Right ventricular ischemic insult: A comprehensive protocol with cardiovascular magnetic resonance

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Late gadolinium enhancement (LGE) imaging is underutilized for the assessment of right ventricular (RV) viability despite it being a conventional protocol in illustrating left ventricular (LV) myocardial fibrosis/necrosis. We introduce a robust protocol for comprehensive assessment of RV viability by applying modified dedicated RV views including LGE and T2W imaging. This protocol may open the venue for better evaluation of RV morphology and function.

The first case is a 28-year-old man admitted with non-sustained ventricular tachycardia. His past history was notable for smoking. The physical examination was unremarkable. The electrocardiogram showed T-wave inversion in the inferior leads. Laboratory investigations uncovered a mild elevation of troponin T levels. Transthoracic echocardiogram (TTE) was technically challenging, although it suggested mild RV dilatation with mild to moderate systolic dysfunction. Cardiac magnetic resonance (CMR) was performed to rule out acute myocarditis. CMR revealed normal LV volume and systolic function as well as mild RV dilatation with moderate systolic dysfunction (RV ejection fraction=34%). Dyskinesis of the inferior RV wall sparing the apex was observed. The remaining RV walls were contracting normally. T2W imaging showed edema in the same wall motion distribution extending to the LV/RV junction. LGE imaging revealed significant enhancement of the entire inferior RV wall sparing the apex, in keeping with isolated RV myocardial infarction (MI) (Fig. 1, Videos 1-5).

Based on the CMR results, acute myocarditis was ruled out. Consequently, coronary angiography was performed, and it demonstrated totally occluded non-dominant right coronary artery (RCA) (Video 6). A consensus decision was reached to proceed with medical treatment as RCA was a small non-dominant vessel. A follow-up CMR was scheduled 6 months later to monitor recovery; however, the patient declined.

The second case is a 65-year-old man admitted with ST-segment elevation inferior MI. He received thrombolytic therapy and still developed right-sided heart failure and complete heart block, which warranted temporary pacemaker implantation. Urgent coronary angiography revealed severe multivessel coronary artery disease with a totally occluded proximal RCA (culprit vessel). Percutaneous coronary intervention was not possible because of technical difficulties. The patient was immediately referred to our center for further evaluation and management.

He was admitted to the coronary care unit with severe congestive heart failure and Mobitz type II heart block. He was monitored closely, and it was decided to not implant a permanent pacemaker because of the acuity of his condition and his potential for recovery. TTE was technically difficult and uncovered mild LV systolic dysfunction, moderate RV dilatation with moderate systolic dysfunction, and moderate to severe tricuspid regurgitation (TR) with mildly elevated pulmonary pressure (approximately 40-45 mm Hg) (Video 7). A consensus decision was reached to proceed with coronary bypass surgery. However, because of the concomitant heart failure and RV dysfunction, CMR was performed to evaluate RV viability and recovery likelihood.

CMR showed a moderately dilated RV with moderate to severe systolic dysfunction (RV ejection fraction=29%). Significant RV wall motion abnormalities were noted with akinesis of the entire inferior wall and basal to mid free wall. The anterior wall and RV outflow tract (RVOT) were contracting normally. Additionally, mild LV systolic dysfunction with akinesis of the inferior wall was prominent. T2W imaging showed edema in the same wall motion distribution of LV/RV abnormalities. LGE RV imaging revealed significant enhancement of the entire inferior RV and basal free walls sparing RVOT and the anterior wall (Fig. 2, Videos 8-11).

