Ventricular Fibrillation with Small Amplitude of Activation and its Implications for Implantable Cardioverter Defibrillator Treatment

Masaomi Chinushi, MD, Hidehiro Kasai, MD, Minoru Tagawa, MD, Takashi Washizuka, MD, and Yoshifusa Aizawa, MD

SUMMARY

An implantable cardioverter defibrillator (ICD) was implanted in a patient with ventricular fibrillation (VF) related to old myocardial infarction. During VF, amplitude of ventricular activation was small, and the ventricular sensitivity at 1.2 mV failed to detect several small ventricular activations. When the sensitivity was changed to 0.3 mV, both under- and oversensed beats occurred during VF, and at the ventricular sensitivity of 0.15 mV, the undersensed beats disappeared while oversensed beats markedly increased. Defibrillation test was repeated one and four weeks after the implantation, and these inappropriate beats were minimized at the ventricular sensitivity of 0.3 mV. We should pay attention to the amplitude of ventricular activation to avoid possible trouble in ICD therapy. (Jpn Heart J 1999; 40: 87–90)

Key words: Implantable cardioverter defibrillator, Ventricular fibrillation, Ventricular undersensed beats

Recent multicenter studies have shown excellent results for implantable cardioverter defibrillator (ICD) treatment for malignant ventricular tachyarrhythmias compared to conventional antiarrhythmic drugs therapy. However, arrhythmic death, possibly including undersensing of small activation of ventricular fibrillation (VF), has been reported among patients with ICD. In this paper, we treat a patient with VF that showed small amplitude of ventricular activation.

CASE REPORT

A 70 year-old man was referred to our hospital for further study of his recurrent unconsciousness attacks. Eighteen years ago, he suffered from broad
Figure. Intracardiac electrogram recordings at the defibrillation tests. Panels A — C were recorded at the ICD operation, and panel D was obtained one week later. First induced VF was defibrillated by 30 Joules (not shown in the figure) following an unsuccessful 20 Joule shock. Top two recordings (panels A and B) were obtained between ICD can and defibrillation lead, and the other two strips (panels C and D) were recorded between the two distal electrodes of the defibrillation lead. Arrow indicates undersensed beat and bar means oversensed beat. See details in the text.
anterior myocardial infarction and has been treated with a nitrate and an ACE inhibitor. In March 1998, he lost consciousness twice, and VF was documented at the second episode. Acute myocardial re-infarction or cerebral accidents were not found by conventional examination. When he was admitted to our hospital, two-dimensional echocardiogram demonstrated the dilatation of left atrium and ventricle, and ejection fraction of the left ventricle was 35%. Electrophysiological study, including 1–3 extrastimuli and burst pacing up to 210 bpm from 3 sites of both ventricles, failed to reproduce any sustained ventricular tachyarrhythmias, and he was considered as a candidate for ICD treatment. During the ICD operation, rapid VF's were induced by T-wave shocks and two of the three events were successfully defibrillated at an energy of 20 Joules. During the sinus rhythm, large ventricular activation (> 12 mV) was recorded from the tips of defibrillation lead and the pacing threshold at the site was 0.15 ms × 2.0 V. However, all VF's showed small amplitude of ventricular activation immediately after induction (Figure, panels A-D). Since the sensitivity at 1.2 mV failed to detect fine ventricular activation (Figure, panel A arrows), ventricular sensitivity was changed to 0.3 mV at the second test. The number of undersensed beats decreased at this sensitivity (Figure, panel B), however, oversensed beats possibly due to a double count of single activation (bars in Figure) became a new problem. The final test was attempted at 0.15 mV sensitivity and intracardiac electrogram was recorded between two distal electrodes of the defibrillation lead in order to carefully assess the local ventricular activation. This sensitivity could avoid undersensed beats, however, the number of oversensed beats increased to > 35% mainly due to double counting (Figure, panel C). One and four weeks later, defibrillation tests were attempted at a sensitivity of 0.3 mV. In both tests, the maker channel showed only a few under- and oversensed beats (Figure, panel D), and the patient was moved to an outpatient clinic at the ventricular sensitivity of 0.3 mV.

**DISCUSSION**

In the present case, the defibrillation lead seemed to be placed at an appropriate site because both amplitudes of ventricular activation and pacing threshold were reasonable during the sinus rhythm. However, all induced VF's showed fast and low amplitude; 5.6 ± 2.7 mV (mean ± SD) as shown in panels C and D, compared to our recent 20 cases; 10.8 ± 3.4 mV, and this was the problem to chose a reasonable ventricular sensitivity in this patient. Although both undersensed and oversensed beats were observed at a sensitivity of 0.3 mV, the number of undersensed beats decreased one week after the ICD operation, and the sensitivity of 0.15 mV resulted in many oversensed beats. Therefore, we chose 0.3 mV in this patient to prevent the occurrence of undersensing of the VF and also to avoid
double counting of the single activation. Careful follow-up and further defibrillation test will be needed because the ventricular amplitude of VF would be different in each event, and may also change during a long follow-up period. The cause of small ventricular activation of VF was unknown and such a case might be rare, but we should pay close attention to the amplitude of ventricular activation during defibrillation test.

REFERENCES