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【 CASE REPORT 】

Isolated Right Ventricular Infarction: A Case Report and Literature Review

Daigo Hiraya, Akira Sato, Hiroaki Watabe, Tomoya Hoshi and Masaki Ieda

Abstract:
Isolated right ventricular (RV) infarction is extremely rare and its diagnosis may be challenging, because RV infarction most often occurs simultaneously with infarction of the inferior wall of the left ventricle. A 66-year-old man with a history of diabetes mellitus presented with cold sweat and general malaise. Although his symptoms were atypical for myocardial infarction, he was quickly diagnosed with RV infarction and successfully underwent urgent percutaneous coronary intervention. He was definitely diagnosed with isolated RV infarction by a scintigram and cardiac magnetic resonance imaging. Our review showed the importance of the combined assessment in the diagnosis of isolated RV infarction.

Key words: isolated right ventricular infarction, diabetes mellitus, electrocardiogram, right precordial lead, echocardiography

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Introduction

Right ventricular (RV) infarction occurs in approximately 30% to 50% of cases of inferior myocardial infarction (MI) involving the proximal right coronary artery (RCA) (1). However, isolated RV infarction is extremely rare and occurs in less than 3% of all patients with MI (2). Although an electrocardiogram (ECG) is the most important noninvasive examination for MI, the ECG findings of isolated RV infarction are not generally known, so it can be easily missed if not suspected (3). RV involvement often leads to worse clinical outcomes, such as cardiogenic shock and in-hospital mortality (4), and RV shock has been reported to have the same mortality rate as left ventricular (LV) shock (5). Therefore, a rapid diagnosis and appropriate treatment of RV infarction is extremely important.

We herein report a case of isolated RV infarction caused by occlusion of a nondominant RCA.

Case Report

A 66-year-old man had a history of diabetes mellitus (DM) and blindness due to diabetic retinopathy. He found he could not move during a walk he had taken due to cold sweat and general malaise. He subsequently ingested high-sugar foods, as the symptoms were similar to hypoglycemic symptoms he'd experienced in the past. However, his symptoms did not improve, so he consulted his family doctor.

He was in shock and was transported to our emergency department. His blood pressure was 78/36 mmHg, and his heart rate was 45 bpm. A blood gas analysis revealed an elevated lactate level of 3.6 mmol/L. An ECG showed junctional rhythm and mild ST-segment elevation in leads V1-V3, and a vector-derived ECG (Nihon Kohden, Tokyo, Japan) showed a 1-mm ST-segment elevation in V3R and V4R of the virtual right precordial leads (Fig. 1). Echocardiography revealed a normal LV systolic function, akinesis of the RV free wall and RV dilatation (Fig. 2) (Supplementary material), resulting in a diagnosis of RV infarction.

Coronary angiography showed a normal left coronary artery and occlusion of the proximal segment of the RCA (Fig. 3A, B), and percutaneous coronary intervention (PCI) was performed. First, a VVI temporary pacemaker lead was inserted via the right femoral vein for bradycardia. After thrombus aspiration and pre-dilatation, a 2.25/12-mm everolimus-eluting stent was deployed with achievement of thrombolysis in myocardial infarction (TIMI) grade 3 flow

Department of Cardiology, Faculty of Medicine, University of Tsukuba, Japan
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Correspondence to Dr. Akira Sato, asato@md.tsukuba.ac.jp

