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Case Report

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Can external defibrillation terminate electrical storm in patients with cardiac resynchronization therapy defibrillator? A case report

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Abstract

Implantable cardioverter-defibrillator has become the main therapeutic tool for use in patients with life-threatening ventricular arrhythmias to prevent sudden cardiac death. However, patients with implantable cardioverter-defibrillators can develop the complication of electrical storm. Electrical storm is defined by 3 or more sustained episodes of ventricular tachycardia, ventricular fibrillation, or appropriate shocks from an implantable cardioverter-defibrillator within 24 hours. Because the ICD is becoming more prevalent, the complication of electrical storm has received greater attention in clinical practice.

In this case study, the authors report positive outcome of using external defibrillator to treat electrical storm for a 75-year-old male with cardiac resynchronization therapy-defibrillator (CRT-D).

Background

Heart failure (HF) is end stage of various organic heart diseases, and irreversible damage of myocardium seriously affects cardiac function. The ventricular synchronous pacing is among the most important methods to treat this condition. Among the ventricular synchronous pacing therapies, cardiac resynchronization therapy (CRT) can regulate ventricular function and improve the clinical status of patients. Also, patients with poor left ventricular ejection fraction (LVEF) have higher incidence of sudden cardiac death associated with ventricular arrhythmias, and the Implantable cardioverter-defibrillator (ICD) can prevent cardiac sudden death. The implantation of CRT-D that combines ICD function with CRT has become an effective therapy to improve the prognosis of heart failure patients. This therapy has been developing very rapidly in recent years [1] and has become class I indication for treating patients with LEVF≤ 35%. However, patients with implantable cardioverter-defibrillators can develop the complication of electrical storm [2]. Because the complication of electrical storm is life threatening emergency, and management of this complication has received greater attention in clinical practice.

Case presentation

A 75-year-old male was admitted to the hospital with coronary atherosclerotic heart disease, cardiac enlargement, premature ventricular beats, heart failure, cardiac function IV (NYHA classification), hypertension class III, hyperlipidemia and constipation. He had a history of smoking for 40 years and has quit for past 20, hyperlipidemia for 15 years, hypertension over 20 years with highest reading of 180/100mmHg. He has no history of alcoholism or drug abuse. During hospitalization, the cardio echogram indicated: LVEF16%, LA 46mm, LV 76mm, and the left ventricle was significantly enlarged. Continuous monitoring showed premature ventricular extra systole contingently and brief paroxysmal ventricular tachycardia. CRT-D was implanted for the arrhythmia on June 15, 2017, the 7th day after admission. On the 8th day, while the patient was defecating, he reported rapid heartbeat and blindness, and then he became unconscious. The monitor indicated he was experiencing electric storm, although the cardiac resynchronization therapy-defibrillator(CRT-D) had been implanted. After 11 shocks of the CRT-D, the patient still had malignant ventricular arrhythmia (Table 1, the CRT - D rescue report). The rescue team-initiated CPR, external defibrillations, and administered dopamine, adrenalin, amiodarone, rocuronium bromide and sodium bicarbonate. After 5 shocks with the automated external defibrillator (**AED**), the patient returned to normal sinus rhythm. Meanwhile, other team members assessed for possible primary causes for the electrical storm [3,4].

Discussion

After discussing this experience, the team members concluded the following: First, we must consider using external defibrillation in time, which has higher defibrillation energy, to terminate ventricular tachycardia and/or ventricular fibrillation when a patient's implantable cardioverter-defibrillator fails to control these malignant arrhythmias [5]. Second, nurses should constantly monitor possible primary causes underlying malignant arrhythmias. Possible causes include hypovolemia, hypoxia, acidosis, hyper-/hypokalemia, cardiac tamponade, tension pneumothorax, cardiac and pulmonary thrombosis (AHA, 2015)

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Table 1. Record of CRT-D defibrillation in rescue process

