Comparison of Left Ventricular Torsion and Strain With Biventricular Pacing in Patients With Underlying Right Bundle Branch Block Versus Those With Left Bundle Branch Block

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The benefits of biventricular pacing in patients with cardiac resynchronization therapy (CRT) remain poorly understood in those with right bundle branch block (RBBB). The aim of this study was to examine the differences in several speckle tracking–derived parameters, including left ventricular torsion and longitudinal strain with CRT on and off for patients with underlying left bundle branch block (LBBB) and RBBB. Twelve patients with CRT and RBBB were compared with a similar group of patients with underlying LBBB who were sent for evaluation and atrioventricular optimization. Echocardiographic images were acquired with biventricular pacing on and off. The 2 groups had similar baseline characteristics, including age, the ejection fraction, and QRS duration. During intrinsic conduction (CRT off), patients with LBBB had lower torsion angles than those with RBBB (2.3 ± 1.0° in those with LBBB vs 6.3 ± 1.0° in those with RBBB, p = 0.03) but trended toward improvements in torsional parameters, including torsional angle and peak untwisting velocity with CRT on, whereas these parameters worsened in patients with RBBB. Compared with CRT off, analyses of septal and lateral strain curves showed significant improvements in septal strain during 100% and 200% of systole with CRT on in patients with LBBB, whereas biventricular pacing resulted in a trend toward worsening of septal strain in patients with RBBB. Negligible changes were noted in lateral strain values. In conclusion, CRT favorably improves regional mechanics in patients with LBBB primarily involving the ventricular septum, with a negligible positive impact on cardiac function in patients with underlying RBBB. **(Am J Cardiol 2015;115:918–923)**

In the present study, we assessed consecutive patients with underlying right bundle branch block (RBBB) who had no response to long-term (>3 months) cardiac resynchronization therapy (CRT). Response was defined by either persistent New York Heart Association class III or IV, failure to improve the ejection fraction, or no decrease of end-systolic volume. The controls were a group of matched CRT nonresponders with underlying left bundle branch block (LBBB). We sought to determine the possible mechanical mechanism of CRT nonresponse and whether it could be mediated by an absence of effects on regional contraction patterns or by factors that cannot be addressed by CRT, such as scar-mediated remodeling.[1]

Methods

We identified a total of 12 consecutive patients with underlying conduction abnormalities consistent with RBBB who were nonresponders on the basis of clinical and/or remodeling criteria. RBBB was diagnosed by conventional electrocardiographic criteria, including a terminal positive deflection in lead V_1 with QRS duration >120 ms.[2] We performed matching with 12 consecutive patients with LBBB who were nonresponders to CRT, with matching according to patients' gender, age, cause of heart failure (ischemic vs nonischemic), QRS duration, and ejection fraction.

All subjects had previously implanted biventricular pacemakers with ICD because of advanced heart failure refractive to medical therapy, systolic dysfunction (left ventricular [LV] ejection fraction ≤ 35%), and prolonged QRS duration (≥120 ms). LV leads were implanted using fluoroscopy. LV lead position was confirmed by chest x-ray. Patients with anteriorly placed LV leads were excluded from the study groups.

All patients underwent standard transthoracic echocardiography (Vivid 7; GE Vingmed Ultrasound AS, Horten, Norway) using an ultrasound machine with a 2.5-MHz probe and digital storage capacity. All data were analyzed off-line by a single observer blinded to patient factors and pacing status. Chamber dimensions were assessed using 2-dimensional or M-mode measurements on the basis of current guidelines.[3] The LV ejection fraction was calculated using the modified Simpson's method.[4]

All patients had an attempted atrioventricular (AV) delay optimization performed using echocardiography. The

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See page 923 for disclosure information.

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Table 1
Baseline Characteristics of Study Patients

Patient	Age (years)	Sex	Ischemic etiology	QRS morphology	QRS Duration (ms)	ACE/ ARB	Beta Blocker	NYHA class	Systolic BP	Diastolic BP	HR (bpm)	BNP (pg/mL)	Time (days) from implant	EF (%)	RVSP (mm Hg)	LVEDD (cm)	LVESD (cm)	LVEDV (mL)	LVESV (mL)
1	71	M	+	LBBB	156	+	+	2	123	55	73	345	652	28	43	6.2	5.2	242	174
2	70	M	+	LBBB	158	+	+	3	104	50	70	741	111	28	41	5.1	4.2	146	104
3	78	M	+	LBBB	172	+	+	3	113	55	60	690	94	32	27	6	5	206	140
4	61	F	0	LBBB	128	+	+	3	118	70	79	541	247	19	38	6.5	5.8	235	190
5	64	F	+	LBBB	130	0	+	3	109	65	64	602	157	20	60	6.6	6.1	284	227
6	59	M	+	LBBB	130	+	+	3	122	80	84	980	102	12	52	8.5	7.6	429	377
7	49	F	0	LBBB	142	+	+	3	140	90	91	317	344	20	35	6.1	5.1	187	150
8	67	M	0	LBBB	156	+	+	2	138	74	75	381	393	15	50	9.4	4.5	545	463
9	48	M	0	LBBB	230	+	+	3	150	94	95	590	600	10	39	9.2	8.9	508	457
10	65	F	0	LBBB	148	0	+	4	100	50	80	400	375	17	33	7.7	6.9	388	322
11	67	M	+	LBBB	150	+	+	2	135	68	72	232	502	20	40	6.7	6.1	260	208
12	66	M	+	LBBB	218	0	+	4	122	79	101	554	1354	11	35	6.4	5.5	237	211
13	65	M	+	RBBB	162	0	+	4	101	62	70	1050	132	23	27	6.6	5.7	327	251
14	65	M	+	RBBB	156	0	0	3	88	58	60	615	719	8	40	7.8	7	363	335
15	66	M	0	RBBB	166	+	+	3	88	49	90	2000	88	10	32	7.4	6.8	270	243
16	69	M	+	RBBB	192	0	0	3	108	55	65	491	96	14	40	5.6	4.8	244	204
17	54	M	+	RBBB	156	+	+	2	114	74	80	212	94	20	61	7.6	5.5	325	260
18	63	F	0	RBBB	140	+	+	3	133	74	63	805	498	12	50	6.7	6.3	375	333
19	66	M	+	RBBB	122	+	+	2	113	70	92	111	102	21	35	4.9	3.9	172	135
20	63	F	0	RBBB	150	+	+	3	108	62	75	65	110	21	48	4.7	4.2	104	83
21	65	M	+	RBBB	208	+	+	2	91	52	74	82	1575	20	32	8.1	7.3	352	280
22	66	F	0	RBBB	154	+	+	3	140	70	90	495	421	13	48	6.2	6	317	275
23	83	M	+	RBBB	120	+	+	2	114	65	66	902	1204	27	67	6.5	5.9	171	125
24	56	F	0	RBBB	131	+	+	3	110	55	71	70	374	11	38	7.8	7.6	375	335

ACE = angiotensin converting enzyme; ARB= angiotensin receptor blocker; BNP = Brain Natriuretic Peptide; BP= blood pressure; bpm= beats per minute; F = female; HR= heart rate; LBBB = left bundle branch block; LVEDD = left ventricular end diastolic dimension; LVEDV = left ventricular end diastolic volume; LVESD = left ventricular end systolic dimension; LVESV = left ventricular end systolic volume; M = male; RBBB = right bundle branch block; RVSP = right ventricular systolic pressure.