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Tei Index: Assessment of the Myocardial Function of the Left Ventricle in Case of Acute Myocardial Infarction

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135 patients with acute myocardial infarction and ST segment elevation were examined, their age was from 27 to 69 (average age 52,06±7,33 years). Reliable increase of TEI index was noticed at the beginning of the disease, pointing onto distinct aggravation of systolic and diastolic functions of the left ventricle. Inverse correlation was detected between this index and ejection fraction of the left ventricle. It was established, that prognostic value of the TEI index related to in-hospital complications was higher than OE LV, and its value ≥0,49 might be used for stratification of the patients with higher risk of adverse events during the in hospital treatment stage.

Keyword: Acute Myocardial Infarction With ST-Segment Elevation, Index Tei, Complicated Hospital Period, Risk Stratification.

1. Introduction

Acute myocardial infarction (AMI) is accompanied with the reducing of the contractile tissue, remodeling of the heart muscle and changing of systolic and diastolic ventricular functions. As a rule, treatment strategy and patient's prognosis are based on the estimation of the systolic function of the left ventricle. However, notwithstanding that diastolic function influences on the flow of the disease as well, its state is usually not taken into account during the choice of the treatment tactics for the inmate. [1].

In 1995 Japanese scientist Chuwa Tei offered doppler index of myocardial performance –Tei index (TI), with the help of which it was possible to estimate the state of the left ventricle in complex – its systolic and diastolic functions simultaneously [14]. Calculation of this index is not a difficult process and does not extend the time needed for the patient's examination.

Highly reliable close correlation between TI and "golden" standards of myocardial function assessment was revealed – invasive hemodynamic indexes: maximal level of the pressure increase during the period of isovulumetric systole (peak + dP/dt), maximal level of the pressure decrease (peak - dP/dt) and temporary constant pressure decrease during the period of isovolumetric relaxation (tau) [9]. Correlation between TI, preload recruitable stroke work, ventricular stiffness constant and cardiac output was discovered by catheterization of the LV and ascending aorta [3].

It is found that patients with heart failure (HF) have higher TI, comparing to the healthy volunteers, and significantly correlates with the HF class on NYHA, ejection fraction (EF) and volume of the LV. It is established that TI reflects severity of the LV dysfunction [11, 13, 17,], and TI of the patients with AMI is much higher than that of practically healthy people

[2, 6, 7, 8], and correlates with the increased in-hospital risk of complications – unexpected death, acute heart failure, appearance of arrhythmias, post-infarction angina [6].

Prognostic value of the TI in relation to the development of cardio-vascular death rate in the distant period after AMI is higher, comparing to movement index of LV wall and correlation of diastolic waves [10].

Prognostic value of TI at valvular heart diseases [4], pulmonary hypertension [18], amyloidosis [5, 15], cardio-toxic influence of the chemotherapy [12], with patients who have transplanted harts [16] was opened.

2. Aim of Our Research: is to define peculiarities of TI changes with patients who have acute myocardial infarction with elevation of the ST segment (AMI↑ST) during the hospital treatment and its connection with systolic function of the LV and complications, arising in the early post-infarction period.

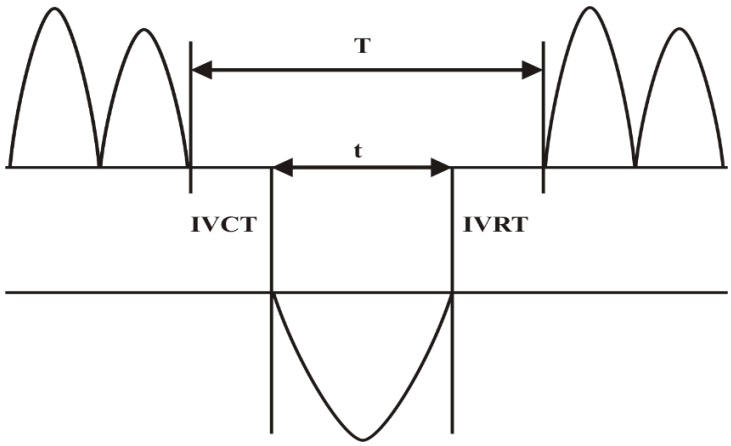
3. Materials and Methods: We examined 135 patients with AMI↑ST in the age from 27 to 69 (average age 52,06±7,33 years). Control group consisted of 12 almost healthy people in the age from 35 to 65 (average age 54,06±3,74 years).

