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Radiofrequency ablation on the right ventricular septum changed a bundle branch block pattern of a ventricular tachycardia: What is the mechanism?

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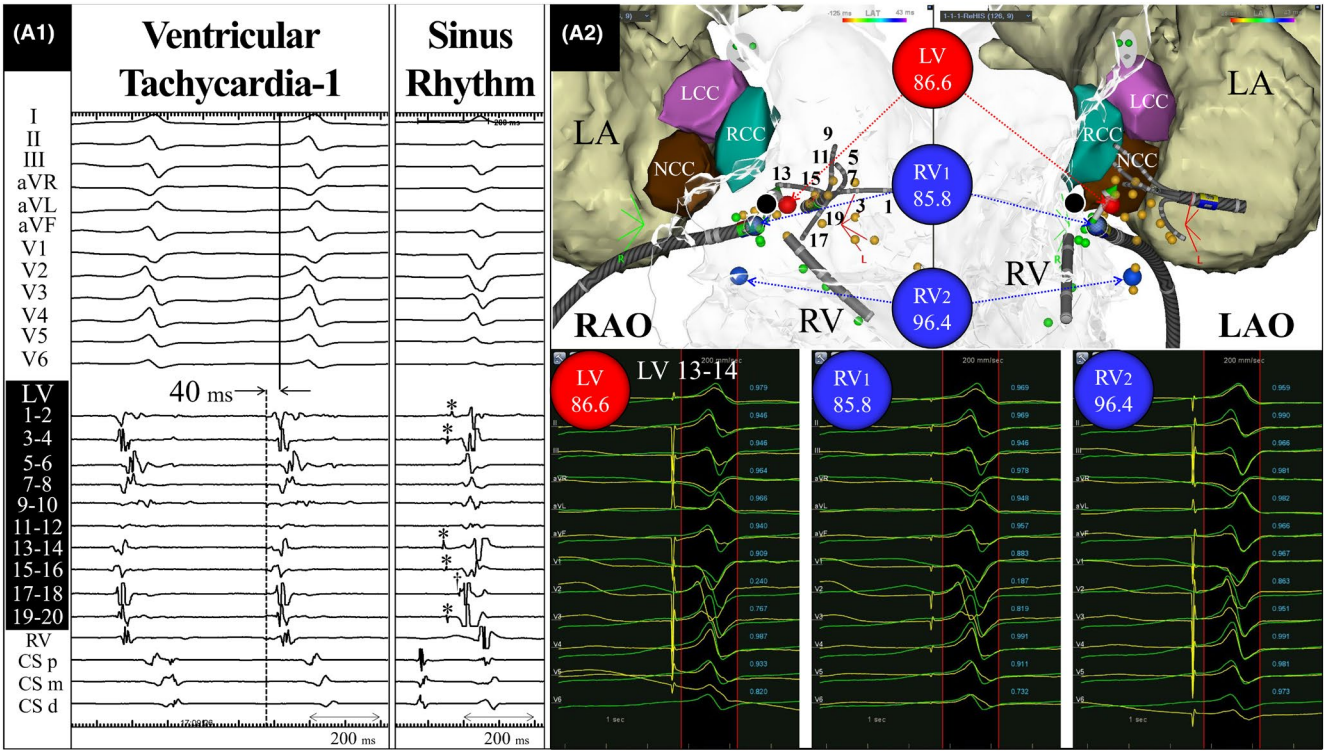
Abstract

A ventricular tachycardia (VT) with a left bundle branch block (BBB) pattern exhibited the earliest activation (EA) at the left ventricular basal septum near the His bundle with no excellent pace map (PM). Radiofrequency ablation at the right ventricular basal septum (opposite site of the EA site) changed the QRS morphology of VT to a right BBB pattern that matched a PM at the opposite site in the left ventricle. VT ablation was successful at the earliest activation site. The VT should have originated from an intramural origin with preferential pathways to the endocardial breakout sites in the right and left ventricular septum.

