Supplemental materials for

Discrepancy between left ventricular hypertrophy by echocardiography and electrocardiographic hypertrophy: clinical characteristics and outcomes

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Supplemental Table 1. Clinical outcomes in each component of MACE

	Both ECG- and echo-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	Only echo-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	Only ECG-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	No LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])
Heart failure	10/131 (9.4)	12/156 (10.0)	13/409 (4.3)	41/2516 (2.3)
Myocardial infarction	1/131 (1.0)	0/156 (0)	2/409 (0.6)	6/2516 (0.3)
Unstable angina pectoris	3/131 (3.1)	5/156 (4.1)	3/409 (1.0)	15/2516 (0.8)
Aorta and peripheral vascular disease	4/131 (3.4)	3/156 (2.6)	6/409 (1.7)	18/2516 (1.0)

Cerebral infarction	3/131 (3.2)	3/156 (2.9)	7/409 (2.1)	34/2516 (1.8)
Cerebral hemorrhage	1/131 (1.2)	3/156 (2.5)	4/409 (1.3)	8/2516 (0.4)

MACE=major adverse cardiovascular events

Supplemental Table 2. Sensitivity analysis using BMI and LVEF as the continuous variable in the multivariable Cox proportional hazard models

	Variables	Adjusted	
		HR (95% CI)	P value
Primary endpoint			
A composite of all-cause death or MACE	Both ECG- and echo-based LVH	1.53 (1.09-2.16)	0.01
	Only echo-based LVH	1.66 (1.22-2.27)	0.001
	Only ECG-based LVH	1.09 (0.85-1.41)	0.49
	No LVH	1 (reference)	
Secondary endpoints			

All-cause death	Both ECG- and echo-based LVH	1.28 (0.80-2.05)	0.30
	Only echo-based LVH	1.14 (0.73-1.78)	0.56
	Only ECG-based LVH	0.93 (0.67-1.29)	0.68
	No LVH	1 (reference)	
MACE	Both ECG- and echo-based LVH	1.78 (1.16-2.74)	0.008
	Only echo-based LVH	1.80 (1.19-2.73)	0.005
	Only ECG-based LVH	1.37 (0.98-1.92)	0.07
	No LVH	1 (reference)	

CI=confidence interval, HR=hazard ratio, MACE=major adverse cardiovascular events

Supplemental Table 3. Patient characteristics using Cornell voltage for ECG-LVH

	Total (n=3212)	**Both ECG- and Echo-based LVH (n=101)**	**Only Echo-based LVH (n=186)**	**Only ECG-based LVH (n=266)**	**No LVH (n=2659)**	**P value**	**Total N**
Clinical characteristics							
Age*, years	64.5 ± 15.9	68.6 ± 13.4	70.1 ± 13.4	68.7 ± 13.7	63.5 ± 16.2	<0.001	3212
>70 years,	1371 (42.7)	52 (51.5)	107 (57.5)	147 (55.3)	1065 (40.1)	<0.001	3212
Women*	1512 (47.0)	71 (70.3)	87 (46.8)	183 (68.8)	1171 (44.0)	<0.001	3212
BMI kg/m^2	23.2 ± 4.2	23.3 ± 5.2	23.9 ± 5.0	23.1 ± 4.5	23.1 ± 4.1	0.10	3202
>25 kg/m^2*	915 (28.6)	71 (70.3)	116 (62.4)	184 (69.4)	1916 (72.3)	0.03	3202
Diabetes*	983 (30.6)	37 (36.6)	84 (45.2)	95 (35.7)	767 (28.8)	<0.001	3212
Hypertension*	1771 (55.1)	86 (85.1)	148 (79.6)	174 (65.4)	1363 (51.3)	<0.001	3212
Dyslipidemia*	941 (29.3)	42 (41.6)	76 (40.9)	87 (32.7)	736 (27.7)	<0.001	3212
Ischemic heart disease*	979 (30.5)	45 (44.6)	82 (44.1)	77 (28.9)	775 (29.1)	<0.001	3212
Chronic kidney disease*	449 (14.0)	40 (39.6)	60 (32.3)	42 (15.8)	307 (11.5)	<0.001	3212
Atrial fibrillation*	267 (8.3)	10 (9.9)	19 (10.2)	26 (9.8)	212 (8.0)	0.50	3212
ECG characteristics							
Heart rate, bpm	71.6 ± 15.6	73.6 ± 15.5	71.5 ± 16.3	73.4 ± 17.3	71.3 ± 15.3	0.11	3212
QRS duration	96.6 ± 9.0	102.1 ± 9.4	99.2 ± 9.3	98.0 ± 8.9	96.0 ± 8.9	<0.001	3212
Sokolow-Lyon voltage-LVH	472 (14.7)	46 (45.5)	59 (31.7)	79 (29.7)	288 (10.8)	<0.001	3212
Cornell voltage, mm	15.8 ± 7.1	29.6 ± 8.4	16.8 ± 5.3	26.5 ± 6.0	14.2 ± 5.5	<0.001	3212
Cornell product, mm・ms	1811.9 ± 744.6	3468.9 ± 894.2	1942.9 ± 533.8	3018.5 ± 620.6	1619.1 ± 541.3	<0.001	3212

