Journal of Arrhythmia ■ (■■■■) ■■■–■■■

Contents lists available at ScienceDirect

Journal of Arrhythmia

journal homepage: www.elsevier.com/locate/joa

Original article

Influence of myopotential interference on the Wavelet discrimination algorithm in implantable cardioverter-defibrillator

Kazuya Mizukami, MD, PhD[a], Hisashi Yokoshiki, MD, PhD[b,*], Hirofumi Mitsuyama, MD, PhD[b], Masaya Watanabe, MD, PhD[b], Taro Tenma, MD[b], Rui Kamada, MD[b], Masayuki Takahashi, MD[b], Ryo Sasaki, CE[c], Motoki Maeno, CE[c], Hiroyuki Tsutsui, MD, PhD[b]

[a] Department of Cardiovascular Medicine, National Hospital Organization Hokkaido Medical Center, Yamanote 5-7-1-1, Nishi-ku, Sapporo 063-0005, Japan
[b] Department of Cardiovascular Medicine, Hokkaido University Graduate School of Medicine, Kita-15, Nishi-7, Kita-ku, Sapporo 060-8638, Japan
[c] Division of Medical Engineering Center, Hokkaido University Hospital, Japan

ARTICLE INFO

Article history:
Received 23 June 2016
Received in revised form
1 August 2016
Accepted 26 August 2016

Keywords:
Implantable cardioverter-defibrillator
Tachycardia discrimination
Morphology
Myopotential interference
Wavelet

ABSTRACT

Background: Wavelet is a morphology-based algorithm for detecting ventricular tachycardia. The electrogram (EGM) source of the Wavelet algorithm is nominally programmed with the Can-RV coil configuration, which records a far-field ventricular potential. Therefore, it may be influenced by myopotential interference.
Methods: We performed a retrospective review of 40 outpatients who had an implantable cardioverter-defibrillator (ICD) with the Wavelet algorithm. The percent-match score of the Wavelet algorithm was measured during the isometric chest press by pressing the palms together. We classified patients with percent-match scores below 70% due to myopotential interference as positive morphology change, and those with 70% or more as negative morphology change. Stored episodes of tachycardia were evaluated during the follow-up.
Results: The number of patients in the positive morphology change group was 22 (55%). Amplitude of the Can-RV coil EGM was lower in the positive morphology change group compared to that in the negative group (3.9 ± 1.3 mV vs. 7.4 ± 1.6 mV, $P=0.0015$). The cut-off value of the Can-RV coil EGM was 5 mV (area under curve, 0.89). Inappropriate detections caused by myopotential interference occurred in two patients (5%) during a mean follow-up period of 49 months, and one of them received an inappropriate ICD shock. These patients had exhibited positive morphology change.
Conclusions: The Wavelet algorithm is influenced by myopotential interference when the Can-RV coil EGM is less than 5 mV.

1. Introduction

The implantable cardioverter-defibrillator (ICD) has become a standard therapy for the prevention of sudden cardiac death in patients with lethal ventricular arrhythmias [1,2]. It has been reported that ICD can also reduce the mortality in patients at risk of such arrhythmias [1–4]. Therefore, ICD implantation continues to be commonly performed.

Inappropriate ICD shocks, most frequently caused by supraventricular tachyarrhythmias [5,6], are not rare [5–8], despite effective device-related discrimination methods such as dual-chamber ICDs [9,10] and the stability/sudden-onset detection [11,12]. Since inappropriate shocks could result in poorer quality of life [13,14], proarrhythmia [15–17], and increased mortality, [5,7] improvements in tachyarrhythmia detection algorithms in ICD devices are required.

Wavelet™ (Medtronic Inc., MN, USA) is one of the morphology-based algorithms that prevent inappropriate ICD therapy due to supraventricular tachycardia (SVT) [18]. It was reported that the Wavelet algorithm effectively distinguishes SVT from ventricular tachycardia (VT) [18,19]. However, since Wavelet is a morphology-based algorithm, its accuracy of discrimination depends on the quality of electrogram (EGM).

The EGM source of the Wavelet algorithm is nominally programmed with the Can-RV coil configuration. It uses a far-field EGM, which is superior to near-field EGM in VT detection [20,21]. In addition, it was reported that the morphology of the Can-RV coil EGM was stable across different body positions, thereby maintaining the high percent-match score on the Wavelet algorithm [22–24]. On the other hand, the far-field EGM obtained by the

* Corresponding author. Fax: +81 11 706 7874.
E-mail address: yokoshh@med.hokudai.ac.jp (H. Yokoshiki).

http://dx.doi.org/10.1016/j.joa.2016.08.005
1880-4276/

Can-RV coil configuration may be influenced by myopotential interference.

The aim of this retrospective study was to evaluate the influence of myopotential interference on the Wavelet algorithm in patients with an ICD.

2. Materials and methods

2.1. Subjects

We performed a retrospective review of 43 consecutive outpatients who received an ICD with the Wavelet algorithm and visited Hokkaido University Hospital from April 2013 to August 2013. Three patients were excluded from analysis because of data insufficiency.