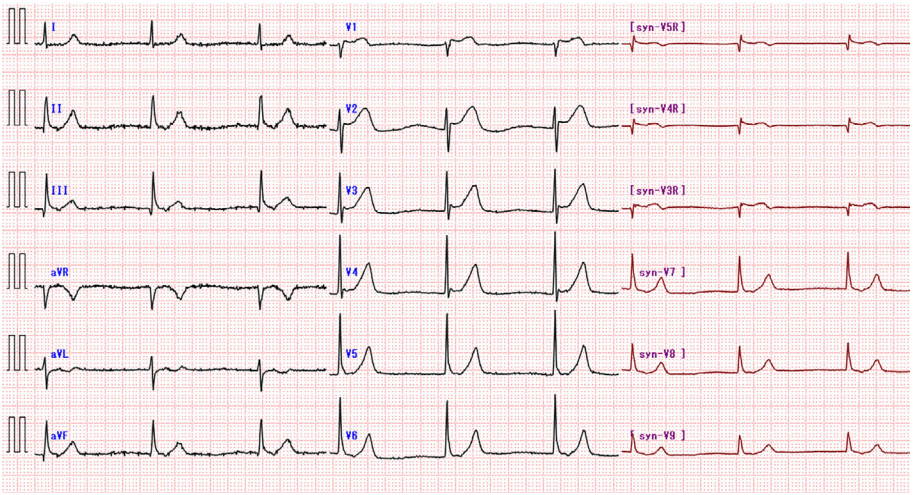

Figure 1. **The ECG obtained at the time of initial admission to the emergency department. The ECG shows junctional rhythm and mild ST-segment elevation in leads V1 to V3. The vector-derived ECG (Nihon Kohden) on arrival showed a 1-mm ST-segment elevation in V3R and V4R of the virtual right precordial leads. The sweep speed was 25 mm/s, 10 mm/mV.**

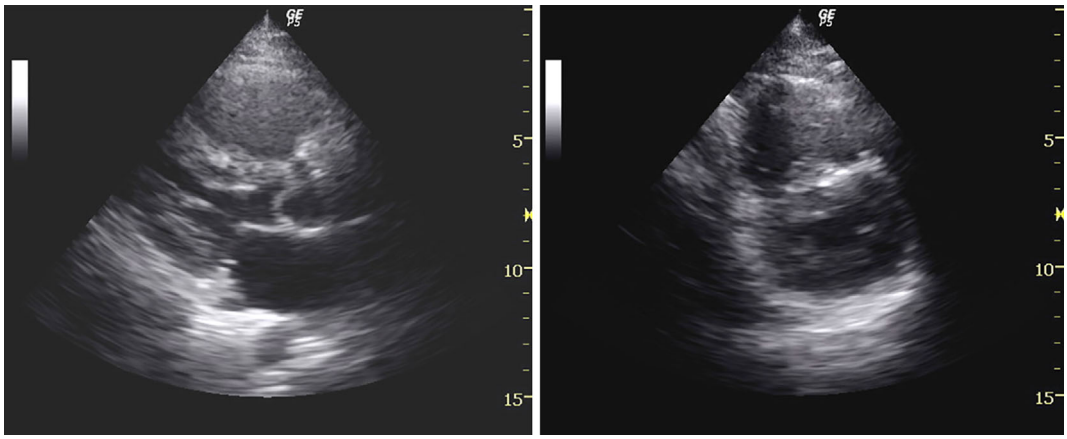

Figure 2. **Bedside echocardiography. Echocardiography revealed a normal left ventricular systolic function and right ventricular (RV) dilatation with akinesis of the RV free wall.**

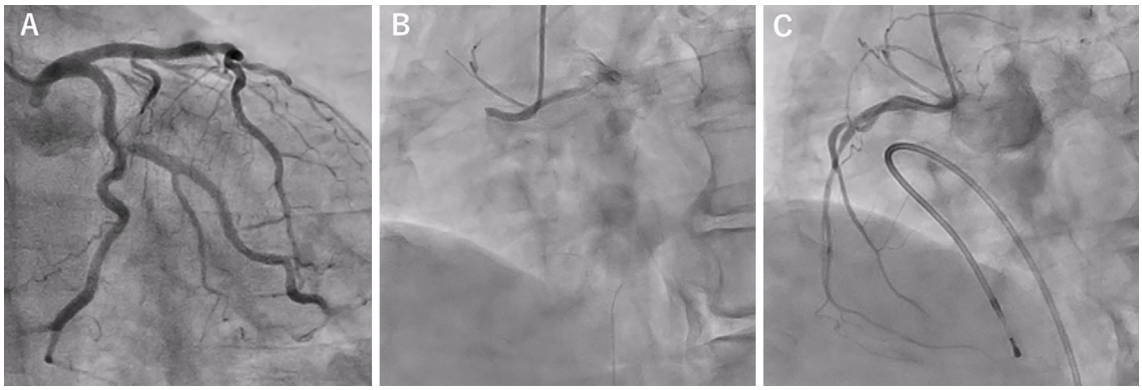

Figure 3. **Coronary angiography and emergent percutaneous coronary intervention. (A) (B) Coronary angiography demonstrated normal left coronary artery and occlusion of the proximal segment of the nondominant right coronary artery. (C) A 2.25/12-mm everolimus-eluting stent was deployed with achievement of TIMI grade 3 flow.**

