

Resolution of QRS-fragmentation: A case report
and review of literature

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Volume 5 Issue 3, 2023

Article Information

Received date: 27/06/2023

Published date: 08/08/2023

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***Key Words:**

Fragmented QRS; Heart failure;
Cardiac resynchronization therapy;
Multipoint pacing

Abstract

Background: It's not clear whether the resolution of fQRS can be used to assess the effectiveness of cardiac resynchronization therapy defibrillator (CRT-D) in patients of heart failure with reduced ejection fraction (HFrEF).

Case presentation: Here we report a 78-year-old male patient with HFrEF and refractory ventricular tachycardia (VT), who's 12-lead electrocardiogram (ECG) showed fQRS in leads V1-V6 with QRS duration of 134 ms on admission. Even though the optimized medication of metoprolol, amiodarone, lidocaine, and berberine was given, the recurrent VT and HFrEF were still refractory. For further management, a CRT-D with multipoint pacing (MPP) function (St. Jude Medical, Sylmar, CA) was considered and implanted. It's very encouraging that no more VTs and fQRS were recorded 9 hours after a CRT-D with MPP function was implanted, and the left ventricle ejection fraction (LVEF) improved significantly later.

Conclusion: CRT-D with MPP is effective in improving the situation of the patient with ischemic cardiomyopathy and HFrEF, and the fQRS resolution can be considered as a sign of its effectiveness.

Introduction

Fragmented QRS (fQRS) on the 12-lead electrocardiogram (ECG) is defined as the presence of additional notches buried within the QRS, which is widely accepted as a sign of myocardial infarction scar or fibrosis. [1, 2] The fQRS is derived from the abnormality of ventricular depolarization due to ventricular heterogeneity and derangement of ventricular conduction around the infarction zone or scar. [3-5] And the fQRS is also a sign of left ventricular desynchronization in patients of heart failure with reduced ejection fraction (HFrEF) and the narrow QRS complex (<150 ms). [6] A meta-analysis showed that fQRS on patient's baseline ECG increased all-cause mortality and major arrhythmic events in HFrEF patients. [7] However, it's not clear whether the resolution of fQRS is useful to assess the effectiveness of cardiac resynchronization therapy defibrillator (CRT-D) in patients with ischemic cardiomyopathy, especially those CRT-D with multipoint pacing (MPP) function. Here we present an HFrEF patient who had fQRS on his admission ECG and frequent ventricular tachycardia (VT) on his Ambulatory ECG. But no more VT and fQRS were recorded, 9 hours after the implantation of a CRT-D with MPP function. The patient had provided informed consent for publication of this case.

Case presentation

A 78-year-old man presented with a complaint of chest congestion and short of breath lasted for 2 hours on his admission. He had hypertension for 10 years, but his blood pressure was normal on admission without taking any medicine. He had an old myocardial infarction and a coronary artery stent implanted 18 years before, and 2 more stents implanted 10 years before. The patient took a semi-sitting position, the blood pressure was 105/65 mmHg, and the heart rate was 80 bpm. Both lungs were clear, the apex was left out of the normal limit, and slight edema in lower extremities was found. His