Cornell product-LVH	540 (16.8)	95 (94.1)	36 (19.4)	237 (89.1)	172 (6.5)	<0.001	3212
Echo characteristics							
LVDd, cm	4.65 ± 0.55	5.10 ± 0.63	5.29 ± 0.65	4.55 ± 0.53	4.60 ± 0.50	<0.001	3212
LVDs, cm	3.10 ± 0.50	3.59 ± 0.75	3.68 ± 0.74	3.04 ± 0.49	3.05 ± 0.43	<0.001	3212
IVSTd, cm	0.81 ± 0.15	1.01 ± 0.19	0.99 ± 0.16	0.82 ± 0.13	0.78 ± 0.14	<0.001	3212
LVPWd, cm	0.79 ± 0.14	0.98 ± 0.18	0.96 ± 0.15	0.81 ± 0.12	0.77 ± 0.12	<0.001	3212
RWT	0.34 ± 0.07	0.39 ± 0.09	0.37 ± 0.09	0.36 ± 0.07	0.34 ± 0.06	<0.001	3212
>0.42	370 (11.5)	33 (32.7)	44 (23.7)	41 (15.4)	252 (9.5)	<0.001	3212
LVMI, g/m	75.4 ± 21.7	122.3 ± 26.3	119.6 ± 16.4	77.0 ± 14.8	70.4 ± 16.0	<0.001	3212
LAD, cm	3.48 ± 0.64	3.92 ± 0.65	4.00 ± 0.71	3.59 ± 0.67	3.42 ± 0.61	<0.001	3210
LAVI, ml/m^2	22.2 ± 10.6	32.3 ± 15.1	32.4 ± 15.9	24.4 ± 10.3	21.0 ± 9.3	<0.001	2901
>34 ml/m^2	293 (10.1)	32 (35.6)	53 (32.5)	32 (13.9)	176 (7.3)	<0.001	2901
EF, %	61.9 ± 7.0	56.5 ± 11.1	56.8 ± 11.7	61.9 ± 8.0	62.5 ± 5.9	<0.001	3212
<50%*	185 (5.8)	23 (22.8)	41 (22.0)	19 (7.1)	102 (3.8)	<0.001	3212

Comparisons among 4 groups were performed using the chi-square test for categorical variables, and one-way analysis of variance for continuous variables. Values are number (%), mean ± SD. BMI=body mass index, EF=ejection fraction, HR=heart rate, IVSTd=diastolic interventricular septal wall thickness, LAVI=left atrial volume index, LVDd=left ventricular diastolic dimension, LVDs=left ventricular systolic dimension, LVH=left ventricular hypertrophy, LVMI=left ventricular mass index, LVPWd=diastolic left ventricular posterior

wall thickness, RWT=relative wall thickness, SD=standard deviation.