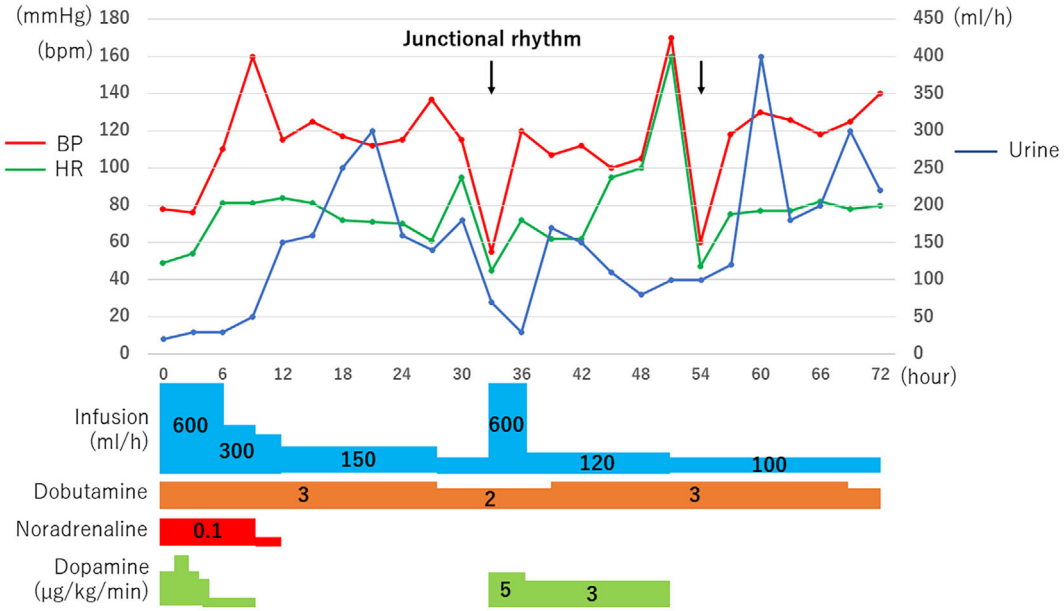

Figure 4. **Clinical course. The acute management required large-volume infusion and administration of multiple catecholamines. For several days, he had repeated paroxysmal atrial fibrillation and junctional rhythm, and his hemodynamics were unstable. In particular, when he was in junctional rhythm (black arrows), he was in shock again and needed a large-volume infusion and increased catecholamine administration. The hemodynamics stabilized after sinus rhythm was maintained. BP: blood pressure, HR: heart rate**

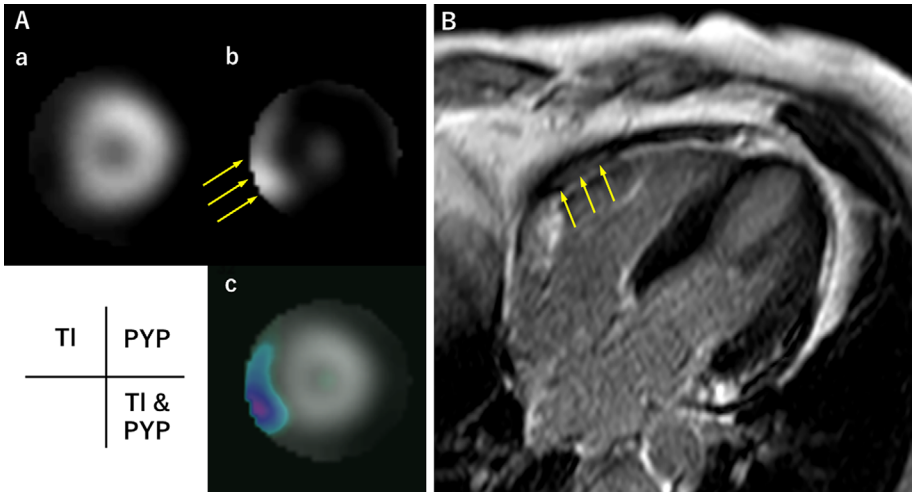

Figure 5. **Thallium/pyrophosphate (Tl/PYP) dual scintigrams and cardiac magnetic resonance imaging. (A) (a) The Tl/PYP dual scintigrams were performed after three days. The Tl scintigram showed no perfusion defect in LV. (b) The PYP scintigram showed the PYP accumulation only in the RV free wall (yellow arrows). (c) This image is the combination of Tl and PYP scintigrams. (B) Cardiac magnetic resonance after five days revealed delayed enhancement in a part of the RV free wall (yellow arrows).**

