INTRODUCTION

Patients with reduced left ventricular ejection fraction (LVEF) after myocardial infarction (MI) are at risk of ventricular arrhythmias and many reports regarding risk stratification in these patients have been published.1-3 Few studies evaluated the risk stratification markers in post-MI patients with preserved LVEF. Risk...
stratification is important in patients with preserved LVEF despite the better prognosis of these patients. Microvolt T-wave alternans (MTWA) is a useful marker for identification of high-risk patients post-MI patients with reduced LVEF ≤30%, or <40%, but the role of MTWA is unknown for risk stratification in post-MI patients with preserved LVEF.

The study purpose is to determine the feasibility of MTWA for ventricular arrhythmia risk evaluation in patients with complete interventional revascularization after myocardial infarction, preserved LVEF and no prior malignant ventricular arrhythmias.

MATERIAL AND METHODS

Patient population
This prospective study enrolled 74 patients (61 men, mean age 56 ± 11 years) with LVEF ≥ 45% and no prior sustained ventricular arrhythmias underwent successfully interventional revascularization with stent implantation for acute or recent myocardial infarction (one or two- coronary vessel disease). The diagnosis of MI was based on the clinical course, serum marker activity and ST elevation on electrocardiogram. The LVEF was assessed by modified Simpson rule on echocardiography. We excluded from our study patients with persistent atrial fibrillation/flutter or those who required a ventricular pacemaker because the MTWA test cannot be interpreted in such circumstances.

An informed consent for procedures was obtained from each patient and the study was approved by the local ethics committee. At 30 days after interventional revascularization all patients underwent MTWA exercise test, followed by an electrophysiological study with standard programmed ventricular stimulation.

Measurement of MTWA testing
Microvolt T wave alternans test was performing using a Heartwave system (Cambridge Heart, Inc., Bedford, Massachusetts) during bicycle exercise. In order to minimize the noise, skin preparation and high resolution electrodes were used. Electrocardiographic leads were placed at standard 12-lead positions and in orthogonal X, Y, Z configuration.

The MTWA test was interpreted as positive, negative and indeterminate according to a previously described report. The test was defined as positive if it had sustained alternans with an onset heart rate ≤110 beats/min or had sustained alternans at resting heart rate, even if the latter is >110 beats/min. Sustained alternans is defined as lasting at least one minute with alternans voltage (Valt) ≥1.9 μV and alternans ratio ≥3.0 in any orthogonal lead or two consecutive precordial leads during exercise. The test was defined as negative when the positive criteria were not met and artifact-free data were available showing a heart rate maintained at a level >105 beats/min for at least one min. The test was defined as indeterminate when the results did not meet either the positive or negative criteria.

Standard programmed ventricular stimulation
After local anesthesia using lidocaine 1%, three 6-Fr quadripolar electrode catheters were inserted percutaneously through the femoral vein and advanced to the high lateral right atrium, across the tricuspid valve, recorded the His bundle electrogram, and to the right apex in all patients.

Programmed ventricular stimulation was performed using stimulus duration of 2-ms at amplitude of two to three times the diastolic threshold, with up to three extrastimuli at basic drive cycle lengths, 600 ms and 400 ms respectively, starting at apex, then at outflow tract. Coupling intervals of extrastimuli were decreased in 10-ms interval until coupling interval of 180 ms was reached or refractoriness of all extrastimuli was reached.

The endpoint of electrophysiology was the induction of sustained ventricular tachycardia (>30 s in duration or associated with hemodynamic compromise requiring earlier intervention) or the completion of stimulation protocol. The induction of ventricular fibrillation was defined prospectively as an indeterminate result.

Follow-up
All patients were followed for an average of 14 months. Clinical follow-up was obtained as regular interval. Arrhythmic events during follow-up were defined as:

1. Sustained ventricular tachycardia or ventricular fibrillation;
2. Appropriate ICD therapy for ventricular tachyarrhythmia with documentation of the rhythm leading to the shock by stored electrograms by the device;
3. Sudden cardiac death

Statistical analysis
All results are expressed as mean ± standard deviation. Sensitivity, specificity, positive and negative predictive value, and the predictive accuracy of event-free prediction were evaluated.
RESULTS

A number of 74 patients (61 men, 82%) evaluated in this study. (Table 1) The mean age of this cohort was 56 ± 11 years, and the mean left ventricular ejection fraction 59 ± 13%. All patients had acute or recent myocardial infarction (one or two coronary vessel disease) that underwent successfully interventional revascularization with stent implantation. At 30 days after interventional revascularization all patients underwent MTWA exercise test followed by electrophysiological study with standard programmed ventricular stimulation as describe earlier.

