

SUPPLEMENTAL MATERIAL

Supplemental Methods:

Additional Information Regarding Patient Recruitment

Twenty-five Brugada syndrome (BrS) patients from two centers in the United States (Washington University, The University of California, San Francisco) and one center in France (Bordeaux University Hospital) participated the study. The first period of recruitment ran from October 2009 and June 2012. Twenty-one BrS patients were offered the ECGI without heart rate acceleration. Nineteen patients participated, and two declined. The second period of recruitment ran from June 2013 to December 2013 to obtain ECG imaging (ECGI) recordings during sinus rhythm and heart rate acceleration. The heart rate acceleration protocol was added to the study after we completed analysis of the data from nineteen patients. The analysis suggested the usefulness of examining rate dependence to obtain insights into mechanisms. From eight patients that were offered the ECGI study, six participated and two declined.

Right bundle branch block (RBBB) patients were recruited between January 2014 and April 2014 at Washington University. Patients who had RBBB ECG pattern with a prolonged QRS $>$ 120ms, no structural heart disease and no history of cardiac arrhythmia were included. Among fourteen patients that were offered the ECGI study, six participated, eight declined.

Historical data from 7 normal subjects (Main text, reference12) provided normal control. These data were previously obtained with the same ECGI methodology; they were not obtained at the time of this study.

Supplemental Table 1. BrS Patient Demographics

Patient ID	Age	Gender	SCN5A Mutation	Previously Aborted SCD	Syncopal	Family History of SCD/Brugada ECG	ICD Implanted	ICD Therapy	ECG Leads with STE
BrS-1	34	M	-	+	-	-	+	+	V1, V2, V3
BrS-2	53	M	+	+	-	+	+	-	V1, V2
BrS-3	54	M	+	-	+	+	-	-	V1
BrS-4	48	M	+	-	+	+	-	-	V1, V2
BrS-5	52	M	+	-	+	+	-	-	V1, V2
BrS-6	62	F	+	-	-	+	-	-	V1
BrS-7	43	M	-	-	-	-	-	-	V1, V2
BrS-8	41	M	+	-	+	-	-	-	V1, V2, V3
BrS-9	66	M	-	-	-	-	-	-	V2
BrS-10	29	M	-	+	-	+	+	-	V1, V2, V3
BrS-11	44	M	+	-	-	+	-	-	V1, V2
BrS-12	45	M	-	-	-	-	-	-	V1, V2
BrS-13	78	M	N/A	+	-	-	-	-	V1
BrS-14	60	M	-	+	-	-	+	+	V2
BrS-15	31	M	+	-	-	-	-	-	V1, V2
BrS-16	30	M	N/A	-	-	+	-	-	V1, V2, V3
BrS-17	54	F	-	-	+	+	-	-	V1, V2
BrS-18	63	M	+	+	-	+	+	-	V2, V3
BrS-19	61	M	N/A	-	+	-	+	-	V1
BrS-20	45	M	N/A	+	-	-	+	+	V1, V2, V3
BrS-21	39	M	N/A	+	-	-	+	+	V1, V2
BrS-22	48	M	+	+	-	-	+	-	V1, V2
BrS-23	19	M	+	+	-	-	+	-	V1
BrS-24	45	M	N/A	-	+	+	-	-	V1
BrS-25	49	M	N/A	-	-	+	+	-	V1, V2

SCD = Sudden Cardiac Death; ICD = Implantable Cardioverter Defibrillator; STE = ST Segment Elevation.

Patients with STE outside the RVOT are highlighted (yellow).

Supplemental Table 2. Subject Characteristics

	BrS (n=25)	RBBB (n=6)	Control (n=7)
Age (Year)	48±13	41±12	28±7
Male	23 (92%)	6 (100%)	4 (57%)
SCN5A Mutation	11 (44%)	N/A	N/A
Previously Aborted SCD	10 (40%)	0 (0%)	0 (0%)
Syncope	7 (28%)	0 (0%)	0 (0%)
Family History of SCD/ Brugada ECG	12 (48%)	0 (0%)	0 (0%)
ICD Implant	11 (44%)	0 (0%)	0 (0%)
ICD Therapy	4 (16%)	0 (0%)	0 (0%)

Data are presented as mean±SD or number (percentage) of patients.

Supplemental Table 3. Number of ECGI Reconstructed EGMs in Epicardial Segments

	RVOT	RV Free Wall	RV Apex	LV Base	LV Free Wall	LV Apex
Number of EGMs	107±14	271±24	42±9	138±22	408±53	50±8

Supplemental Table 4. A Comparison of ECGI parameters between BrS and non-BrS RBBB Patients