*Potential risk-adjusting variables selected for cox proportional hazard model

Supplemental Table 4. Crude and adjusted hazard ratio using Cornell voltage for ECG-LVH

	Both ECG- and Echo-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	Only Echo-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	Only ECG-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	No LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	Variables	Unadjusted		Adjusted	
						HR (95% CI)	P value	HR (95% CI)	P value
A composite of all-cause death or MACE	26/101 (31.4)	53/186 (33.8)	43/266 (20.1)	329/2659 (15.8)	Both ECG- and Echo-based LVH	2.22 (1.55-3.18)	<0.001	1.68 (1.15-2.46)	0.008
					Only Echo-based LVH	2.30 (1.75-3.01)	<0.001	1.66 (1.24-2.21)	<0.001
					Only ECG-based LVH	1.21 (0.90-1.63)	0.20	1.17 (0.86-1.57)	0.32
					No LVH	1 (reference)		1 (reference)	

CI=confidence interval, HR=hazard ratio, MACE= major adverse cardiac events

Supplemental Table 5. Patient characteristics using Sokolow-Lyon voltage for ECG-LVH

	Total (n=3212)	Both ECG- and Echo-based LVH (n=105)	Only Echo-based LVH (n=182)	Only ECG-based LVH (n=367)	No LVH (n=2558)	P value	Total N
Clinical characteristics							
Age*, years	64.5 ± 15.9	68.7 ± 12.0	70.1 ± 14.1	66.7 ± 15.4	63.6 ± 16.1	<0.001	3212
>70 years,	1371 (42.7)	51 (48.6)	108 (59.3)	182 (49.6)	1030 (40.3)	<0.001	3212
Women*	1512 (47.0)	46 (43.8)	112 (61.5)	126 (34.3)	1228 (48.0)	<0.001	3212
BMI kg/m^2	23.2 ± 4.2	23.5 ± 4.6	23.8 ± 5.3	22.5 ± 3.7	23.2 ± 4.2	0.003	3202
>25 kg/m^2*	915 (28.6)	33 (31.4)	67 (36.8)	77 (21.0)	738 (29.0)	<0.001	3202
Diabetes*	983 (30.6)	46 (43.8)	75 (41.2)	110 (30.0)	752 (29.4)	<0.001	3212
Hypertension*	1771 (55.1)	85 (81.0)	149 (81.9)	223 (60.8)	1314 (51.4)	<0.001	3212
Dyslipidemia*	941 (29.3)	42 (40.0)	76 (41.8)	98 (26.7)	725 (28.3)	<0.001	3212
Ischemic heart disease*	979 (30.5)	45 (42.9)	82 (45.1)	108 (29.4)	744 (29.1)	<0.001	3212
Chronic kidney disease*	449 (14.0)	38 (36.2)	62 (34.1)	59 (16.1)	290 (11.3)	<0.001	3212
Atrial fibrillation*	267 (8.3)	7 (6.7)	22 (12.1)	36 (9.8)	202 (7.9)	0.14	3212
ECG characteristics							
Heart rate, bpm	71.6 ± 15.6	71.6 ± 14.7	72.6 ± 16.8	70.1 ± 16.4	71.7 ± 15.4	0.22	3212
QRS duration	96.6 ± 9.0	102.3 ± 9.2	99.1 ± 9.4	99.0 ± 8.5	95.8 ± 8.9	<0.001	3212
Cornell voltage, mm	15.8 ± 7.1	24.0 ± 10.8	19.7 ± 7.3	19.0 ± 8.3	14.8 ± 6.2	<0.001	3212
Cornell voltage-LVH	367 (11.4)	46 (43.8)	55 (30.2)	79 (21.5)	187 (7.3)	<0.001	3212
Cornell product, mm・ms	1811.9 ± 744.6	2760.3 ± 1230.0	2318.2 ± 796.2	2085.1 ± 871.5	1697.8 ± 634.2	<0.001	3212

