

Supplementary Material

Variability of Myocardial Strain During Isometric Exercise in Subjects With and Without Heart Failure

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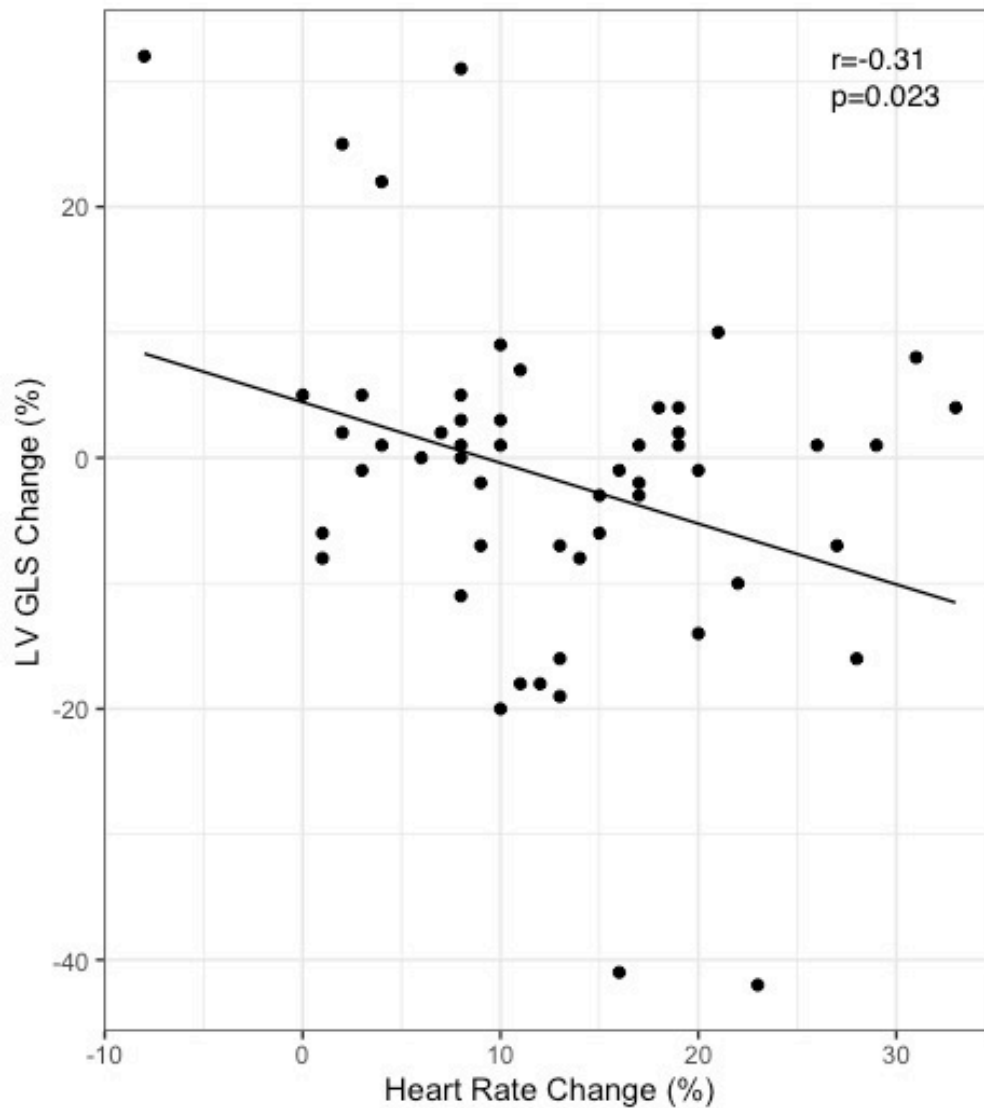
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1 Supplementary Figures and Tables

1.1 Supplementary Figures



Supplementary Figure 1. Association of heart rate change and LV GLS change in response to isometric exercise. LV GLS, left ventricular global longitudinal strain. Only subjects with heart failure were included in this exploratory analysis.

