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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Application of microvolt T-wave alternans testing in scheduling implantable cardioverter--defibrillator placement for the primary prevention of sudden cardiac death in patients with left ventricular dysfunction

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Abstract

Background: Patients with left ventricular ejection fraction (LVEF) ≤ 35% are eligible for implantable cardioverter-defibrillator (ICD) placement for the primary prevention of sudden cardiac death (SCD). This recommendation results in continuously growing waiting lists of patients who have been qualified for and are awaiting the procedure. Whiled reduced LVEF is a feature shared by all the patients in this group, the risk of malignant ventricular arrhythmias varies widely. It therefore seems important from the clinical point of view to improve the waiting lists by identifying patients at the lowest risk of SCD, who can safely wait for the procedure, while higher-risk patients undergo the procedure before them.

Aim: To verify the utility of microvolt T-wave alternans (MTWA) testing, which is characterised by high negative predictive value (NPV), in scheduling ICD implantation in these patients.

Methods: The study included 152 patients with LVEF ≤ 35%, qualified for ICD implantation for the primary prevention of SCD, and managed in accordance with the current recommendations. Patients with a history of malignant ventricular arrhythmias were excluded. Each patient underwent MTWA testing during chronic treatment (including beta-blockers) and was followed-up.

Results: During 14 ± 8 months of follow-up, the primary outcome, which included SCD, non-fatal sustained ventricular arrhythmia, or appropriate high-voltage ICD discharge, was observed in 16 patients. The one-year event rate was 13.1% (5.8–19.8%) in non-negative MTWA patients and 0% in those who had negative MTWA result ($p = 0.027$). The NPV of the MTWA test was 100% (95% CI 92.73– 00%).

Conclusions: In the group of patients with left ventricular systolic dysfunction, excluding patients with a history of malignant ventricular arrhythmia, the NPV of MTWA was 100% over 12 months of observation. MTWA may therefore be considered useful in determining the order of ICD implantation procedures in this group of patients by identifying patients at a relatively low risk of malignant ventricular arrhythmias, who can be relatively safely rescheduled for ICD implantation at a later time. Future studies should concentrate on this issue.

Key words: ventricular arrhythmias, sudden cardiac death, microvolt T-wave alternans

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INTRODUCTION

Primary prevention of sudden cardiac death (SCD) constitutes an important problem in contemporary cardiology. Left ventricular ejection fraction (LVEF) is a well-established prognostic parameter for SCD, and according to current recommendations, an implantable cardioverter-defibrillator (ICD) should be

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implanted in all patients with an LVEF ≤ 35% [1–3]. Although such treatment markedly reduces the mortality rate in this group of patients [4, 5], it should be noted that implantation of an ICD is an expensive procedure [6]. The implantation rate varies depending on the financial resources available in various countries, ranging from approximately 600 per million inhabitants in the United States to an average of 250 per million inhabitants in European countries. However, the implantation rate in some countries is below this average. Therefore, the above-mentioned recommendation can lead to continuously growing waiting lists of patients who have been qualified for and are awaiting the procedure. While reduced LVEF is a feature shared by all the patients in this group, the risk of malignant ventricular arrhythmias varies widely. It therefore seems important from the clinical point of view to improve the waiting lists by identifying patients at the lowest risk of SCD who can safely wait for ICD implantation, while higher-risk patients undergo the procedure before them.

The evaluation of microvolt T-wave alternans (MTWA) is potentially interesting in this context, as this parameter is characterised by a high negative predictive value (NPV) in patients with left ventricular (LV) systolic dysfunction [7–12]. Although, there are a lot of publications concerning the usefulness of MTWA testing in risk stratification of patients with LV dysfunction, this topic has never been discussed in the literature in a comprehensive manner before, and all the previous studies were aimed at identifying patients at the highest risk of SCD, which has become less significant given the acceptance of the fact that reduced LVEF is the only and sufficient parameter that qualifies patients for ICD implantation.

The aim of this study was to determine whether MTWA testing could be useful in establishing the order of ICD implantation procedures in a group of patients with LV systolic dysfunction, who have been qualified for ICD implantation for the primary prevention of SCD by identifying patients at a relatively low risk of malignant ventricular arrhythmias who can safely wait for the procedure.