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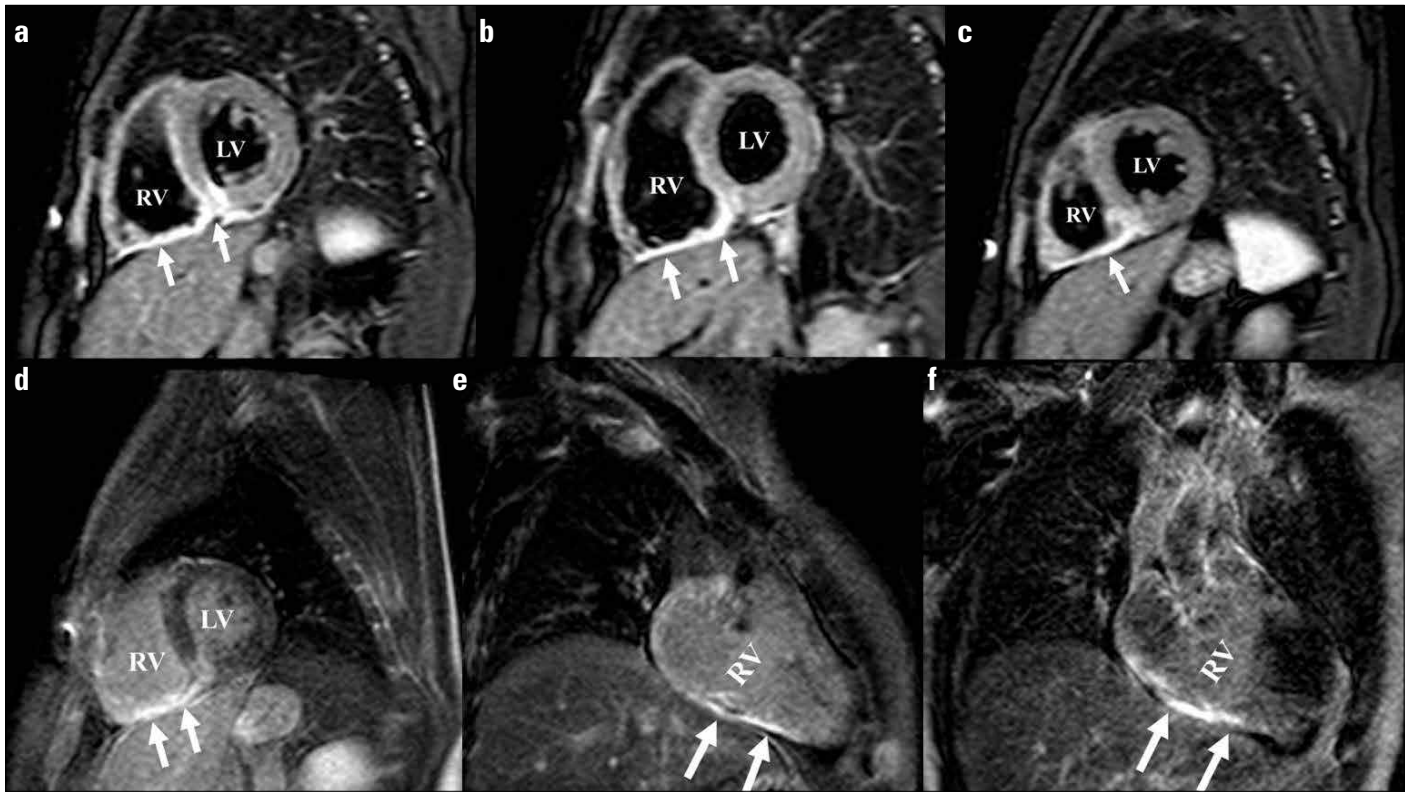

Figure 1. a-f. (a-c) Short-axis T2W imaging from the base to the apex showing myocardial edema in the RV inferior wall extending to the RV/LV junction (arrows). (d-f) Short-axis (d), RV vertical long axis (e), and RV inflow outflow (f) LGE views showing significant enhancement of the inferior wall sparing the apex (arrows)