1.2 Supplementary Tables

Supplementary Table 1. Numeric difference between rest and isometric exercise					
	Controls n=19	HFpEF n=17	HFmrEF n=18	HFrfEF n=18	p-value
Δ Heart rate (/min)	+9.5 ± 6.5	+7.9 ± 5.1	+7.4 ± 4.6	+9.1 ± 6.1	0.663
Δ Systolic BP (mmHg)	+33. ± 17.8	+29.6 ± 17.4	+27.9 ± 10.6	+22.2 ± 11.7	0.148
Δ Diastolic BP (mmHg)	+16.2 ± 7.5	+16.9 ± 8.2	+14.3 ± 7.9	+13.8 ± 10.6	0.658
Δ Pulse Pressure (mmHg)	+17.2 ± 13.3	+12.7 ± 12.4	+13.6 ± 7.0	+8.3 ± 5.8	0.082
Δ LV GLS	-0.2 ± 1.0	+0.1 ± 1.6	+0.4 ± 1.5	+0.4 ± 1.7	0.626
Δ LV GCS	+0.2 ± 1.9	-0.4 ± 2.1	-0.1 ± 3.8	+0.6 ± 2.3	0.702
Abbreviations: BP, blood pressure; EF, ejection fraction; GCS, global circumferential strain; GLS, global longitudinal strain; HF, heart failure; HFpEF, HF with preserved EF; HFmrEF, HF with mid-range EF; HFrfEF, HF with reduced EF, isoHG, isometric handgrip; LV, left ventricle.					

Supplementary Table 2. Post-hoc subgroup comparisons		
Variable	Comparison	P-value
Systolic BP during IsoHG	HFpEF-Control	0.716
	HFmrEF-Control	0.096
	HFrEF-Control	0.005
	HFmrEF-HFpEF	0.599
	HFrEF-HFpEF	0.109
	HFrEF-HFmrEF	0.713
Pulse Pressure during IsoHG	HFpEF-Control	0.733
	HFmrEF-Control	0.116
	HFrEF-Control	0.001
	HFmrEF-HFpEF	0.636
	HFrEF-HFpEF	0.043
	HFrEF-HFmrEF	0.426
LV GLS at Rest	HFpEF-Control	0.683
	HFmrEF-Control	<0.001
	HFrEF-Control	<0.001
	HFmrEF-HFpEF	0.006
	HFrEF-HFpEF	<0.001
	HFrEF-HFmrEF	<0.001
LV GLS during IsoHG	HFpEF-Control	0.510
	HFmrEF-Control	<0.001
	HFrEF-Control	<0.001
	HFmrEF-HFpEF	0.003
	HFrEF-HFpEF	<0.001
	HFrEF-HFmrEF	<0.001
LV GCS at Rest	HFpEF-Control	0.267
	HFmrEF-Control	<0.001
	HFrEF-Control	<0.001
	HFmrEF-HFpEF	0.001
	HFrEF-HFpEF	<0.001
	HFrEF-HFmrEF	0.290
LV GCS during IsoHG	HFpEF-Control	0.487
	HFmrEF-Control	<0.001
	HFrEF-Control	<0.001
	HFmrEF-HFpEF	<0.001
	HFrEF-HFpEF	<0.001
	HFrEF-HFmrEF	0.020
Hemodynamic and strain variables which differed significantly between subgroups when assessed with analysis of variance were included in this post-hoc analysis using Tukey's test. Abbreviations: BP, blood pressure; GCS, global circumferential strain; GLS, global longitudinal strain; IsoHG, isometric handgrip; LV, left ventricle.		

Supplementary Table 3. Characteristics of patients with increase, no change and decrease of LV GLS in response to isometric exercise