(Fig. 3C). The RCA was nondominant. Hypotension and bradycardia persisted after reperfusion, and he entered the intensive-care unit with a VVI temporary pacemaker. The peak creatinephospho kinase and creatine kinase-MB levels were 1,140 U/L and 82 U/L, respectively. Acute management required a large-volume infusion of 300 mL/h and multiple administrations of catecholamine (dobutamine 3 μg/kg/min, noradrenaline 0.1 μg/kg/min and dopamine 3 μg/kg/min). After several days of repeated paroxysmal atrial fibrillation and junctional rhythm, a sinus rhythm was maintained, and his hemodynamics stabilized (Fig. 4).

The thallium/pyrophosphate (Tl/PYP) dual scintigrams after three days showed no perfusion defect in LV and PYP accumulation only in the RV free wall (Fig. 5A). Cardiac

Table. **List of Case Reports of Isolated Right Ventricular Infarction.**

Reference	Age, sex	Clinical scenario	Hemodynamics	Rhythm	ST-segment elevation in standard 12-lead ECG right precordial leads	Echocardiography of the RV
10	72, F	Occlusion of nondominant RCA	Stable	JR	None None	NA
11	96, F	Occlusion of nondominant RCA	Stable	AF	V1-V4 NA	Slightly dilatation
12	52, M	Occlusion of RVB	NA	SR	V1-V2 NA	NA
	59, F	Occlusion of nondominant RCA	NA	SR	V1-V2 NA	Moderate hypokinesis
13	42, M	Occlusion of RVB	Resuscitation after arrest	SR	V1 NA	Systolic dysfunction
	39, M	Occlusion of nondominant RCA	Resuscitation after arrest (VF)	SR	V1 NA	Normal lower limit
14	64, F	Occlusion of RCA after AVR	Shock	JR	V1-V3 V2R-V6R	Dilatation and akinesis of free wall
15	73, F	Occlusion of nondominant RCA	Shock	JR	None None	Akinesis of free wall
16	64, M	Occlusion of nondominant RCA	Shock	JR	V1-V3 V4R	Slightly dilatation
17	60, M	Occlusion of nondominant RCA	Stable	AF	V1-V4 NA	Dilatation
18	49, M	Occlusion of nondominant RCA	Stable	SR	V1-V3 NA	Normal motion
19	58, M	Occlusion of nondominant RCA	Stable	SR	V1 V4R-V5R	Systolic dysfunction
20	83, M	Occlusion of nondominant RCA	Stable	AFL	V1-V4 NA	NA
21	55, F	Occlusion of nondominant RCA	Resuscitation after arrest (VF)	AF	V1-V2 NA	Systolic dysfunction
22	62, M	Occlusion of AMB due to stent jail	NA	SR	V1-V4 NA	Dilatation and akinesis
23	58, M	Occlusion of RVB due to stent jail	NA	SR	V1-V3 NA	NA
24	60, M	Occlusion of RVB	Stable	SR	V1-V3 V3R-V5R	NA
25	55, M	Occlusion of RVB during PCI	NA	SR	V1-V4 V4R	NA
26	73, M	Occlusion of nondominant RCA	Stable	AF	V1-V3 NA	Normal function
27	78, F	Occlusion of nondominant RCA	Shock	JR	V1-V2 V3R-V4R	Dilatation and akinesis
28	76, M	Occlusion of nondominant RCA	Stable	SR	V1-V4 V3R-V6R	NA

AF: atrial fibrillation, AFL: atrial flutter, AMB: acute marginal branch, AVR: aortic valve replacement, ECG: electrocardiogram, F: female, JR: junctional rhythm, M: male, NA: not available, PCI: percutaneous coronary intervention, RCA: right coronary artery, RV: right ventricle, RVB: right ventricular branch, SR: sinus rhythm, VF: ventricular fibrillation

magnetic resonance imaging performed after five days revealed a delayed enhancement in a part of the RV free wall (Fig. 5B). Therefore, he was definitely diagnosed with isolated RV infarction. Cardiac rehabilitation was performed, and he was discharged 14 days later.