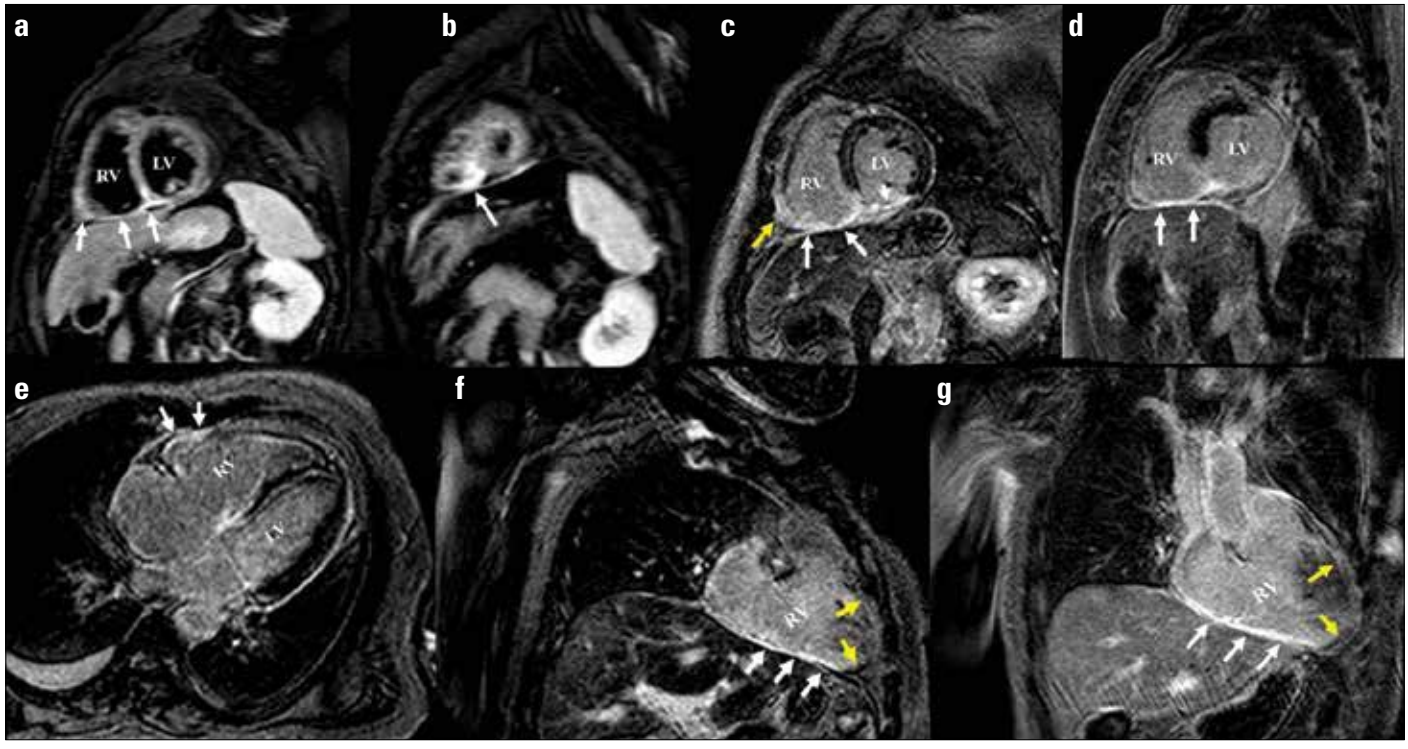

Figure 2. a-g. (a, b) Short-axis T2W imaging showing myocardial edema in the inferoseptal LV segment extending to the RV inferior and part of lateral walls (arrows). (c, d) Short-axis (c) and modified RVOT (d) LGE imaging showing significant enhancement of the inferior wall (white arrows) and basal lateral wall (yellow arrow) sparing RVOT. The inferior LV wall shows enhancement as well (C, arrowhead). (e) Four-chamber LGE imaging showing significant enhancement of basal RV lateral wall (arrows). (f, g) RV vertical long axis (F) and RV inflow outflow (G) showing significant enhancement of the inferior wall (white arrows) sparing the anterior wall and apex (yellow arrows)

Based on the results of CMR, RV had a reasonable chance of recovery with bypass surgery as RVOT, the anterior, and most of the free walls were spared. The patient showed remarkable improvement of symptoms with no recurrence of heart block. He was discharged in a stable condition as he declined further intervention. Unfortunately, a follow-up CMR was not scheduled because the patient declined.

In this report, we were able to explore a robust protocol for comprehensive assessment of RV viability by applying modified dedicated RV views including LGE and T2W imaging. This protocol may open the venue for a better evaluation of RV morphology and function.

In acute or chronic MI, LGE imaging is a conventional method for illustrating myocardial fibrosis and necrosis. In addition, T2W imaging is validated in detecting myocardial edema in acute LV MI in multiple studies. Consequently, the utilization of an amalgamated approach of T2W and LGE imaging is considered to be the best method for evaluating LV ischemic myocardial insult. However, LGE imaging is underutilized in the assessment of RV MI despite it being a conventional protocol in LV MI (1-4).

Currently, LGE imaging has several pitfalls in depicting RV viability. RV is inherently a thin and trabeculated structure inviting many artifacts essentially because of poor spatial resolution and partial volume effects. Improvement of RV LGE imaging is still in its infancy; however, applying certain techniques such as utilization of thinner slices, fat-saturation pulse sequence, and adapted range of inversion times may be helpful. Imaging during systole may be considered as the RV wall is thicker and can clearly delineate LGE (1, 2, 5, 6).

Detecting myocardial edema by T2W imaging is difficult in RV (because of the thin wall and trabeculations) and in the presence of artifacts from adjacent structures. In the presence of slow flow, wall motion abnormalities, or pericardial effusion, perception of RV myocardial edema may be challenging (1, 3).

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Video 1-3. CMR short axis (1), 4-chamber (2), and RVOT (3) cine images demonstrating mildly dilated RV with moderate systolic dysfunction. Inferior RV wall akinesis was noted.
Video 4, 5. CMR RV vertical long axis (4) and inflow-outflow (5) cine images demonstrating inferior RV wall akinesis.
Video 6. Coronary angiogram showing totally occluded proximal RCA.
Video 7. TTE apical 4-chamber view showing moderate RV dilatation and systolic dysfunction.
Video 8, 9. CMR short axis (8) and 4-chamber (9) cine images demonstrating dilated RV with moderate systolic dysfunction and wall motion abnormalities (see text for details). Mild LV systolic dysfunction with akinesis of the inferior wall and TR were prominent as well.
Video 10, 11. CMR RV vertical long axis (10) and inflow–outflow (11) cine images demonstrating RV wall motion abnormalities (see text for details). TR was noted.

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