		Increase n=20	No change n=29	Decrease n=23	p-value
Subgroup					0.668
Control – no. (%)		7 (35.0)	7 (24.1)	5 (21.7)	
HFpEF – no. (%)		6 (30.0)	7 (24.1)	4 (17.4)	
HFmrEF – no. (%)		3 (15.0)	9 (31.0)	6 (26.1)	
HFrEF – no. (%)		4 (20.0)	6 (20.7)	8 (34.8)	
Female Sex – no. (%)		8 (40.0)	10 (34.5)	8 (34.8)	
Age – years		69.80 ± 8.28	71.00 ± 10.83	68.21 ± 10.52	0.738
BMI – kg/m ²		27.66 ± 4.37	26.55 ± 4.19	26.94 ± 3.27	0.632
CAD – no. (%)		11 (55.0)	18 (62.1)	10 (43.5)	0.408
Hypertension – no. (%)		15 (75.0)	19 (65.5)	17 (73.9)	0.715
Previous MI – no. (%)		9 (45.0)	13 (44.8)	7 (30.4)	0.506
Previous PCI – no. (%)		10 (50.0)	15 (51.7)	10 (43.5)	0.831
Diabetes mellitus – no. (%)		6 (30.0)	7 (24.1)	2 (8.7)	0.195
LBBB on ECG – no. (%)		1 (5.0)	1 (3.4)	1 (4.3)	0.946
Ever Smoked – no. (%)		10 (50.0)	17 (58.6)	13 (56.5)	0.832
Packyears – years		15.79 ± 34.99	19.16 ± 41.97	16.91 ± 20.94	0.945
NYHA Class	II – no. (%)	10 (66.7)	16 (69.6)	13 (68.4)	0.999
	III – no. (%)	4 (26.7)	6 (26.1)	5 (26.3)	
Leg Edema – no. (%)		11 (55.0)	17 (58.6)	13 (56.5)	0.757
6 min walk distance – m		410.70 ± 132.67	411.32 ± 119.76	462.57 ± 130.05	0.284
MLHFQ QOL Score		24.15 ± 24.20	17.69 ± 19.11	27.13 ± 25.15	0.31
Beta-Blocker – no. (%)		14 (70.0)	19 (65.5)	15 (65.2)	0.933
ACE-Inhibitor – no. (%)		4 (20.0)	8 (27.6)	9 (39.1)	0.376
ARB – no. (%)		10 (50.0)	11 (37.9)	10 (43.5)	0.703
MRA – no. (%)		5 (25.0)	5 (17.2)	8 (34.8)	0.349
ARNI – no. (%)		1 (5.0)	1 (3.4)	3 (13.0)	0.37
Statin – no. (%)		12 (60.0)	16 (55.2)	9 (39.1)	0.342
Loop Diuretic – no. (%)		4 (20.0)	7 (24.1)	5 (21.7)	0.941
HCT – no. (%)		3 (15.0)	5 (17.2)	3 (13.0)	0.916
Hb – g/dl		13.72 ± 1.79	13.87 ± 1.15	14.09 ± 1.09	0.665
RBC – /pl		4.65 ± 0.50	4.69 ± 0.47	4.60 ± 0.48	0.784
WBC – /nl		7.77 ± 2.10	7.25 ± 2.54	7.61 ± 2.33	0.73
Platelets – /nl		276.50 ± 58.93	245.76 ± 63.14	236.78 ± 81.54	0.148
Hematocrit		0.41 ± 0.05	0.41 ± 0.03	0.41 ± 0.03	0.989
Cholesterol – mg/dl		163.65 ± 37.23	174.18 ± 46.76	177.39 ± 40.74	0.546
LDL – mg/dl		101.80 ± 32.65	106.36 ± 45.57	107.65 ± 35.91	0.878
HDL – mg/dl		52.50 ± 17.63	55.21 ± 22.08	57.78 ± 18.22	0.682

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Triglycerides – mg/dl	143.95 ± 103.46	129.36 ± 93.37	158.52 ± 102.61	0.582
HbA1c – %	5.74 ± 0.77	5.83 ± 0.76	5.59 ± 0.58	0.491
NTproBNP – ng/l	747.60 ± 1909.24	782.74 ± 2083.60	1089.57 ± 1802.21	0.808
Hs TroponinT – ng/l	17.90 ± 17.69	16.36 ± 17.14	13.55 ± 9.98	0.648
CRP – mg/l	1.96 ± 1.82	2.40 ± 3.74	1.70 ± 1.44	0.64
LVEF – %	54.50 ± 13.78	49.98 ± 11.47	47.49 ± 13.47	0.202
LV EDV – ml	165.07 ± 63.44	177.56 ± 62.06	193.70 ± 68.92	0.351
LV ESV – ml	80.29 ± 54.96	94.59 ± 53.74	108.06 ± 63.57	0.292
LV SV – ml	83.36 ± 17.36	83.10 ± 16.00	85.36 ± 18.75	0.885
Increase: Δ LV GLS < -0.5; No change: $-0.5 \leq \Delta$ LV GLS $\leq +0.5$; Increase: Δ LV GLS > +0.5; Non-standard abbreviations: ARB, angiotensin receptor blocker; ARNI, angiotensin receptor blocker – neprilysin inhibitor; BP, blood pressure EDV, end-diastolic volume; EF, ejection fraction; ECG, electrocardiogram; ESV, end-systolic volume; GCS, global circumferential strain; GLS, global longitudinal strain; HF, heart failure; HFpEF, HF with preserved EF; HFmrEF, HF with mid-range EF; HFrEF, HF with reduced EF; LBBB, left bundle branch block; MI, myocardial infarction; MLHFQ, Minnesota living with heart failure questionnaire; MRA, mineralocorticoid receptor antagonist; PCI, percutaneous coronary intervention; QOL, quality of life; RBC, red blood cells; WBC, white blood cells.				