Cornell product-LVH	540 (16.8)	57 (54.3)	74 (40.7)	114 (31.1)	295 (11.5)	<0.001	3212
Echo characteristics							
LVDd, cm	4.65 ± 0.55	5.23 ± 0.61	5.22 ± 0.67	4.69 ± 0.51	4.58 ± 0.50	<0.001	3212
LVDs, cm	3.10 ± 0.50	3.69 ± 0.75	3.63 ± 0.74	3.15 ± 0.48	3.04 ± 0.42	<0.001	3212
IVSTd, cm	0.81 ± 0.15	1.03 ± 0.19	0.98 ± 0.16	0.83 ± 0.13	0.78 ± 0.13	<0.001	3212
LVPWd, cm	0.79 ± 0.14	1.00 ± 0.19	0.95 ± 0.15	0.82 ± 0.12	0.77 ± 0.12	<0.001	3212
RWT	0.34 ± 0.07	0.39 ± 0.10	0.37 ± 0.08	0.36 ± 0.07	0.34 ± 0.06	<0.001	3212
>0.42	370 (11.5)	33 (31.4)	44 (24.2)	54 (14.7)	239 (9.3)	<0.001	3212
LVMI, g/m	75.4 ± 21.7	124.2 ± 21.8	118.5 ± 19.3	79.6 ± 16.1	69.7 ± 15.6	<0.001	3212
LAD, cm	3.48 ± 0.64	3.95 ± 0.62	3.98 ± 0.73	3.60 ± 0.64	3.41 ± 0.61	<0.001	3210
LAVI, ml/m^2	22.2 ± 10.6	29.8 ± 10.3	34.0 ± 17.9	24.4 ± 9.9	20.8 ± 9.3	<0.001	2901
>34 ml/m^2	293 (10.1)	29 (30.2)	56 (35.7)	48 (14.3)	160 (6.9)	<0.001	2901
EF, %	61.9 ± 7.0	56.3 ± 11.8	56.9 ± 11.3	61.3 ± 7.5	62.6 ± 5.9	<0.001	3212
<50%*	185 (5.8)	23 (21.9)	41 (22.5)	22 (6.0)	99 (3.9)	<0.001	3212

Comparisons among 4 groups were performed using the chi-square test for categorical variables, and one-way analysis of variance for continuous variables. Values are number (%), mean ± SD. BMI=body mass index, EF=ejection fraction, HR=heart rate, IVSTd=diastolic interventricular septal wall thickness, LAVI=left atrial volume index, LVDd=left ventricular diastolic dimension, LVDs=left ventricular systolic dimension, LVH=left ventricular hypertrophy, LVMI=left ventricular mass index, LVPWd=diastolic left ventricular posterior

wall thickness, RWT=relative wall thickness, SD=standard deviation.

*Potential risk-adjusting variables selected for cox proportional hazard model

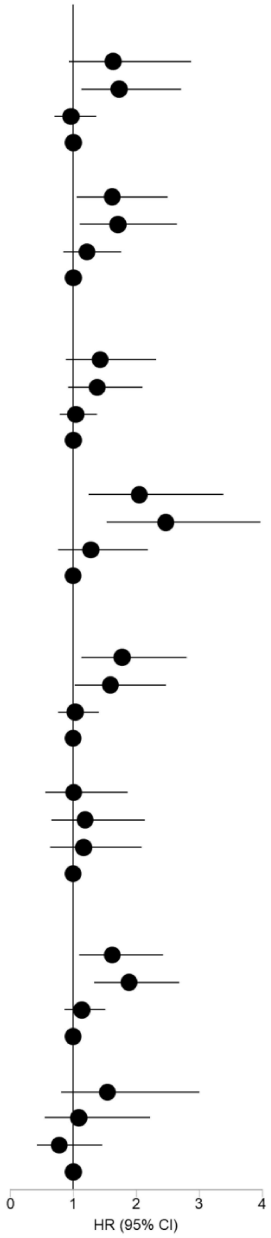
Supplemental Table 6. Crude and adjusted hazard ratio using Sokolow-Lyon voltage for ECG-LVH