KEYWORDS
ablation, para-Hisian, preferential pathway, QRS morphology, ventricular tachycardia

1 | CASE PRESENTATION

A 69-year-old man with a history of a remote anteroseptal myocardial infarction underwent catheter ablation of a ventricular tachycardia (VT) refractory to amiodarone requiring multiple implantable cardioverter-defibrillator shocks. The VT exhibited a left bundle branch block morphology with a QS pattern in lead V1 and relatively narrow QRS width (140 ms). During an electrophysiological study, the clinical VT (VT-1) with a cycle length (CL) of 450 ms was induced by programmed ventricular stimulation. Activation mapping during VT-1 revealed the earliest ventricular activation (EA) preceding the QRS onset by 40 ms on the basal septum of the left ventricle (LV) anterior to the right coronary cusp (RCC) where the bifurcation between the left anterior and posterior fascicles was located (Figure 1A). At this site, Purkinje potentials were recorded during sinus rhythm but did not precede the local ventricular activation during VT-1. The pace maps (PMs) at the EA site or right ventricular (RV) basal septum (site opposite the EA site), were not excellent but had similar matching scores (86.6% vs 85.8%). The best PM (96.4%) was obtained at the RV basal inferoseptum, 20 mm inferiorly away from the EA site (Figure 1-A2). The first radiofrequency application (ABL-1) was applied during sinus rhythm at the RV basal septum opposite the EA site, where the local activation was 20 ms later than the EA during VT-1, but Purkinje potentials were not evident during sinus rhythm, to avoid atrioventricular block (AVB). ABL-1 developed a right bundle branch block (RBBB) and transient AVB. Although VT-1 became no longer inducible after ABL-1, VT-2 with a CL of 500 ms exhibiting an RBBB morphology with a qR pattern in lead V1 was induced (Figure 1-B1). The EA site during VT-2 remained the same on the LV basal septum as that during VT-1, where the local activation preceded the QRS onset by 40 ms. The best PM (96.6%) was obtained on the LV septum, 23 mm apically away from the EA site (Figure 1-B-2). The second radiofrequency application (ABL-2) just above the EA site underneath the RCC successfully eliminated VT-2 with a transient AVB. What is the mechanism to explain these findings?


(A1)
Ventricular Tachycardia-1
Sinus Rhythm
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
LV
1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
RV
CS p
CS m
CS d
40 ms
200 ms
200 ms
(A2)
LV 86.6
RV1 85.8
RV2 96.4
LCC
RCC
NCC
LA
RAO
RV
LAO
LV 13-14
200 mm/sec
1 sec