METHODS

Patient selection

Consecutive patients with LV systolic dysfunction (LVEF ≤ 35%), qualified for ICD implantation for the primary prevention of SCD and managed in accordance with the current recommendations that take into account the optimal pharmacological treatment according to present guidelines including wide use of beta-blockers, were included in the study. The exclusion criteria were as follows: age less than 18 years; history of prior sustained ventricular arrhythmia or cardiac arrest; permanent atrial fibrillation/flutter; permanent second- or third-degree atrioventricular block; prior pacemaker implantation; New York Heart Association (NYHA) functional class IV of heart failure; and the inability to exercise on a treadmill. This study is part of a large project on the risk stratification of life-threatening ventricular arrhythmias. The research protocol was approved by the Independent Review Board of Gdansk Medical University. Written informed consent was obtained from all participants.

During the baseline visit, medical history was taken, and physical examination and 12-lead electrocardiogram were performed.

MTWA testing

MTWA was tested in the morning hours during a treadmill exercise test. Patients were instructed not to stop their current pharmacotherapy, including the use of beta-blockers. Following an appropriate preparation of the patients' skin in order to minimise artefacts (cleansing with abrasive paper), the electrodes were placed in three orthogonal Frank leads (X, Y, and Z; High-Res high-resolution MTWA Sensors, Cambridge Heart) as well as in 12 standard leads. The exercise test was performed on a treadmill (Delmar Reynolds) following the protocol for MTWA testing, with the heart rate (HR) gradually increasing firstly to 100–110 bpm and then to 110–120 bpm (for at least 2 min). MTWA was analysed using the analytic spectral method (CH2000 system, Cambridge Heart, Bedford MA, USA). The computer-guided analysis was completed with an evaluation by the physician performing the test. The result of the test was classified as positive, negative, or indeterminate on the basis of the following literature-approved criteria [13]:

Positive MTWA (MTWA_pos) — defined as sustained alternans (lasting at least 1 min) with ≥ 1.9 μV amplitude, recorded at any orthogonal lead or in two consecutive precordial leads, and an onset HR ≤ 110 bpm that persisted with continued exercise and increasing HR or was observed at rest.

Negative MTWA (MTWA_neg) — defined as not meeting the criteria of positive MTWA and a maximum negative HR ≥ 105 bpm.

Indeterminate MTWA (MTWA_ind) — defined as not meeting the criteria of either positive or negative MTWA.

The results classified as MTWA_pos or MTWA_ind are similar in their bad prognosis of patients with LV systolic dysfunction [13], and so were qualified in common as abnormal (MTWA_non-neg).

Follow-up

In all the patients ICDs were programmed to two detection zones: slow arrhythmia detection zone (ventricular tachycardia [VT] zone) of more than 170 bpm, and fast arrhythmia detection zone (ventricular fibrillation [VF] zone) of more than 200 bpm. In order to avoid misdiagnosing the exercise-induced tachycardia as VT, each patient was subjected to control exercise test with determination of maximum HR. If maximum HR exceeded 150 bpm, we resigned from the VT zone and programmed ICD solely to the VF zone. The therapy in the VT zone was comprised of six sequences of anti-tachycardia pacing therapy (three sequences of burst pacing and three

sequences of ramp pacing), followed by one shock with energy 10 J below the maximum shock energy deliverable by a given ICD. Further shocks were delivered at full energy. The therapy in the VF zone included one sequence of anti-tachycardia pacing therapy (ATP during charging) followed by a series of full-energy shocks. Only the shock-terminated episodes detected in the VT zone were classified as EVENTs and subjected to further analysis. This enabled us to exclude potential non-persistent episodes from the analysis. In turn, all the ICD shock-terminated arrhythmias detected in the VF zone were by default considered persistent. The duration of these episodes prior to delivery of high-energy therapy was not analysed as it could be affected not only by the parameters of detection, difficult to compare between various types of ICDs, but also by ICD battery status, determining capacitor charging rate, as well as by delivery of a single sequence of anti-tachycardia pacing therapy (ATP during charging) and the efficiency thereof.