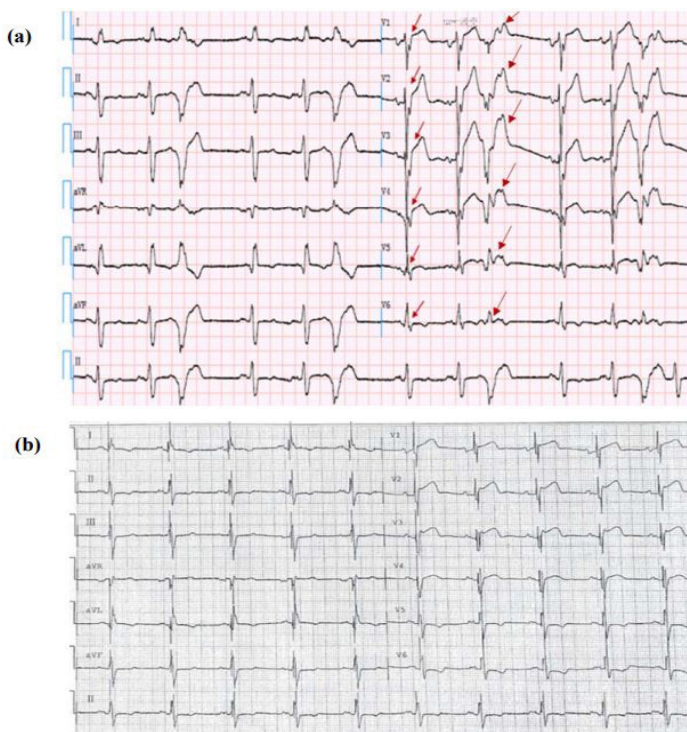


Figure 1: (a) The patient's 12-lead electrocardiogram (ECG) showed fQRS (QRS duration 134ms) in leads V1-V6 at baseline, and it was more apparent when located in the premature ventricular complex. (b) The resolution of fQRS (QRS duration 122ms) was shown one day after the CRT-D implantation.

laboratory examination, including blood routine, hepatic and renal function, electrolyte, coagulation function, and Cardiac troponin I (CTNI), was normal, but the level of brain natriuretic peptide (BNP) elevated to 3082 pg/ml. The ECG showed sinus rhythm, ventricular bigeminy, fQRS in leads V1-V6, QRS duration of 134 ms, and abnormal Q wave in leads V4-V6 (Fig. 1a). His 24-hours Holter monitoring showed 41,320 polymorphic ventricular premature beats (PVCs), which is 42% of the total 98327 beats, and 254 paroxysmal polymorphic VT (Fig. 2a). His chest x-radiography revealed pulmonary congestion, pear-shaped heart and cardio-thoracic proportion of more than 50% (Fig. 3a). His transthoracic echocardiography showed left atrium and ventricle enlargement with the left ventricular end-diastolic diameter of 62 mm; there was a ventricular aneurysm of 5.2×2.0 cm²; there was minor regurgitation of mitral and aortic valves; the left ventricular ejection fraction (LVEF) was 28%. Moreover, no coronary artery or stent stenosis was shown by coronary angiography. We proposed the patient's primary diagnosis was ischemic cardiomyopathy and HFrEF. Even though the optimized medication of metoprolol, amiodarone, lidocaine, and berberine was given, the recurrent VT and HFrEF were still refractory. For further management, a CRT-D with MPP function (St. Jude Medical, Sylmar, CA) was considered and implanted. It's very encouraging that 9 hours after the procedure, no