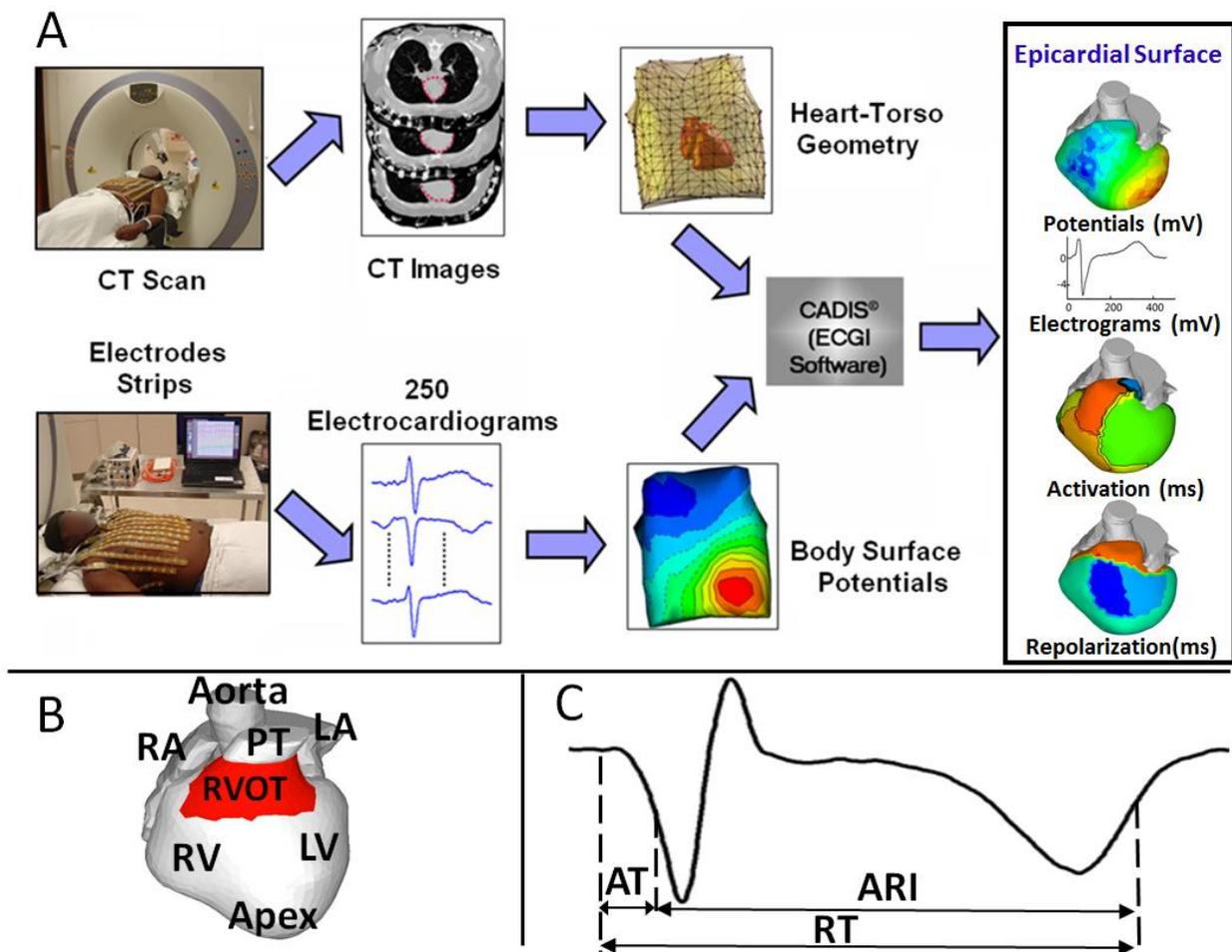
	Activation Duration (ms)			EGM Fractionation (# of small deflections)		EGM Magnitude (mV)		ARI Dispersion (ms/cm)	RT Dispersion (ms/cm)
	RVOT [†]	RV free wall	Entire RV [†]	RVOT [†]	RV free wall [†]	RVOT [†]	RV free wall	RVOT [†]	RVOT [†]
BrS	36±16	16±3	40±14	2.97±0.69	1.04±0.80	0.47±0.16	2.52±0.94	105±24	96±28
RBBB	14±5	16±6	24±6	0	0	3.74±0.65	3.53±0.60	8±4	6±3

† Unpaired t-test: P<0.005

BrS data include the BrS patient with RBBB ECG pattern.

Supplemental Figure 1

(A) The noninvasive ECGI procedure. Body surface potential recordings (250 electrodes) and gated, non-contrast thoracic computed tomography (CT) scan are processed mathematically to obtain epicardial potentials, 1500 unipolar electrograms, and maps of epicardial activation and repolarization. (B) The right ventricular outflow tract (RVOT) region in one patient's heart (shown in red) as determined from CT images. This representative image serves as an example. (C) Temporal fiducial points on electrograms. AT: activation time; RT: recovery time; ARI: activation recovery interval.



Supplemental References (ECGI Validation; for Noninvasive Mapping in the Methods Section)

1. Oster HS, Taccardi B, Lux RL, Ershler PR and Rudy Y. Noninvasive electrocardiographic imaging: Reconstruction of epicardial potentials, electrograms, and isochrones and localization of single and multiple electrocardiac events. *Circulation*. 1997;96:1012-1024.
2. Burnes JE, Taccardi B and Rudy Y. A noninvasive imaging modality for cardiac arrhythmias. *Circulation*. 2000;102:2152-2158.
3. Ghanem RN, Jia P, Ramanathan C, Ryu K, Markowitz A and Rudy Y. Noninvasive electrocardiographic imaging (ECGI): Comparison to intraoperative mapping in patients. *Heart Rhythm*. 2005;2:339-354.
4. Ghosh S and Rudy Y. Accuracy of quadratic versus linear interpolation in noninvasive electrocardiographic imaging (ECGI). *Annals of Biomedical Engineering*. 2005;33:1187-1201.
5. Ghosh S and Rudy Y. Application of L1-norm regularization to epicardial potential solution of the inverse electrocardiography problem. *Annals of Biomedical Engineering*. 2009;37:902-912.
6. Cuculich PS, Wang Y, Lindsay BD, Faddis MN, Schuessler RB, Damiano RJ, Li L and Rudy Y. Noninvasive characterization of epicardial activation in humans with diverse atrial fibrillation patterns. *Circulation*. 2010;122:1364-1372.
7. Cakulev I, Sahadevan J, Arruda M, Goldstein RN, Hong M, Intini A, Mackall JA, Stambler BS, Ramanathan C, Jia P, Strom M and Waldo AL. Confirmation of Novel Noninvasive High-Density Electrocardiographic Mapping With Electrophysiology Study: Implications for Therapy. *Circulation: Arrhythmia and Electrophysiology*. 2013;6:68-75.