The patients were followed at the University outpatient clinic. The first visit was performed within three months of enrolment; subsequently, the patients were followed every six months or earlier if clinically required. During each visit, the clinical status of the patient was evaluated, and all adverse events were recorded. The ultimate decision to implant or not implant an ICD in any patient was left to the discretion of the treating physician. The primary end point (EVENT) used in this study included SCD, non-fatal sustained ventricular arrhythmias (VT or VF), or ICD shocks with intracardiac electrograms documenting rapid ventricular arrhythmia (VT ≥ 170/ /min or VF ≥ 200/ min). The relevance of the intervention was verified by analysis of the electrograms stored in the memory of the ICD. Patients with more than one VT or ICD discharge reached the primary end point with the first such episode. All terminal episodes were verified with medical documentation of the patient and/or death certificate information.

Statistical analysis

The minimum sample size was estimated by statistics according to the mathematical formula accepted in statistical analysis: $n = (1.96/0.2)^2 = 97$ (95% confidence interval [CI] would not exceed 20% [that means the error of the estimation would not exceed 10%]). For safety the sample size was set at 152 patients (the accuracy was improved and the error value was 8.1%). We classified MTWA tests as negative or non-negative (positive or indeterminate). The patients' data were censored on the date of heart transplantation or last follow-up. All data are presented as the mean ± standard deviation (SD) or as the number (n) and percentage (%). Due to the lack of distribution normality, the quantitative demographic and clinical data of patients from the EVENT_(+) and EVENT_(–) groups were compared using the Mann-Whitney test, while the qualitative data were compared using the χ^2 test or Yates' χ^2 test (depending on the sample size). The time course of the primary end point, stratified according to the MTWA results, was estimated using the Kaplan-Meier method. The association between MTWA and the primary end point was tested using the log-rank test. The event rate, estimated using the Kaplan-Meier method, was used to analyse the outcome of patients classified by MTWA. The sensitivity, specificity, positive predictive value (PPV), and NPV of MTWA for projecting end-point events during follow-up were analysed along with the 95% CI. All results were regarded as statistically significant if the p values were ≤ 0.05. The statistical analysis was conducted using the STATISTICA 9.0 (StatSoft, Tulsa OK, USA) package.

RESULTS

Baseline characteristics

All of the patients were recruited as outpatients. The clinical characteristics of the 152 patients enrolled in this study are listed in Table 1; briefly, the mean age of these patients was 63 years, 86% were male, and the average LVEF was 28%. Almost two-thirds of the patients had ischaemic heart disease, and the average time elapsed since myocardial infarction was 9.6 years. More than one-third of the patients were classified as NYHA functional class II. One patient had undergone heart transplantation. Almost all patients were treated with a beta-blocker, and all patients remained on their usual, long-term medications, including beta-blockers, during MTWA testing.

MTWA results

MTWA results were classified as negative in 49 (32%) patients, positive in 66 (44%) patients, and indeterminate in 37 (24%) patients. There were no demographic or clinical differences between the MTWA_neg and MTWA_non-neg groups (Table 1).

Primary outcome

During the 14 ± 8 months of follow-up, the primary end point was observed in 16 patients (Table 2). The number of EVENT episodes was significantly higher among MTWA_non-neg patients in comparison to MTWA_neg patients (p = 0.008). There were no demographic or clinical differences between the EVENT_(+) and EVENT_(–) groups (Table 3). The one-year event rate was 13.1% (5.8–19.8%) among MTWA_non-neg patients and 0% among MTWA_neg patients (p = 0.027). Figure 1 demonstrates the probability for end-points in patients with abnormal (MTWA_non-neg) and normal (MTWA_neg) MTWA results.

The sensitivity of the MTWA test was 100% (95% CI 80.64–100%), the specificity was 36.03% (95% CI 28.45––44.38%), the PPV was 15.53% (95% CI 9.79–23.75%), and the NPV was 100% (95% CI 92.73–100%).

