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Ineffective cardioverter-defibrillator therapy due to an increase in defibrillation threshold

Nieskuteczne terapie kardiowertera-defibrylatora spowodowane wzrostem progu defibrylacji

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Abstract

We present the case report of a 28 year-old man with postmyocarditis cardiomyopathy and cardioverter-defibrillator (ICD) implantation in secondary prevention. He survived an episode of circulatory arrest due to ventricular fibrillation/ /polymorphic ventricular tachycardia. All high energy therapy delivered by ICD was unsuccessful. The reason for the failure of the therapy was an increase in the defibrillation threshold. The implantation of an additional subcutaneous lead lowered the defibrillation threshold.

Key words: high defibrillation threshold, unsuccessful ICD defibrillation, subcutaneous defibrillation lead

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Introduction

The implantation of cardioverter-defibrillator (ICD) systems decreases the total mortality of sudden cardiac death survivors due to ventricular tachycardia/ventricular fibrillation (VT/VF). In the modern era, with a diversity of lead types, including double coil leads, biphasic shocks and high energy devices, the clinical problem of a high or increasing defibrillation threshold is marginal, but it still exists and can have fatal consequences [1, 2].

Case report

A 28 year-old man with postmyocarditis cardiomyopathy and double circulatory arrest with secondary prevention ICD implantation at the age of 19 was admitted to our Department after cardiac arrest and successful reanimation. He presented with circulatory arrest due to ventricular fibrillation in the vicinity of our hospital. Sinus rhythm restoration was achieved by an external biphasic defibrillator shock of 200 J.

Admission basic blood test results presented no significant deviations, normal electrolytes, high-sensitivity troponin T(hsTnT) 26 ng/L (N < 14), pro-B-type natriuretic peptide (proBNP) 26 ng/L (N < 84). Electrocardiogram (ECG) revealed a sinus rhythm 53 bpm, normogram, no R-wave progression in V1–V4 leads, negative T-wave in I, V1–V6 leads, resembling the former ECGs. Left ventricular ejection fraction (LVEF) was 37–42%, septal and medial anterior segments hypokinesis and left ventricular end-diastolic diameter (LVEDD) — 58 mm with left ventricular end-systolic diameter (LVESD) — 42 mm was seen in echocardiography. ICD records revealed a ventricular fibrillation (VF) episode and six unsuccessful defibrillations with a maximal 36 J of energy (Figure 1). The total circulatory arrest time was almost 10 minutes.

Two more VF episodes with an unsuccessful first defibrillation at 30 J, restored by a second shock of 36 J had been recorded two-and-a-half and three-and-a-half years earlier (Figure 2).

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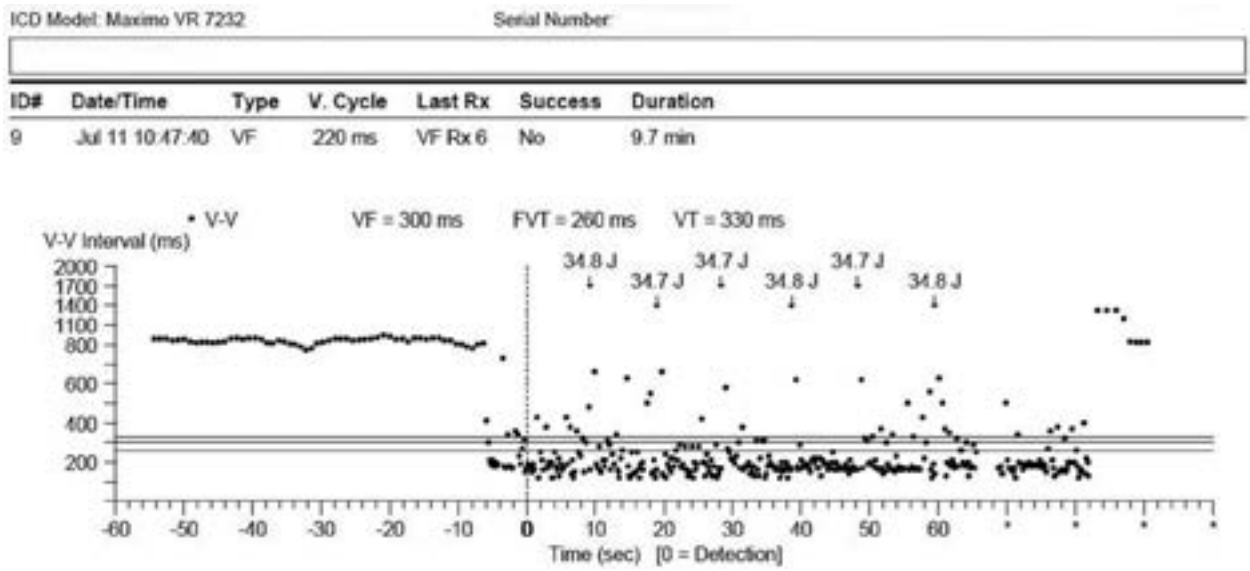