	Both ECG- and Echo-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	Only Echo-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	Only ECG-based LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	No LVH N of patients with event/N of patients at risk (Cumulative 3-year incidence [%])	Variables	Unadjusted		Adjusted	
						HR (95% CI)	P value	HR (95% CI)	P value
A composite of all-cause death or MACE	27/105 (31.0)	52/182 (34.2)	53/367 (18.9)	319/2558 (15.8)	Both ECG- and Echo-based LVH	2.07 (1.44-2.97)	<0.001	1.48 (1.03-2.15)	0.04
					Only Echo-based LVH	2.42 (1.84-3.18)	<0.001	1.73 (1.29-2.32)	<0.001
					Only ECG-based LVH	1.22 (0.94-1.59)	0.13	1.00 (0.77-1.30)	0.99
					No LVH	1 (reference)		1 (reference)	

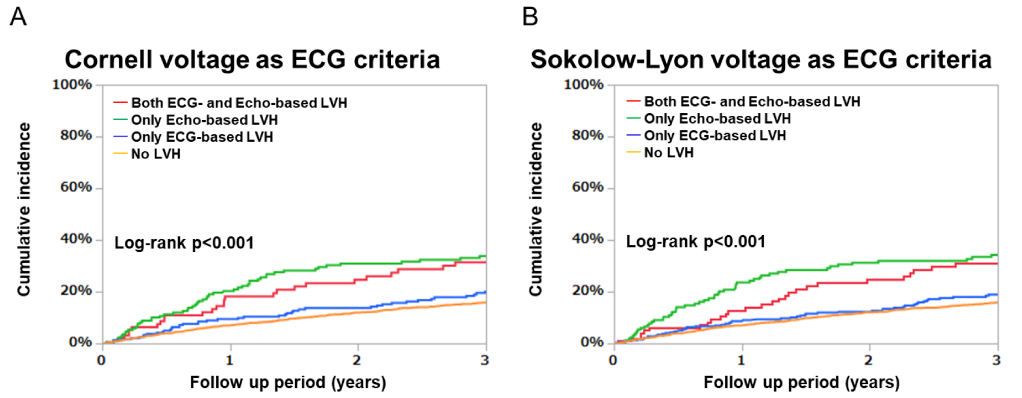
CI=confidence interval, HR=hazard ratio, MACE= major adverse cardiac events

Supplemental Figure 1.