There were three patients who died suddenly before ICD implantation. The time from MTWA testing to SCD in these patients was from two to five months. These patients were

Table 1. Baseline clinical characteristics of all patients and the MTWA_non-neg and MTWA_neg subgroups (data are presented as the mean ± SD or numbers and percentages)

	MTWA overall (n = 152)	MTWA_non-neg (n = 103)	MTWA_neg (n = 49)	P*
Age [years]	63 ± 13	64 ± 13	61 ±13	0.1
Males	130 (86%)	90 (87%)	40 (82%)	0.5
History of ischaemic heart disease	108 (71%)	73 (71%)	35 (71%)	0.9
History of myocardial infarction:				
Positive history	94 (62%)	63 (61%)	31 (63%)	0.9
Time elapsed [years]	9.6 ± 9.1	9.7 ± 9	9.4 ± 9.4	0.9
PCI/CABG	90 (59%)	61 (59%)	29 (59%)	0.8
Left ventricular ejection fraction [%]	28 ± 6	28 ± 7	29 ± 6	0.6
NYHA class:				
NYHA I	21 (14%)	14 (14%)	7 (14%)	0.9
NYHA II	103 (68%)	69 (67%)	34 (69%)	0.9
NYHA III	28 (18%)	20 (19%)	8 (17%)	0.8
Medication:				
Beta-adrenolytics	147 (97%)	99 (96%)	48 (98%)	0.9
ACE-I/ARB	142 (93%)	96 (93%)	46 (94%)	0.8
Spironolactone/eplerenone	84 (55%)	55 (53%)	29 (59%)	0.6
Acetylsalicylic acid	121 (80%)	83 (81%)	38 (78%)	0.8
Vitamin K antagonists	24 (16%)	15 (15%)	9 (18%)	0.7
Amiodarone	21 (13%)	13 (12%)	8 (16%)	0.7
Statins	136 (89%)	90 (87%)	46 (94%)	0.3
Diuretics	80 (53%)	73 (71%)	30 (61%)	0.3
Comorbidities:				
Arterial hypertension	86 (56%)	58 (56%)	28 (57%)	0.9
Type 2 diabetes	36 (24%)	26 (25%)	10 (20%)	0.7
Other parameters:				
History of tobacco smoking	97 (64%)	67 (65%)	30 (61%)	0.8

*P value between MTWA_non-neg and MTWA_neg groups; MTWA_neg — negative for microvolt T-wave alternans; MTWA_non-neg — not negative (positive and indeterminate) for microvolt T-wave alternans; PCI — percutaneous coronary intervention; CABG — coronary artery bypass graft; NYHA — New York Heart Association; ACE-I — angiotensin converting enzyme inhibitors; ARB — angiotensin receptor blockers

Table 2. Distribution of clinical events contributing to the primary end points

	MTWA_non-neg	MTWA_neg	All
Number of patients	103	49	152
Sudden cardiac death	3	–	3
Spontaneous sustained VT/VF	3	–	3
Appropriate ICD discharge	10	–	10

MTWA_non-neg — positive and indeterminate for microvolt T-wave alternans; MTWA_neg — negative for microvolt T-wave alternans; VT/VF — ventricular tachycardia/ventricular fibrillation; ICD — implantable cardioverter-defibrillator

above than 50 years old, all of them had ischaemic origin of LV systolic dysfunction, and all of them had a history of myocardial infarction. All patients had had successful and complete revascularisation, and they were all active smokers.

ICD implantation

All ICDs were implanted after the patients were enrolled into the study. The mean time from the MTWA study and ICD implantation in part of the patients was 6.0 ± 4.4 months. The

Table 3. Comparison of the demographic and clinical data for patients from the EVENT_(–) and EVENT_(+) groups (data are presented as the mean ± SD or numbers and percentages)