Discussion

We reported a diabetic patient diagnosed with isolated RV infarction due to occlusion of the nondominant RCA. This case was a diagnostic challenge at the initial doctor due to the absence of typical chest pain. Fujino et al. reported that 20% and 80% of patients with symptomatic MI had atypical and typical symptoms, respectively (6). Especially in patients with DM, atypical or asymptomatic MI may occur, likely as a result of cardiac autonomic dysfunction.

Isolated RV infarction without involvement of the LV inferior wall accounts for less than 3% of all patients with acute myocardial infarction (AMI) and might result in considerable morbidity and mortality (2). Isolated RV infarction may occur when a nondominant RCA is occluded proximal to the right ventricular branch or the acute marginal branch, and its diagnosis may be challenging.

An ECG is the most important noninvasive examination

for AMI. First, ST-segment elevation in V1 suggests the RV involvement, as lead V1 directly faces the RV. Outcome data from the HERO-2 trial has shown that ST-segment elevation ≥1 mm in lead V1 increased mortality of inferior AMI patients by 28% (7). In addition, a nondominant RCA usually does not cause significant LV posterior infarction, which may conversely result in relative ST-segment elevation in leads V1-V3. Second, ST-segment elevation of ≥1 mm in the right precordial leads, especially in V3R and V4R, is the most sensitive indicator of the occlusion of the proximal RCA, with a sensitivity of 82% to 100% and a specificity of 68% to 77% (8). We observed these ECG findings in virtual right precordial leads of the vector-derived ECG. However, the findings of a virtual ECG are not the same as the actual findings of the right precordial leads, and there is a limit to the diagnosis of isolated RV infarction based on an ECG alone.

AMI is the most common cause of sinus node dysfunction, and bradycardia is often accompanied with infarction of proximal RCA. Furthermore, echocardiography has a significant role in the diagnosis of isolated RV infarction, the assessment of LV ischemia and the exclusion of other diagnoses. The most frequent echocardiographic findings are RV dilatation and dysfunction, which were observed in this case. In addition to the ECG, the combined assessment of clinical signs, such as shock and bradycardia, and bedside echocardiography may be useful for the acute diagnosis of isolated RV infarction. However, invasive pressure measurements are important for the hemodynamic diagnosis of RV infarction. According to the guideline of the Japanese Circulation Society, the diagnosis of RV infarction can be confirmed when the right atrial pressure exceeds 10 mmHg with a pulmonary artery wedge pressure of 1-5 mmHg (9). However, right heart catheterization was not performed in this case.

We searched the PubMed medical database on May 2, 2021, for all articles published on cases of isolated RV infarction. The following search terms were used: "isolated right ventricular infarction" OR "pure right ventricular infarction". The literature with confirmed ECG findings published after 2,000 were summarized (Table) (10-28). There were surprisingly few that described both the right precordial leads and echocardiographic findings. Furthermore, it was found that the patients with junctional rhythm often showed unstable hemodynamics. This means that the decrease in ventricular filling due to the absence of atrial contraction reduces cardiac output, as was observed in this case. The appropriate treatment of RV infarction includes volume loading to maintain adequate RV preload as well as catecholamine support and maintenance of atrioventricular synchrony (1). In the present case, volume loading and catecholamine support were able to maintain blood pressure in the acute phase. The hemodynamics were not completely stable during repeated paroxysmal atrial fibrillation and junctional rhythm, but became stable after maintaining sinus rhythm. The insertion of an AAI temporary pacemaker is considered in patients with hemodynamic instability in junctional rhythm. Although few data are available in the literature, the use of an intra-aortic balloon pump in isolated RV infarction may be beneficial even in the presence of intact LV contraction (29). Reperfusion therapy should be performed for early recovery from RV dysfunction. However, although the acute phase of RV infarction is often hemodynamically unstable, RV dysfunction due to myocardial infarction is transient and completely recovers in a short period of time (1).

This case was diagnosed as isolated RV infarction by dual scintigrams and cardiac magnetic resonance imaging. Therefore, it was possible to perform treatments characteristic of the acute phase of RV infarction, such as volume loading and catecholamine support mainly involving dobutamine, while predicting the subsequent clinical course.

The authors state that they have no Conflict of Interest (COI).

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