Echocardiography was conducted twice with the help of the appliance Sonoline Versa Plus, Siemens (Germany) – on the first-second day and before the hospital discharge.

All measurements were done in AB mode by parasternal access through long and short axis, as well as by the apical access with the help of the four-chamber and dual-chamber sections.

EF of the LV is defined in accordance with the Simpson biplane formula. Characteristics of the mitral and aortal flows were received by apical access with the help of pulse Doppler and placing the trial volume above the tips of the mitral valves into diastole and between aortal valves into systole.

To define TI (myocardial performance index) time between the end of the previous and beginning of the following trans-mitral flows (T) and ejection time (ET) of the blood into aorta (t) were measured. Interval T includes isovolumic contraction time (IVCT) of the LV, ejection time t of the blood into aorta and isovolumic relaxation time (IVRT) of the LV (pic. 1). TI measurement may be presented as correlation T-t/t or IVCT+ IVRT/ET [14].



Picture 1. Scheme of the doppler flows:
T – time between the end of the previous and beginning of the following trans-mitral flows;
t – ejection time of the blood into aorta;
IVCT - isovolumic contraction time of LV;
IVRT - isovolumic relaxation time of LV.

For the objective assessment of final diastolic volume (FDV) of LV final diastolic index of LV was defined (FDI LV) (ml/м^2): FDI LV = FDV LV / square of the body surface (mm/m^2).

4. Results and Discussions:

Emergence of the AMI in the examined patients was accompanied with significant, comparing to the control group, lowering of the average values of EF LV and increase of the TEI index (resulting from prolongation of the periods of isovolumentric contractions (IVCT) and isovolumetric relaxation (IVRT) with shortening of time for blood ejection from LV). Significant increase of FDV LV was detected (p=0,08), and within this time FDI LV was practically without changes (table 1).

Table 1: ECHO Indexes of patients with AMI↑ST at hospital stay (n=135)

Index	At the time of hospitalization	At the end of examination	Dynamics of changes, %	Control group (n=12)
FDV LV, sm	5,39±0,51	5,65±0,44*″	+4,82, p=0,001	5,1±0,88
FDI LV, cm/m^2	2,79±0,31	2,87±0,27″	+2,87, p=0,03	2,74±0,32
TEI index	0,52±0,1*	0,36±0,08*″	-30,77, p=0,001	0,29±0,03
EF LV, %	45,44±5,39*	47,88±5,52*″	+5,37, p=0,003	63,00±3,18

Remark: 1. * - difference between average values of indexes, comparing to control group, statistically reliable, p≤0,05; 2. ″ – difference of changes at the end of examination, comparing to data recorded at the hospitalization, statistically reliable, p≤0,05.

All researched indexes were reliably measured during the treatment process. FDV and FDI LV were increasing, TI decreased, EF LV was growing. Positive dynamics of TI, comparing to EF LV, was more distinct (-30,77 and +5,37%, correspondingly).

Inverse correlation between TI and EF LV was established – at hospitalization (r=-0,52, p≤0,05), as well as at hospital discharge (r=-0,54, p≤0,05).

It is important to stress that patients with EF LV ≤40% (group 1, 54 people) at the beginning had TEI index equal to 0,53±0,05, and people with preserved systolic function of LV (group 2, 81 people) - 0,51±0,08, without reliable difference between groups. TI parameters of the same patients got lower at the end of the examination period to 0,42±0,05 (group 1) and to 0,32±0,04 (group 2) (with the distinct differences between the index values, p=0,03), which, obviously, was caused due to more expressed LV remodeling in the patients of group 2.