	EVENT_(–) (n = 136)	EVENT_(+) (n = 16)	P
Age [years]	63 ± 13	65 ±10	0.5
Males	115 (85%)	15 (94%)	0.5
History of IHD	94 (69%)	14 (88%)	0.2
History of myocardial infarction:			
Positive history	82 (60%)	12 (80%)	0.4
Time elapsed [years]	9.7 ± 9.2	8.8 ± 8.3	0.9
PCI/CABG	80 (59%)	10 (63%)	0.9
LVEF [%]	28 ± 6	29 ± 8	0.6
NYHA class			
NYHA I	19(14%)	2 (13%)	0.8
NYHA II	92 (68%)	11 (69%)	0.8
NYHA III	25 (18%)	3 (18%)	0.7
Medication:			
Beta-adrenolytics	131 (96%)	16 (100%)	0.9
ACE-I/ARB	127 (93%)	15 (94%)	0.6
Spironolactone/eplerenone	75 (55%)	9 (56%)	0.9
Acetylsalicylic acid	106 (78%)	15 (94%)	0.2
Vitamin K antagonists	23 (17%)	1 (6%)	0.5
Amiodarone	19 (14%)	2 (13%)	0.8
Statins	120 (88%)	16 (100%)	0.3
Diuretics	94 (52%)	9 (56%)	0.9
Comorbidities:			
Arterial hypertension	77 (57%)	9 (56%)	0.8
Type 2 diabetes	33 (24%)	3 (18%)	0.9
Other parameters:			
History of tobacco smoking	87 (64%)	10 (63%)	0.8

IHD — ischaemic heart disease; PCI — percutaneous coronary intervention; CABG — coronary arteries by-pass graft; LVEF — left ventricular ejection fraction; NYHA — New York Heart Association; ACE-I — angiotensin converting enzyme inhibitors; ARB — angiotensin receptor blockers

ICD implantation status and the reasons for ICD absence are described in Table 4.

DISCUSSION

The finding of our study pertains to the fact that none of the patients with negative MTWA test experienced fatal arrhythmic events during the average 14-month follow-up period. In our opinion, this observation is clinically important because it suggests that MTWA testing could be considered potentially useful for scheduling ICD implantation in this group of patients.

There is a large body of evidence indicating that negative MTWA results are associated with a significantly lower risk of life-threatening ventricular arrhythmias in patients with both ischaemic [8, 10, 14, 15] and non-ischaemic LV systolic dysfunction [7, 9, 11] as compared to abnormal (not negative) MTWA results. Although the reported NPV of this test is generally high, it differs depending on the specific study and not all studies are consistent with the overall trend [8, 10–12, 16–20]. Factors that can modulate the prognostic value of MTWA testing include pharmacotherapy administered during the test, the duration of follow-up, and the selection criteria employed in enrolling the examined group of patients [21].

According to many authors, the withdrawal of beta-adrenolytics for the period of testing is reflected by a decrease in the prognostic value of the test [22–24]. For example, a meta-analysis by Calo et al. [23], which included 15 studies that examined more than 5,000 patients with a mean LVEF of 32%, revealed that the NPV of MTWA testing performed during beta-blocker therapy was 99% as opposed to 90% when this agent was withdrawn during the test.

The duration of the follow-up period is another factor that may influence the prognostic value of MTWA testing. The literature indicates that longer follow-up periods are associated with lower NPVs for this test. In the ABCD trial, which included 566 individuals with an LVEF ≤ 40%, the NPV of MTWA was 95% during the first year of follow-up but was significantly lower, less than 90%, during the second year [10]. Consequently, if MTWA testing was considered a potentially useful tool for scheduling ICD implantation for the primary prevention of SCD, it should be periodically repeated in MTWA-negative patients, and our findings suggest that the NPV of MTWA testing remains high for at least one year of follow-up.

According to various authors, the prognostic value of MTWA testing can also be modulated by the selection criteria for the studied group [24, 25]. For example, the NPV of MTWA testing was significantly lower in a meta-analysis of studies involving patients with a history of life-threatening ventricular arrhythmias [25]. Our study performed on a group of carefully selected patients, optimally treated according to present guidelines, including beta-adrenolytics, with exclusion of individuals with a history of lethal ventricular arrhythmias, revealed the NPV value to be 100% during the average one-year follow-up period. This selected group of individuals reflects a typical population of patients who are qualified for ICD implantation within the framework of primary SCD prevention. Therefore, the high prognostic value of MTWA testing documented in this group is of high practical importance.