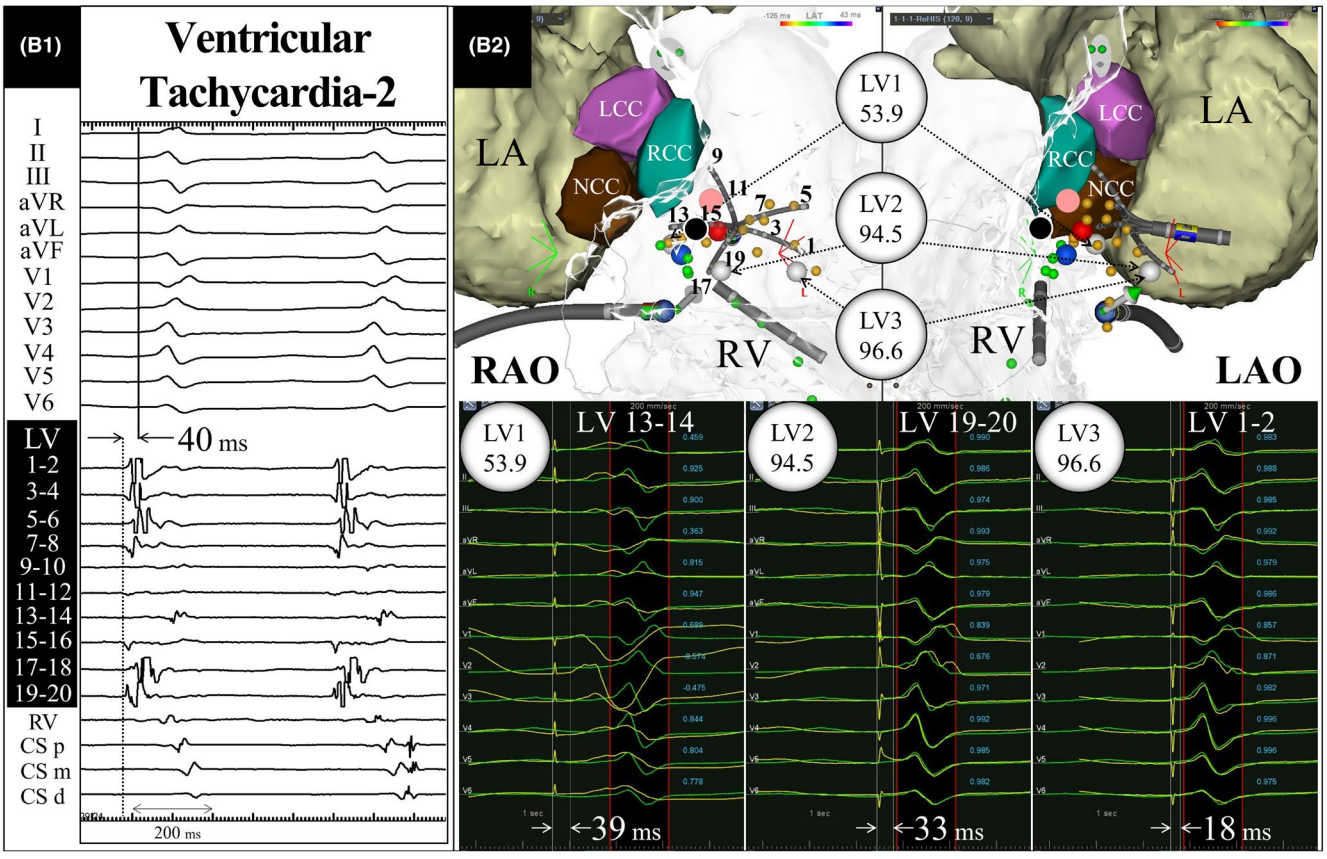

(B1)
Ventricular Tachycardia-2
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
LV
1-2
3-4
5-6
7-8
9-10
11-12
13-14
15-16
17-18
19-20
RV
CS p
CS m
CS d
40 ms
200 ms
(B2)
LV1 53.9
LV2 94.5
LV3 96.6
LCC
RCC
NCC
LA
RAO
RV
LAO
LV 13-14
LV 19-20
LV 1-2
200 mm/sec
1 sec
39 ms
33 ms
18 ms

FIGURE 1 (A1) Cardiac tracings recorded during VT-1 and sinus rhythm. (A2-upper) Three-dimensional geometries of the right ventricle (RV), left atrium (LA), and coronary cusps. The red tag indicates the earliest activation (EA) site during VT-1; blue tags, pace map sites in the RV; black tag, the first ablation site (ABL-1). (A2-lower) Twelve-lead electrocardiograms exhibiting VT-1 (green) with pace maps (yellow). Numbers indicate pace map scores. (B1) Cardiac tracings recorded during VT-2. (B2-upper) Three-dimensional geometries of the RV, LA, and coronary cusps. The red tag indicates the EA site during VT-1 and VT-2; white tags, pace map sites in the left ventricle (LV); blue tags, pace map sites in the RV; black/pink tag, ABL-1/ABL-2 site. (B2-lower) Twelve-lead electrocardiograms showing VT-2 with pace maps. CSp/m/d = proximal/mid/distal coronary sinus; L(R)AO = left (right) anterior oblique; NCC/LCC/RCC = non-/left/right coronary cusp