Table 1. Patients characteristics.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>74 pts</td>
</tr>
<tr>
<td>Male/Female ratio</td>
<td>61 (82%) / 13 (18%)</td>
</tr>
<tr>
<td>Age, mean ± SD</td>
<td>56 ± 11 years</td>
</tr>
<tr>
<td>Left ventricular ejection fraction, mean ± SD</td>
<td>59 ± 13 %</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td></td>
</tr>
<tr>
<td>- anterior</td>
<td>40 pts (54%)</td>
</tr>
<tr>
<td>- inferior</td>
<td>27 pts (36%)</td>
</tr>
<tr>
<td>- lateral</td>
<td>7 pts (10%)</td>
</tr>
</tbody>
</table>

Table 1. Patients characteristics

The microvolt TWA test was positive in 16 patients (22%), negative in 52 patients (70%), while 6 patients (8%) had an indeterminate test. (Fig. 1,2)

Indeterminate test was primarily due to frequent ectopic beats or the inability to achieve the target heart rate of >105 beats/min. Previous report in the MI population with reduced LV function has combined positive and indeterminate microvolt TWA into one “abnormal” group. In our study we separated patients with a positive microvolt TWA test from patients with an indeterminate microvolt TWA test.

At electrophysiological study, sustained ventricular arrhythmias were induced in two patients (both with previous positive microvolt TWA test), one with ventricular monomorphic tachycardia and one with ventricular polymorphic tachycardia, with hemodynamic deterioration requiring immediate cardioversion. (Figs. 3-5) These patients received a cardioverter implantable defibrillator. In 12 patients (nine with positive microvolt TWA test, three with negative microvolt TWA test) with negative response on programmed ventricular stimulation nonsustained ventricular tachycardia (between 10-25 s) was induced. Two patients with positive microvolt TWA refused the electrophysiological study with programmed ventricular stimulation. The sensitivity of predictive value of microvolt TWA for ventricular arrhythmic events was 90%, with 81% specificity. The negative predictive value of microvolt TWA for ventricular arrhythmic events was 97% and the positive predictive value was 14.3%.

Figure 2. T-wave alternas positive test. Allenans vector trend summary.
in this type of patients (prior MI, preserved LVEF) and can be used for risk stratification. The most common mechanism of sudden cardiac death after acute MI is ventricular tachyarrhythmia. The risk of sudden cardiac death among post-MI patients with preserved LVEF is considered low in patients who benefit from early revascularization. Arrhythmic events have a lower incidence in patients with preserved cardiac function than in patients with reduced cardiac function.

Numerous studies evaluate the risk of sudden cardiac death in patients with reduced LVEF after MI. Little information is available with respect to the prognostic value of risk stratification markers in post-MI patients with preserved LVEF. Accurate identification of patients at increased risk for sustained ventricular arrhythmias is critical for development of effective strategies to prevent sudden cardiac death.

In our study, microvolt TWA test has a low positive predictive value (14.3%), thus, for risk stratification of sudden cardiac death further investigation is needed. Because sensitivity and negative predictive value of microvolt TWA test in our study were high (90% and 97%), the test could be used in the primary screening of patients for risk of ventricular arrhythmias in this population.

The positive predictive value of microvolt TWA could be improved when the test is combined with other noninvasive markers, such as NSVT and ventricular late potential. We consider that in patients with positive microvolt TWA further evaluation, including electrophysiological study with programmed ventricular stimulation, is needed.

Study limitations
The study is limited because of reduced number of patients included. Medical and interventional treatment played an important role in evolution of post-MI patients and the incidence of ventricular arrhythmias can be influenced by this. We did not include in our study other risk of ventricular arrhythmias variable such as signaled average electrocardiography and autonomic imbalance markers (heart-rate variability, baroreflex sensitivity and heart rate turbulence). The microvolt TWA test was indeterminate in some patients because they could not achieve a heart rate of at least 105 beats per minute with exercise or due to frequent ectopic ventricular beats.

CONCLUSION
The MTWA test has a good negative predictive value for arrhythmic events in post-MI patients with
preserved LVEF and can be used for risk stratification. We consider that in patients with positive MTWA further invasive evaluation, respectively programmed ventricular stimulation, is necessary.

REFERENCES