The extremely high NPV of MTWA testing suggests that patients who were scored as negative on this test are unlikely to experience SCD, and this finding supports the use of MTWA as a diagnostic parameter when scheduling ICD implantation for the primary prevention of SCD in patients with LV systolic dysfunction. Although a 10% frequency of life-threatening ventricular arrhythmia episodes were documented during the follow-up of individuals with abnormal (not negative) results

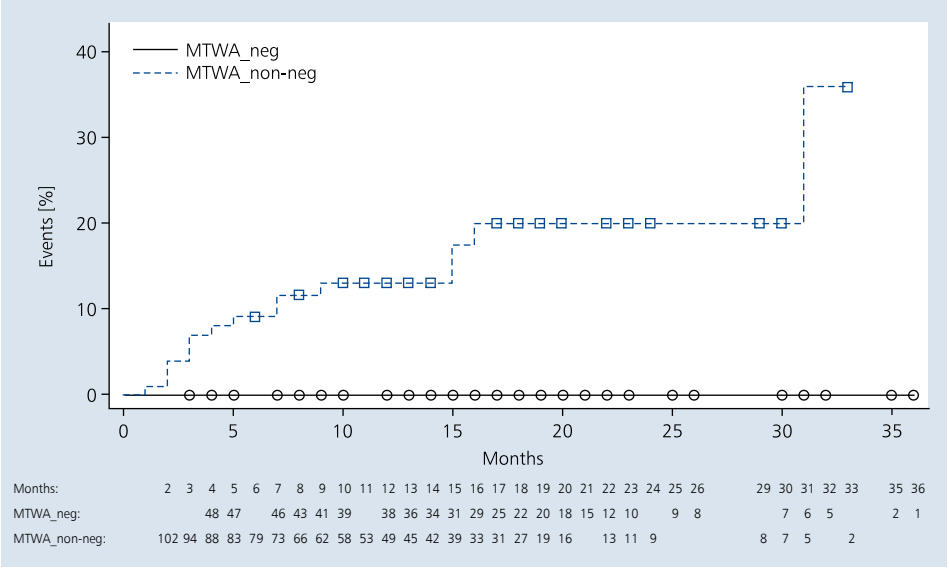

Figure 1. Kaplan-Meyer estimates of the probability for arrhythmic events in patients with abnormal (MTWA_non-neg) and normal (MTWA_neg) microvolt T-wave alternans (MTWA) results. During the 14 ± 8 months of follow-up, the primary end point occurred in 16 patients with MTWA_non-neg, whereas no events were documented in MTWA_neg patients (p = 0.027); MTWA_neg — negative result of MTWA testing; MTWA_non-neg — non-negative result of MTWA testing

Table 4. Implantable-cardioverter defibrillator (ICD) implantation status

	MTWA_non-neg	MTWA_neg
ICD implantation	83	32
Without ICD:		
Consent not given	12	6
Death prior to ICD implantation:		
Sudden cardiac death	3	–
Non-cardiac death	1	–
Awaiting ICD	4	9
Other reasons:		
Technical problems	–	1
Poor prognosis of 1-year survival (malignancy)	–	1

MTWA — microvolt T-wave alternans; MTWA_neg — negative results on MTWA testing; MTWA_non-neg — non-negative results on MTWA testing

of the MTWA testing, which is consistent with the incidence of such events reported in literature, none of these events were reported in MTWA-negative patients. This finding suggests that a certain fraction of patients (e.g. 10 per 100) who are waiting for ICD implantation at electrotherapy centres will die prior to receiving this procedure. In this context, the stratification of individuals waiting for ICDs into those at higher and lower risk, giving priority to the former group, could reduce the mortality of these subjects and should therefore be considered clinically justifiable. Our findings can be the first step to verifying this concept.

Limitations of the study

Several limitations should be noted concerning our study. Firstly, we excluded numerous patients with persistent atrial fibrillation/flutter, patients who were unable to exercise on the treadmill, or patients with IV NYHA functional class. Secondly, we did not analyse other risk factors in the context of their influence on prognosis. Finally, our results should be considered preliminary findings due to the small number of patients examined and the relatively short period of follow-up. The number of implanted ICDs were lower among MTWA_neg patients in comparison with MTWA_non-neg patients (with borderline statistical significance, p = 0.064), which can influence the number of end-point episodes, but programming of ICDs, precisely described in the methods section, enabled us to exclude potential non-persistent episodes from the analysis. MTWA_neg patients as the group of relatively low-risk patients were not qualified to ICD in an urgent way.