Subgroups	N of patients with event/ N of patients at risk (Cumulative 3-year incidence)	Adjusted HR (95% CI)	P value	P interaction
Ischemic heart disease				0.59
No				
Both ECG- and echo-based LVH	11/68 (23.2)	1.63 (0.93-2.87)	0.09	
Only echo-based LVH	22/92 (28.8)	1.73 (1.10-2.71)	0.02	
Only ECG-based LVH	35/284 (15.6)	0.97 (0.69-1.37)	0.88	
No LVH	182/1789 (13.7)	Reference		
Yes				
Both ECG- and echo-based LVH	23/63 (39.5)	1.62 (1.05-2.50)	0.03	
Only echo-based LVH	23/64 (40.5)	1.71 (1.10-2.65)	0.02	
Only ECG-based LVH	30/125 (26.4)	1.22 (0.84-1.76)	0.30	
No LVH	125/727 (19.8)	Reference		
Chronic kidney disease				0.33
No				
Both ECG- and echo-based LVH	17/82 (26.0)	1.43 (0.88-2.31)	0.15	
Only echo-based LVH	23/105 (27.1)	1.38 (0.90-2.11)	0.14	
Only ECG-based LVH	49/345 (17.4)	1.04 (0.78-1.39)	0.78	
No LVH	246/2231 (14.4)	Reference		
Yes				
Both ECG- and echo-based LVH	17/49 (40.6)	2.05 (1.25-3.38)	0.005	
Only echo-based LVH	22/51 (45.6)	2.47 (1.53-3.99)	<0.001	
Only ECG-based LVH	16/64 (27.1)	1.28 (0.76-2.17)	0.35	
No LVH	61/285 (24.1)	Reference		
Left atrial volume index				0.88
≤34 ml/m^2				
Both ECG- and echo-based LVH	15/78 (24.4)	1.78 (1.13-2.80)	0.01	
Only echo-based LVH	20/90 (25.5)	1.59 (1.02-2.47)	0.04	
Only ECG-based LVH	43/318 (15.9)	1.03 (0.76-1.40)	0.85	
No LVH	225/2122 (13.8)	Reference		
>34 ml/m^2				
Both ECG- and echo-based LVH	17/39 (48.4)	1.01 (0.55-1.86)	0.97	
Only echo-based LVH	16/46 (41.0)	1.19 (0.66-2.13)	0.57	
Only ECG-based LVH	13/47 (37.0)	1.16 (0.64-2.08)	0.63	
No LVH	43/161 (30.1)	Reference		
Relative wall thickness				0.18
≤0.42				
Both ECG- and echo-based LVH	26/92 (34.9)	1.62 (1.09-2.42)	0.02	
Only echo-based LVH	37/118 (38.1)	1.89 (1.33-2.68)	<0.001	
Only ECG-based LVH	56/347 (19.4)	1.14 (0.86-1.50)	0.37	
No LVH	258/2285 (14.6)	Reference		
>0.42				
Both ECG- and echo-based LVH	8/39 (25.3)	1.54 (0.80-2.99)	0.20	
Only echo-based LVH	8/38 (22.2)	1.09 (0.54-2.21)	0.80	
Only ECG-based LVH	9/62 (17.4)	0.78 (0.42-1.45)	0.42	
No LVH	49/231 (26.2)	Reference		



Supplemental Figure 2.



Interval (Years)	0	1	2	3
Both ECG- and Echo-based LVH				
N of patients with at least 1 event		16	21	26
N of patients at risk	101	66	57	49
Cumulative incidence		18.2%	24.7%	31.4%
Only Echo-based LVH				
N of patients with at least 1 event		33	49	53
N of patients at risk	186	123	101	89
Cumulative incidence		20.3%	30.9%	33.8%
Only ECG-based LVH				
N of patients with at least 1 event		22	31	43
N of patients at risk	266	197	174	141
Cumulative incidence		9.4%	13.7%	20.1%
No LVH				
N of patients with at least 1 event		159	258	329
N of patients at risk	2659	1984	1689	1445
Cumulative incidence		7.0%	11.9%	15.8%

Interval (Years)	0	1	2	3
Both ECG- and Echo-based LVH				
N of patients with at least 1 event		12	22	27
N of patients at risk	105	77	62	52
Cumulative incidence		12.8%	24.6%	31.0%
Only Echo-based LVH				
N of patients with at least 1 event		37	48	52
N of patients at risk	182	112	96	86
Cumulative incidence		23.5%	31.2%	34.2%
Only ECG-based LVH				
N of patients with at least 1 event		27	37	53
N of patients at risk	367	263	228	182
Cumulative incidence		8.6%	12.3%	18.9%
No LVH				
N of patients with at least 1 event		154	252	319
N of patients at risk	2558	1918	1634	1404
Cumulative incidence		7.0%	12.0%	15.8%

Supplemental Figure legends

Supplemental Figure 1. Subgroup analyses.

ECG=electrocardiogram, HR=hazard ratio, LVH=left ventricular hypertrophy.

Supplemental Figure 2. **Cumulative incidence of the primary outcome measure (a composite of all-cause death or MACE) using Cornell voltage for ECG-LVH and Sokolow-Lyon voltage for ECG-LVH.**

A; Cornell voltage as ECG criteria, B; Sokolow-Lyon voltage as ECG criteria.

ECG=electrocardiogram, LVH=left ventricular hypertrophy.