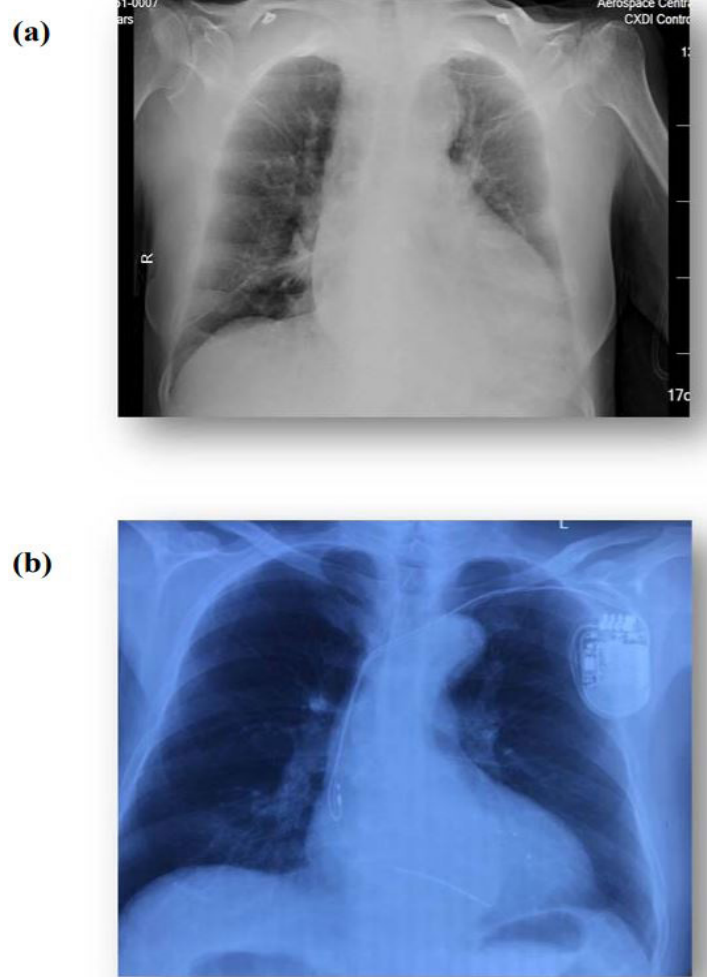


Figure 3: (a) The patient's chest x-radiography revealed pulmonary congestion, pear-shaped heart, and cardio-thoracic proportion more than 50% at baseline; (b) There was no pulmonary congestion, and the cardio-thoracic percentage decreased significantly, 30 days after the CRT-D implantation.

VT was monitored again (Fig. 2b); twenty-four hours later, the fQRS was absent and never been recorded after that, and the QRS duration decreased from 134 ms to 122 ms (Fig. 1b). Also, the level of BNP significantly dropped to 357 pg/ml. Furthermore, nine days after the procedure, the LVEF increased to 45%; 30 days later, no pulmonary congestion was found on his Chest x-radiography and the cardio-thoracic proportion improved significantly (Fig. 3b). While, over one year of follow-up, the patient has remained symptom-free of VT and HF.

Discussion

Considering this patient's old MI history, we supposed that the possible reason for short of breath on admission was acute myocardial ischemia or acute heart failure. But there was no coronary artery or stent stenosis on his coronary angiography, and the level of CTNI was normal. Combined with clinical signs, chest x-radiography, echocardiographic signs, and elevated levels of BNP, the reason for short of