Figure 1. Six unsuccessful shocks with 36 J

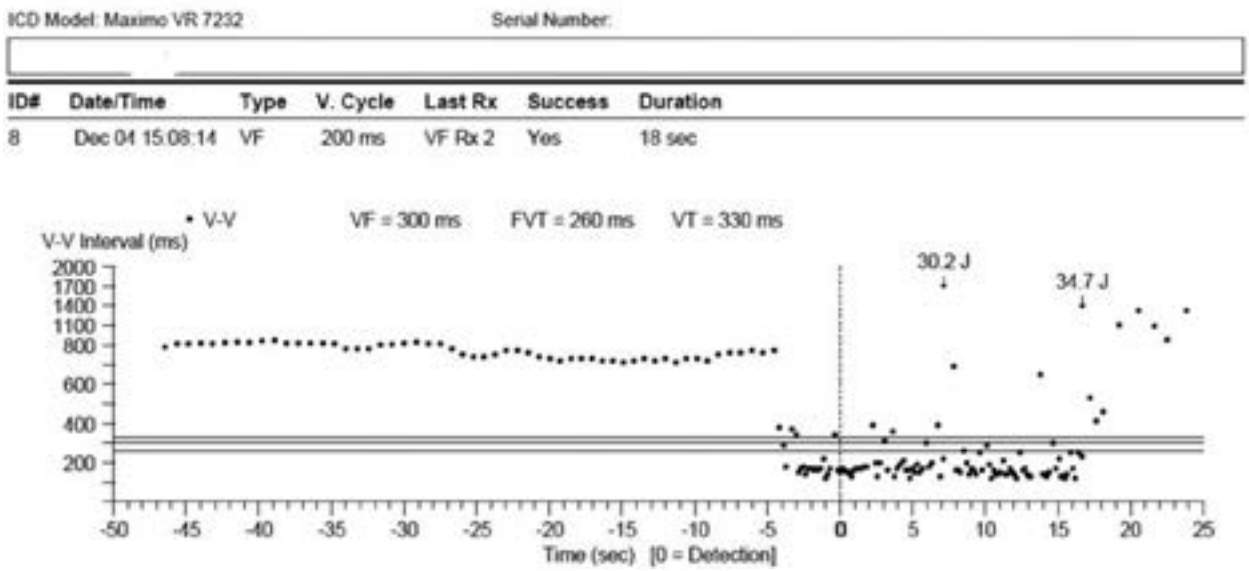

Figure 2. Unsuccessful first 30 J defibrillation; the second 36 J shock interrupts arrhythmia

No procedural reasons that could have been held responsible for the unsuccessful defibrillation, such as significant dyselectrolytemia, extreme circulatory insufficiency, *etc.* were found. An effective 20 J shock during the implantation procedure defibrillation test, and consecutive efficacious 30 J shocks during follow-up were recorded. Therefore, an increase of defibrillation threshold was diagnosed. The patient was qualified to subcutaneous lead implantation. The additional lead was connected to the SVC port (Figure 3).

The defibrillation test settled a positive 20 J shock. A further three-year observation revealed a further four episodes of ventricular arrhythmia classified to VF zone (cycle length of arrhythmia 170, 190, 195, 260 ms) effectively captured with 36 J. The patient is still alive.

Discussion

Defibrillation efficacy is reported to be lower in everyday life compared to its efficacy during implantation. The risk of ineffective ICD shocks is higher in patients with hypertrophic cardiomyopathy and catecholaminergic cardiomyopathy, and when they are applied for polymorphic ventricular tachycardia or bidirectional ventricular tachycardia, but not

Figure 3. Chest X-ray with subcutaneous lead implanted

for ventricular fibrillation, in the same patient [3]. There are no studies devoted to defibrillation threshold changes due to disease progression and automatic system ageing during further follow-up. There have only been a few case reports describing patients who have survived when all high-energy therapies have proved unsuccessful. In some of them, the system was modified, however none of them have presented more of the patient's history or the efficiency of the adapted method [4–7].

In our opinion, ineffective shocks with 30 J of energy were the cause of the defibrillation threshold increase. The question remains, should we routinely modify the system in case of a single unsuccessful shock with submaximal energy (*i.e.* more than 10 J below the maximal available device energy) to avoid the grim scenario of unsuccessful therapies in the future? To the best of our knowledge, this is the first reported case of subcutaneous lead implantation for a survivor of six unsuccessful ICD high energy therapies due to a defibrillation threshold increase.

Streszczenie

Przedstawiono przypadek kardiomiopatii pozapalnej i wszczepienia implantowalnego kardiowertera-defibrylatora (ICD) w ramach prewencji wtórnej u 28-letniego pacjenta, który przeżył epizod zatrzymania krążenia w przebiegu migotania komór/polimorficznego częstoskurczu komorowego. Wszystkie zastosowane terapie wysokoenergetyczne z ICD były nieskuteczne. Za przyczynę nieskuteczności terapii uznano zwiększenie progu defibrylacji. Próg defibrylacji obniżono, implantując elektrodę podskórną.

Słowa kluczowe: wysoki próg defibrylacji, nieskuteczna terapia ICD, elektroda podskórna

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