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Case Report

An appropriate shock of the wearable cardioverter-defibrillator in an outpatient setting

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ABSTRACT

The wearable cardioverter-defibrillator (WCD) represents an alternative clinical approach to prevent sudden cardiac death as a bridge to therapy when making a final decision regarding the need for an implantable cardioverter defibrillator (ICD), especially in patients who are in the so-called gray zone according to ICD guidelines. Although the WCD system was introduced in Japan in April 2014, data regarding its usage and experience are limited. We report the first case of appropriate shock therapy using the WCD in an outpatient setting in Japan. We describe the case of a 22-year-old-woman who received the first case of successful appropriate WCD shock therapy in an outpatient setting in Japan.

1. Introduction

The wearable cardioverter-defibrillator (WCD; LifeVest 4000, ZOLL, Pittsburgh, PA, USA) is designed to automatically detect and treat life-threatening ventricular tachycardia/fibrillation (VT/VF) by delivering a biphasic electrical shock through body-surface patches. Although a specific surgical technique is not required for implantation, as with the implantable cardioverter defibrillator (ICD) system, the WCD detects and terminates VT/VF with a high sensitivity and specificity almost comparable to those of the ICD system [1]. Although the continuous wearing of a specific WCD jacket system limits the patient's quality of life and may render the device unsuitable for long-term usage, its profile should be useful as a bridge to ICD therapy, especially in patients who are in the so-called gray zone according to ICD guidelines. The WCD system has been used worldwide, and its clinical applications have been documented in several reports [2,3]. The WCD was introduced in Japan in April 2014, but data regarding its usage and experience are limited [4]. Here, we report a case in which appropriate shock therapy was applied using the WCD in an outpatient setting. To the best of our knowledge, this is the first such case reported to date.

2. Case

A 22-year-old woman presented to our institute due to serious left ventricular dysfunction (echocardiographic left ventricular ejection fraction, 22%) and was admitted to our hospital for the purpose of diagnosis and introduction of medical treatment. At the time of admission, she had never experienced palpitations, syncope, or shortness of breath. During hospitalization, she had a spontaneous VT attack (230 beats/min) that subsequently changed to VF. Emergent therapy including external defibrillation successfully terminated the VT/VF without any complications. Subsequent examinations including catheterization and coronary angiography revealed no stenosis, and idiopathic dilated cardiomyopathy was diagnosed. The ICD guidelines indicated that this patient was class I; however, the patient and her family did not immediately accept our therapeutic recommendation, despite the fact that they seemed to be rational and highly educated. They strongly hoped to calmly discuss treatment options in their own at their home. We advised that this type of postponement was not recommended. Fortunately, we offered the WCD as an alternative risk control method and suggested that the patient consider this option. In addition, some stenosis of the celiac artery was noted, and the superior mesenteric artery and left renal artery were detected in 3-dimensional computed tomography scanning. Although magnetic resonance imaging (MRI) was recommended for further diagnosis, it could not be immediately scheduled. ICD implantation was postponed due to this MRI scheduling issue, because 3-T MRI is not possible after ICD implantation. WCD profiles were set as follows: VT rate threshold,

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150 bpm; VT response time, 60 s; VF rate threshold, 200 bpm; VF response time, 25 s; delivery energy settings, 150 J (5 times). Education and training about the wearing of a WCD were provided by our WCD training team, which includes doctors, nurses, and medical engineers, and the patient was discharged from the hospital after completing this training course. During WCD education and training, we prescribed several antiarrhythmic agents and anti-heart failure agents such as amiodarone (100 mg/day), carvedilol (20 mg/day), perindopril (2 mg/day), and spironolactone (25 mg/day). We also prescribed cardiac rehabilitation including exercise stress testing (7 metabolic equivalents), which showed no episodes of arrhythmic events.

Twelve days after hospital discharge, the patient experienced chest discomfort and palpitations after taking her dog for a walk. While she was experiencing those symptoms, the WCD records showed incessant, non-sustained VT and subsequent VF (Fig. 1). During the initial VT sequence, VT was detected at the first red arrow (grid #29), and the patient canceled the shock therapy sequence because she had not yet fallen into unconsciousness (second red arrow at grid #86). However, a subsequent VF rendered her unconscious, and a 150-J shock was delivered and eliminated VT/VF (third red arrow at grid #116). She did not feel any pain at the time of shock delivery, probably because she lost consciousness during this period. During this episode, a patient's family member was standing nearby, but he followed the rules and did not touch her during the WCD therapeutic sequence. This choice kept him safe, avoiding unnecessary injury due to shock. After this event, the patient was readmitted to our hospital until the time of her scheduled MRI and final ICD implantation. Sporadic non-sustained VT was suppressed by intravenous administration of nifekalant, and 100 mg amiodarone daily was changed to 320 mg sotalol daily. Finally, an ICD was implanted 7 days after WCD shock delivery without any complications.