The baseline Can-RV coil EGM was obtained usually during sinus rhythm at rest and was stored as a template. The percent-match score on the Wavelet algorithm, which would represent the degree of morphologic similarity from the baseline EGMs, was measured during isometric chest press by pressing the palms together [25,26]. This maneuver was the most sensitive provocative test for myopotential interference in patients with a permanent unipolar pacemaker [25]. We classified patients with percent-match scores below 70% due to myopotential interference as positive morphology change, and those with 70% or more as negative morphology change. The cut-off value of 70% is the nominal value to discriminate VT from supraventricular tachyarrhythmias [18,22].

In most cases, the VF zone detected ventricular events faster than 185–200 beats/min, while the VT zone detected ventricular events faster than 150–170 beats/min. In cases of patients with documented slow VT, the detection zone lower than 150 beats/min was sometimes programmed [6].

The study was approved on September 20, 2012, by the Ethics Committee of Hokkaido University Hospital (approval number: 012-0156 and 016-0118).

2.2. Data acquisition

For each patient, baseline data at the time of ICD implantation were collected from medical records. These included demography, underlying heart diseases, heart failure status, comorbidities, and medications. Left ventricular ejection fraction was measured by echocardiogram. The ICD parameters were measured at each outpatient visit (every 3–4 month). The data regarding the amplitude of Can-RV coil EGM and the percent-match score on the Wavelet algorithm during the isometric chest press were collected during the outpatient visits from April 2013 to August 2013. Stored episodes of tachycardia were collected at the regular follow-up visits and each visit prompted by ICD therapy. Data from the day of ICD implantation to the end of March 2015 were collected.

2.3. Statistical analysis

Continuous variables were presented as mean ± SE (standard error) and categorical variables as number and percentage. Simple between-group analysis was conducted using Student's t-test, while categorical variables were compared using Fisher's exact test. To evaluate the predictors of positive morphology change during the isometric chest press, we used logistic regression analyses. For the model selection, we used stepwise logistic regression procedures (model entry $P < 0.05$ and removal $P > 0.1$). The sensitivity and specificity of amplitude of Can-RV coil EGM for its prediction were evaluated using the receiver operating characteristic (ROC) curve. Differences with $P < 0.05$ were considered significant. JMP® 10 (SAS Institute Inc., Cary, NC, USA) was used for all statistical analysis.

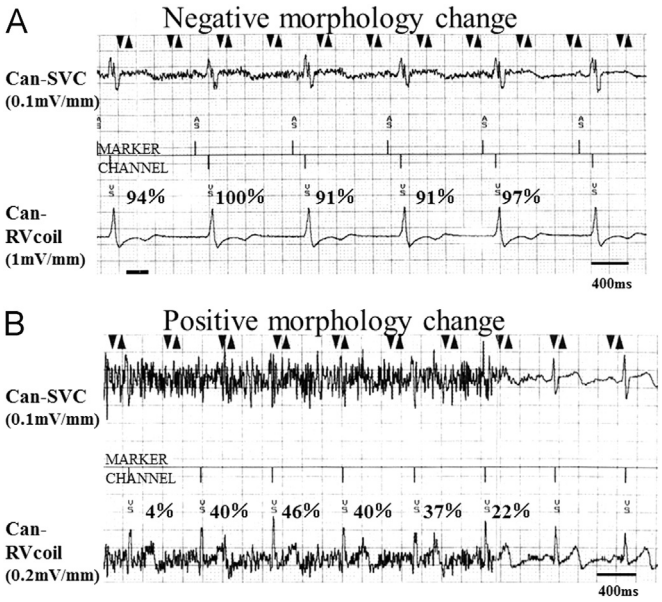

Fig. 1. Electrograms (EGMs) during the isometric chest press. Representative EGMs from negative morphology change (A) and positive morphology change (B) are shown. The isometric chest press was achieved by pressing the palms together. % is the percent-match score of the Can-RV coil EGM on the Wavelet algorithm.

3. Results

3.1. Patient characteristics

The present study included 40 patients and the number of patients with positive morphology change was 22 (55%). The representative EGMs during the isometric chest press by pressing the palms together are shown in Fig. 1 for both groups of patients. Patient characteristics are summarized in Table 1. There were significant differences in height, sex, New York Heart Association (NYHA) functional class, use of diuretics, and amplitude of the Can-RV coil EGM between the groups.

The ROC curve analysis revealed that 5 mV was an appropriate cut-off point for the Can-RV coil EGM amplitude (Fig. 2), and the area under the curve was estimated to be 0.89.

3.2. Predictors of the positive morphology change during the isometric chest press

Stepwise logistic regression modeling was used to identify factors associated with the positive morphology change incorporating unadjusted variables, which include height ($P=0.0196$), gender ($P=0.0398$), NYHA class ($P=0.023$), use of diuretics ($P=0.0177$), and amplitude of the Can-RV coil EGM less than 5 mV ($P<0.0001$). The results revealed that the candidate predictors were amplitude of the Can-RV coil EGM less than 5 mV ($P<0.0001$) and male sex ($P=0.0212$). The odds ratios determined by the stepwise logistic regression are shown in Fig. 3.

3.3. Inappropriate Wavelet detections caused by myopotential interference

Inappropriate detections caused by myopotential interference occurred in two patients (5%) during the mean follow-up of 49 months (range: 24–92 months). Both of them were classified in

Please cite this article as: Mizukami , et al. Influence of myopotential interference on the Wavelet discrimination algorithm in implantable cardioverter-defibrillator. J Arrhythmia (2016), http://dx.doi.org/10.1016/j.joa.2016.08.005