CONCLUSIONS

In the group of patients with LV systolic dysfunction, qualified for primary prevention of SCD, the NPV of MTWA was 100% over 12 months of observation. MTWA may therefore be considered useful in determining the order of ICD implantation procedures in this group of patients by identifying those at relatively low risk of malignant ventricular arrhythmias, and who can be relatively safely rescheduled for ICD implantation at a later time.

Conflict of interest: *none declared*

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Przydatność badania mikrowoltowej naprzemienności załamka T w planowaniu kolejności zabiegów implantacji kardiowertera-defibrylatora serca w profilaktyce pierwotnej nagłej śmierci sercowej u chorych z dysfunkcją skurczową lewej komory

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Streszczenie

Wstęp: Zgodnie z aktualnymi rekomendacjami każdy pacjent z dysfunkcją skurczową lewej komory [frakcja wyrzutowa lewej komory (LVEF ≤ 35%)] powinien mieć implantowany kardiowerter-defibrylator serca (ICD) w ramach profilaktyki pierwotnej nagłej śmierci sercowej (SCD). Zalecenie to nieuchronnie prowadzi do powstania ciągle narastających kolejek osób zakwalifikowanych i oczekujących na ten zabieg. Poza wspólnym dla wszystkich chorych zakresem obniżonej LVEF grupa ta jest bardzo zróżnicowana pod względem ryzyka złośliwych arytmii komorowych, dlatego ważna z klinicznego punktu widzenia wydaje się racjonalizacja takich kolejek poprzez wyłonienie osób o najniższym stopniu ryzyka SCD, mogących bezpiecznie oczekiwać na ten zabieg, ustępując miejsca pozostałym, bardziej zagrożonym pacjentom.

Cel: Celem niniejszej pracy była weryfikacja potencjalnej przydatności testu mikrowoltowej naprzemienności załamka T (MTWA), cechującego się wysoką negatywną wartością prognostyczną, w ustaleniu kolejności wykonywania zabiegów implantacji ICD u chorych z dysfunkcją skurczową lewej komory.

Metody: Badaniem objęto grupę 152 chorych z LVEF ≤ 35%, zakwalifikowanych do implantacji ICD w ramach profilaktyki pierwotnej SCD, leczonych zgodnie z aktualnymi standardami. Kryterium wykluczającym z udziału w badaniu był m.in. epizod złośliwej arytmii komorowej w wywiadzie. Każdego pacjenta poddawano testowi MTWA (bez odstawienia żadnego z dotychczas stosowanego leku, w tym beta-adrenolityka), a następnie dalszej klinicznej obserwacji.

Wyniki: W okresie 14 ± 8 miesięcy obserwacji zdarzenie końcowe (epizody SCD, spontaniczne utrwalone złośliwe arytmie komorowe, adekwatne wysokonapięciowe interwencje ICD z powodu arytmii komorowej) stwierdzono u 16 chorych. Prawdopodobieństwo wystąpienia zdarzenia końcowego dla jednego roku obserwacji wyniosło 13,1% (5,8–19,8%) dla chorych z nie-ujemnym wynikiem MTWA oraz 0% dla osób, u których stwierdzono ujemny wynik testu (p = 0,027). Negatywna wartość prognostyczna (NPV) testu MTWA wyniosła 100% (95% CI Wilsona: 92,73–100%).

Wnioski: W grupie chorych z dysfunkcją skurczową lewej komory, po wykluczeniu pacjentów z wywiadem złośliwej arytmii komorowej, wartość NPV testu MTWA wynosi 100% dla rocznego okresu obserwacji. Badanie MTWA można rozważać jako potencjalnie przydatne w ustaleniu kolejności zabiegów implantacji ICD w tak zdefiniowanej grupie chorych, gdyż pozwala wyłonić osoby o relatywnie niewielkim ryzyku złośliwych arytmii komorowych, u których można wykonać zabieg implantacji ICD w późniejszym okresie. Potrzebne są dalsze badania poświęcone temu zagadnieniu.

Słowa kluczowe: arytmie komorowe, nagła śmierć sercowa, mikrowoltowa naprzemienność załamka T

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