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In Patients with Left Bundle Branch Block QRS Duration is a Stronger Predictor of Left Ventricular Hypertrophy than QRS Voltage

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Background

- Standard ECG criteria for left ventricular hypertrophy (LVH) heavily rely on QRS amplitudes and voltages.
- ECG correlates of LVH in the setting of left bundle branch block (LBBB) are not known.
- QRS voltage-time-integral (VTI) is a novel marker and has been used in left bundle branch block patient selection for cardiac resynchronization therapy.

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Study Objectives

- We sought to evaluate quantitative ECG measures as predictors of LVH in the presence of left bundle branch block (LBBB).

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Methods

- We included adult (≥ 18 years) patients with an ECG demonstrating LBBB and a corresponding echocardiogram performed within 3 months of each other at KUMC between January 2010 and December 2020
- ECGs were manually verified and downloaded. ECG files were processed in Python and utilized the Kors matrix to reconstruct orthogonal X, Y, and Z ECGs.
- Adjusted linear regressions were used to assess associations between ECG QRS parameters and echocardiogram parameters of LVH.
- We evaluated overall QRS duration and frontal plane axis, amplitudes, and voltage-time-integrals.

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Results

Variable	Males (N=194)	Females (N=219)
	Median (IQR)	Median (IQR)
Age, years	72.5 (66-80)	74 (65-83)
BSA, m^2	2.1 (2.0-2.3)	1.9 (1.7-2.1)
LV Mass, g	227 (187-275)	164 (133-197)
LVEDV, ml	147 (113-199)	101 (76-138)
LVESV, ml	68 (48-105)	45 (31-71)
LVEF, %	53 (38-63)	54 (45-63)
QRS duration, ms	157 (150-168)	149 (140-158)
QRS 3D Amplitude, mV	1.7 (1.3-1.9)	1.4 (1.2-1.7)
QRS 3D VTI, μVs	124 (99-150)	102 (85-123)

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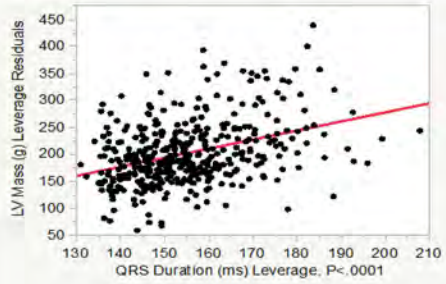
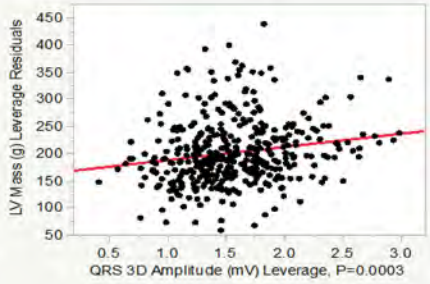
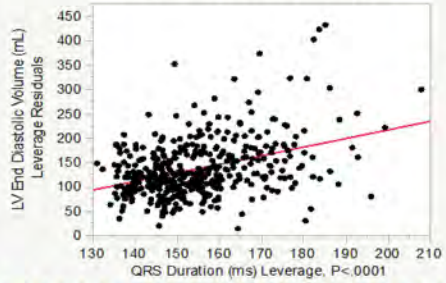
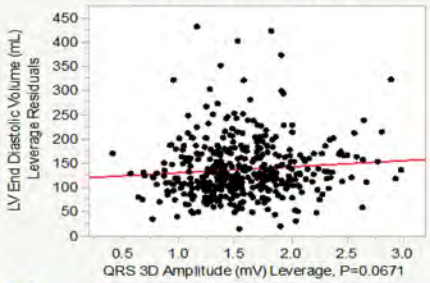
Results









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Results

Table 2. Prediction of LV echocardiographic parameters by ECG*

	QRS Duration		$Amplitude_{QRS-3D}$		VTI_{QRS-3D}	
	t-score	p-value	t-score	p-value	t-score	p-value
LV Mass	8.19	<0.00001	3.64	0.0003	5.78	<0.00001
LVEDV	8.52	<0.00001	1.84	0.07	4.12	0.00005
LVESV	8.04	<0.00001	1.38	0.2	3.51	0.0005
LVEF	-4.48	<0.00001	-0.88	0.4	-1.84	0.07

***Multivariable adjusted for age, sex, BSA**

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Results

Table 3A. Area under curve (AUC) from ROC curves for prediction of LV echocardiographic abnormalities by ECG (N=413)

Echo abnormality	QRS Duration	VTI_{QRS-3D}	$Amplitude_{QRS-3D}$
Increased LVMi ($F > 95$, $M > 115$ g/m^2)	0.646	0.636	0.603
Concentric Hypertrophy (LVH & RWT >0.42)	0.567	0.631	0.621
Eccentric Hypertrophy (LVH & RWT ≤0.42)	0.701	0.569	0.514
Increased LVEDVi ($F > 61$, $M > 74$ mL/m^2)	0.681	0.592	0.542
Increased LVESVi ($F > 24$, $M > 31$ mL/m^2)	0.64	0.591	0.561
Decreased LVEF (≤40%)	0.659	0.558	0.525

VTI, voltage-time-integral; LV, left ventricular; Mi, mass indexed; EDVi, end-diastolic volume indexed; EF, ejection fraction

Results

- QRS duration ≥150 ms in women has a sensitivity of 56.3%, specificity of 64.4% for LVMi >95 g/m^2 and a sensitivity of 62.7%, specificity of 67.8% for LVEDVi >61 mL/m^2.
- QRS duration≥160 ms in men has a sensitivity 63.1%, specificity 72.1% for LVMi >115 g/m^2 and sensitivity 58.3%, specificity 74.5% for LVEDVi >74 mL/m^2.

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Conclusions

- In patients with LBBB, an increase in QRS duration rather than QRS voltage is a superior predictor of LVH, specifically eccentric hypertrophy.
- QRS voltage-time-integral is a better predictor of LVH than QRS 3D amplitudes.
- *Why does QRS voltage show a weak correlation with LVH?*
  - Dominant effect of electrical dyssynchrony
  - Myocardial fibrosis, infiltrative cardiomyopathy, epicardial adipose tissue, and LV dilation

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