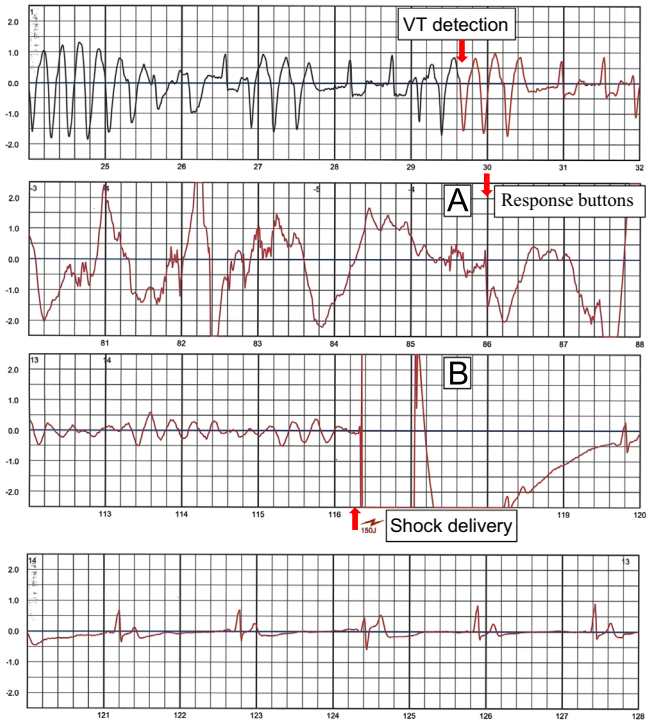

Fig. 1. ECG recording of channel 'SS' in WCD during the shock episode. The shock sequence was once canceled by the patient with the response buttons 56 s after VT detection (A), but 150 J shock was delivered after 30 s because of subsequent VF detection, then it finally recovered sinus rhythm (B).

3. Discussion

The main indication for the WCD is as a bridge to ICD implantation in patients at temporal risk of sudden cardiac death in the subacute phase of acute myocardial damage, those with accepted indicators for ICD implantation but also temporal contraindication factors (e.g., infection), or those waiting for a final decision regarding ICD implantation [5]. In our case, idiopathic dilated cardiomyopathy with severe left ventricular dysfunction and documented spontaneous VT/VF was diagnosed, so she was considered to have a class I indication for ICD implantation [6]. However, she did not immediately accept this therapeutic recommendation because she was young and wanted to discuss her future plans with her family in the comfort of her own home while waiting to undergo a scheduled MRI. Fortunately, we offered the WCD as a therapeutic option and facilitated its use in an outpatient setting. Eventually, the device saved her life, and this episode encouraged her to accept the fact that ICD implantation was her best therapeutic option. Various conditions can lead to a waiting period for ICD therapy, not only during hospitalization but also under outpatient conditions. The WCD might be a useful therapeutic tool that is safer that plain monitoring during this waiting period.

To prevent inappropriate WCD shock, the patient can cancel the shock sequence by pushing response buttons. This feature worked well in the present case. A shock delivered during repeated non-sustained VT while the patient is still conscious, which might have been inappropriate in this case, can thus be avoided. Eventually, this sequence led to subsequent VF, which was successfully terminated by the WCD. Because VF caused unconsciousness, the patient did not experience any pain due to the shock. These properties are similar to those of the ICD system, suggesting that the WCD can replace the ICD, at least for the purpose of preventing sudden death due to VT/VF.

Some features of the WCD are different from an ICD. First, antitachycardia pacing is not available in the WCD system. This patient had a VT episode resulting in VF, and the antitachycardia pacing might have been useful to avoid shock therapy. This is one limitation of the WCD system. Second, bystanders around the patient must be careful to avoid shock delivery. Because shock energy of the WCD is much higher than that of the ICD, which is similar to an external defibrillator, bystanders must not touch a patient wearing a WCD to avoid electrical injury. This type of accident must be avoided by carefully educating patients and significant friends or family members in an education program provided by a specific training team including nurses and/or medical engineers. This education program also improves the patient's understanding and level of comfort with the device and increases the wearing time in a day, which is essential for increased WCD efficacy [7]. The voice announcement that comes from the WCD before defibrillation begins (i.e., not to touch the patient) is also incredibly effective to avoid this type of accident. Third, the choice of an optimally sized jacket and settings of electrodes and patches is quite important, because fitting these materials to the skin surface is essential for arrhythmia detection and therapeutic shock delivery [8]. Realistically, a doctor cannot spend enough time to explaining these practical but important points, but a specific training team can achieve adequate an understanding, as mentioned in a statement of the Japanese Heart Rhythm Society [9]. In this case, the WCD wearing time was 23.23–23.55 h per day, which represents a good level of compliance, and the noise alarm was not activated during her use of the WCD. These good results were probably achieved by our training program, which is handled by a specific WCD training team. Because WCD shock therapy was delivered in an outpatient setting, an ambulance was called in order to transport the patient to the hospital. Because the ambulance crew had not received WCD education and training, they did not recognize the WCD jacket or understand what kind of therapy was being used. Fortunately, the patient and her family were able to explain the WCD system to the ambulance crew,

who confirmed this information by calling our hospital. However, a broader announcement will be needed in the future to avoid inappropriate WCD undressing by uninformed bystanders.

4. Conclusions

We experienced a case of successful and appropriate WCD shock therapy in an outpatient setting that is presumably the first such case in Japan. WCD is considered to be effective and safe even in an outpatient setting, at least for patients who meet specific conditions.

Conflict of interest

All authors declare no conflict of interest related to this study.

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