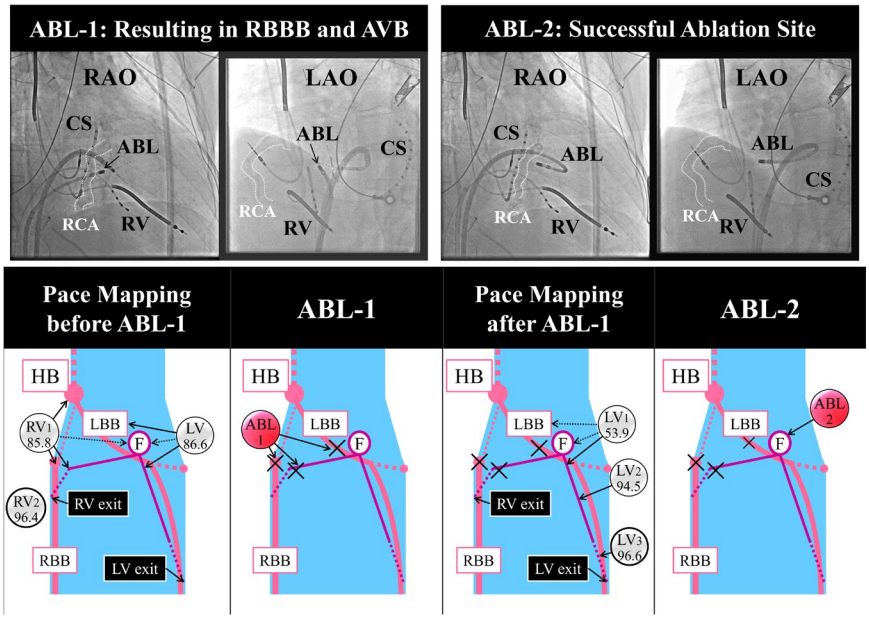


FIGURE 2 (Upper) Fluoroscopic images exhibiting the ablation sites. The dotted lines indicate the calcified right coronary artery (RCA). (Lower) Schematic diagrams illustrating a postulated mechanism. The numbers indicate pace map scores. HB = His bundle; F = focus; L(R)BB = left (right) bundle branch. The other abbreviations are the same as in Figure 1

2 | COMMENTARIES

Two VTs, in this case, were suggested to have been focal from the same origin and were unlikely to have been different macroreentrant VTs with shared isthmus for several reasons. First, no mid-diastolic potentials were recorded at the successful ablation site during either VT. Second, a highly matched pace map for each VT was recorded at two different sites. The VT ablation was successful in the para-Hisian region where no excellent PMs or Purkinje potentials were recorded. Excellent PMs were recorded at multiple sites more than 20 mm away from the successful ablation site. Therefore, the VT origin was suggested to have been located in the intraseptal myocardium with preferential pathways in the ventricular septum to multiple remote endocardial breakout sites (Figure 2). Pacing from the site close to the EA site (LV1) might have captured not only the preferential conduction pathway but also the bystander tissue, resulting in a fusion less matching the QRS of the VT. It was noted that the latency was longer during pacing from sites near the successful ablation site (LV1 and LV2) than the excellent pace map site (LV3) (Figure 1-B1), suggesting that site LV3 should have been closer to the breakout site of the VT than sites LV1 and LV2. Thus, pacing from site LV3 resulted in less fusion better matching the QRS of the VT. An excellent pace map was recorded on the RV septum at baseline and LV septum after ABL-1 on the RV septum. Therefore, the activation from the VT origin should have conducted more preferentially to a breakout site in the RV septum rather than that in the LV septum at baseline. Because ABL-1 eliminated the preferential pathway to the RV septum and also developed RBBB during sinus rhythm, the preferential pathway to the RV septum should have been located near the RBB (Figure 2). To the best of our knowledge, this is the first report to illustrate a shift in the breakout site of para-Hisian VAs from one ventricle to the other ventricle after the ablation.[1]

CONFLICT OF INTEREST

None declared.

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