Type	ATP seq	Shocks	Success	Time hh:mm	Duration Hh:MM: SS	Avg bpm A/V
FVT	4	35J,35J	YES	11:48	0:01:14	158/162
FVT	2		NO	11:50	0:01:03	—/182
High rate-NS				11:51	0:00:02	—/333
FVT	1		YES	11:52	0:00:54	—/167
FVT	4	15J,35J	YES	11:53	0:01:17	—/194
FVT	1	35J,35J	YES	11:55	0:00:42	—/200
VF	1		YES	11:58	0:01:24	—250
……						
FVT	2		YES	12:42	0:00:14	—/200
FVT	2		YES	12:43	0:00:16	—/194
FVT	3		YES	12:45	0:00:28	—/150
FVT	1		YES	12:46	0:00:10	—/200
……						

Note. FVT = fast ventricular tachycardia, VF = ventricular fibrillation, ATP=ant tachycardia pacing

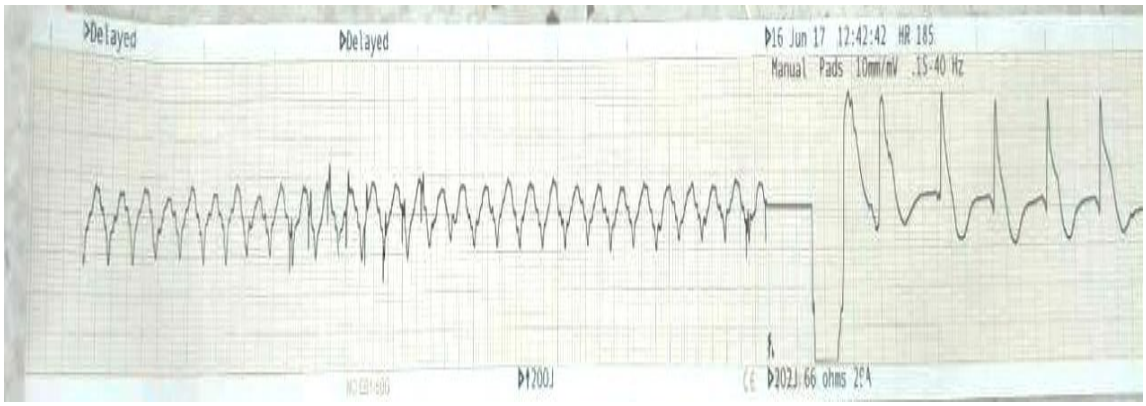

Figure 1. The electrocardiogram after patients were treated with AED

Third, the team suspects that the patient's forced defecation may have been one of contributing factors to the development of the electrical storm This suggests that interventions for prevention of constipation should be implemented from the first day of admission.

Because of this experience, the team members wondered why the ATP did not initiate shocks as soon as the malignant ventricular arrhythmias occurred? After consulting the literature, we learned that the following factors may be related to this issue: 1) The perimeter of tachycardia is the most critical factor; it becomes more difficult for ATP to stop VT when its perimeter becomes longer. 2) The size of excitable gap is related to the VT perimeter and placement of pacing electrodes. When the perimeter is shorter, and the placement is nearer, the excitable gap becomes smaller. 3) The third factor is the distance between the position of the pacing electrode and the exit distance of the exhumation excitation. The farther the distance, the more difficult it is to terminate the malignant ventricular arrhythmias. 4) The forth factor is the length of the irritation part of the pacing and the exportation of the exhumation ring [6]. In addition, we also wondered why CRT-D does not defibrillate immediately when patients have ventricular arrhythmias? To rule out the problem that may be caused CRT-D itself, we must first satisfy the following two basic conditions for detection of ventricular arrhythmias. First, the RR interval should conform to the prescribed range of ventricular tachycardia, and then the arrhythmia that meets this range will continue to exceed the prescribed time (Figure 1).

Conclusion

Finally, we must consider whether the use of external defibrillation affect the function of the CRT-D. If yes, what is the effect and how could it be avoided? These questions have yet to be further studied.

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