts greater CRT response.

The prognostic information of QRS 3D-voltage-time-integral is mostly contained in the anteroposterior Z-axis.

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