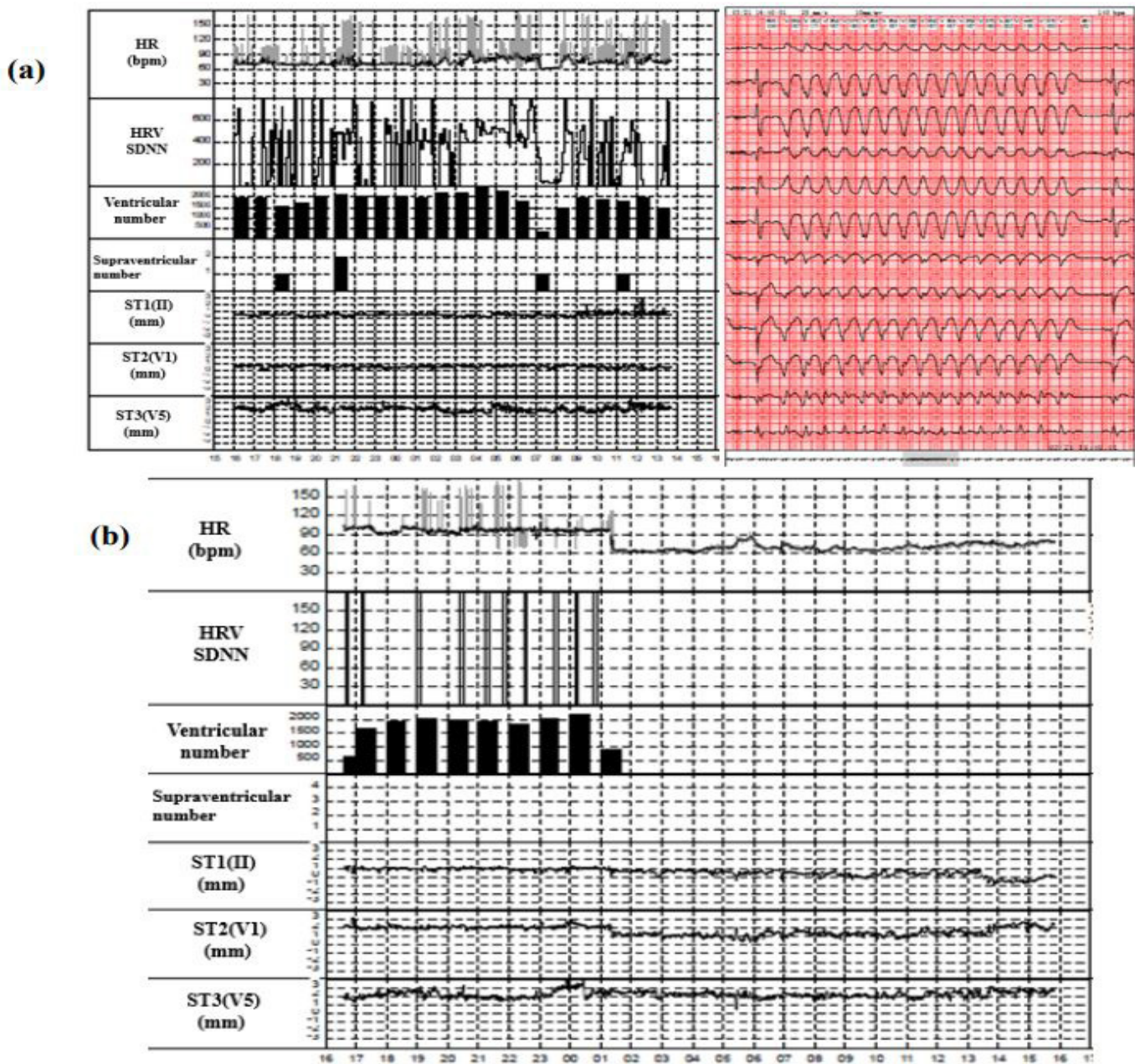


Figure 2: (a) The 24-hours Holter monitoring revealed that the total number of paroxysmal ventricular tachycardia (VT) was 254 at baseline; (b) There was no recurrent VT 9 hours after the CRT-D implantation.

breath was sure to be acute heart failure.

The fQRS is defined as various ‘RSR’ patterns, with or without a Q wave, located in two contiguous leads of a major coronary artery territory. And, the fQRS manifests as an extra R (R’) wave, ≥ 2 notches in R wave, or ≥ 2 notches in the down or up-stroke of S wave.[4] It’s reported that fQRS was associated with myocardial infarction scar or fibrosis, and was considered as a sign of old myocardial infarction. [1, 2] The fQRS was also considered as a marker of left ventricular dyssynchrony in HFrEF patients with narrow QRS complex (<150 ms). [6] Furthermore, the fQRS was also associated with higher all-cause mortality, and cardiac

event rate defined as MI, need for revascularization, VT and cardiac death. [8, 9] The fQRS found in contiguous 3 leads was a significant predictor of the cardiac death or heart failure hospitalization. [9] fQRS increased MAE in HFrEF patients. [7] In this HFrEF patient, the fQRS, with narrow QRS complex of 134 ms, presented on all the 6 precordial leads (V1-V6) on his admission ECG. As it was discussed on the above, the presence of fQRS, with narrow QRS complex on the ECG, was showed that he had left ventricular dyssynchrony caused by myocardial infarction scar or fibrosis. Therefore, our strategy focused on improving the ischemic cardiomyopathy induced HFrEF, and CRT-D

with MPP was the best choice for the management of his refractory VT and HFrEF. Practically, the complete resolution of fQRS accompanied by the improvement of HFrEF in a relatively short hospital stay is strong evidence support for the effectiveness of CRT-D with MPP function.

Implantable CRT with MPP is a new quadripolar technology that involves a left ventricle lead with 4 different pacing electrodes and a dedicated device with multiple pacing options. [9] MPP is superior to the conventional biventricular pacing on the improvement of acute cardiac hemodynamics, left ventricle synchronization, and QRS complex narrowing, and all of this manifested as a higher number of acute responders to CRT. [10-12] Therefore, a CRT-D with MPP was implanted in our patient. Then, he had a significant improvement, such as the termination of VT, the narrowing of QRS, the elevation of LVEF, and the relief of HF symptoms.

Conclusion

In conclusion, CRT-D with MPP is very useful in improving the LVEF of the patient with ischemic cardiomyopathy and HFrEF. And the resolution of fQRS may be a sign of the alleviation of HFrEF by using CRT-D with MPP.

Acknowledgements

Funding: None.

Footnote

Reporting Checklist: The authors have completed the work of reporting checklist.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form. The authors have no conflicts of interest to declare.

Ethical statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient.

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