We observed that positive TI dynamics at the hospital stay treatment was more expressed in the patients after successfully conducted thrombolysis (66 people). TI of these patients lowered to 0,34±0,06 at the time of hospital discharge, contrasting to 69 patients without thrombolytic therapy, whose index was 0,38±0,04 (p=0,09) at the end of the examination period.

In order to study Tei index dependence on disease flow character among the examined people, we selected patients with and without complicated hospital treatment.

We considered as complications during the hospital stay treatment the following issues: development of the acute left ventricle failure; establishment of the post-infarction angina and ischemic episodes (painless and painless), documented on ECHO (daily monitoring, routine ECHO records); appearance of ventricle arrhythmias and ventricle extra systoles of high gradations, which are dangerous for life; cases of sudden heart death; post-infarction remodeling of LV (cavity dilation, formation of LV aneurysm).

At least one attribute of complicated flow was detected in 52,59% (71 people) of patients and 64 patients (47,41%) had no signals during the hospital stay treatment.

It is noticed that patients with complicated disease flow comparing to patients without it, had considerably higher TEI index – both, when being hospitalized and during the discharge, with the less distinct positive dynamics during the treatment process (Table 2).

Table 2: Dynamics of the TEI-index values depending on the peculiarities of disease flow

Groups of patients	TI, hospitalization	TI, discharge	Δ, %
Patients without complicated disease flow, n=64	0,44±0,08	0,29±0,13	-34,01
Patients with complicated disease flow, n=71	0,55±0,09*	0,49±0,07*	-10,91

Remark. * - difference with comparison to patients without complicated disease flow, statistically reliable, p≤0,05.

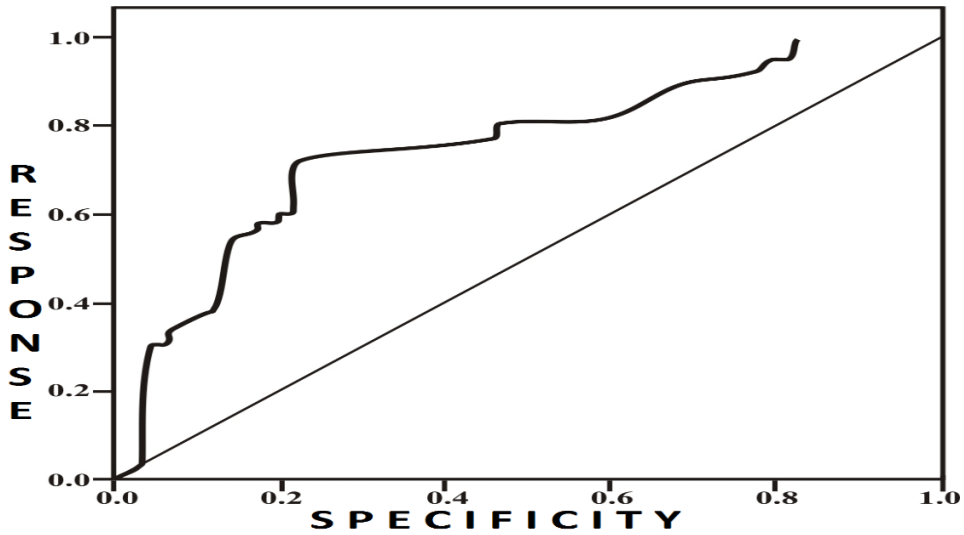
We registered the same regularity with the values of EF LV (Table 3): this index was considerably lower in the patients with complicated disease flow, than in patients without complications – both during the hospitalization and discharge.

Table 3: Dynamics of EF LV values depending on peculiarities of the disease flow

Groups of patients	OF LV (%), hospitalization	OF LV (%), discharge	Δ, %
Patients without complications, n=64	47,81±3,77	51,67±4,50	+8,07, p=0,001
Patients with complications, n=71	42,80±4,95*	44,09±5,03*	+3,01, p=0,13

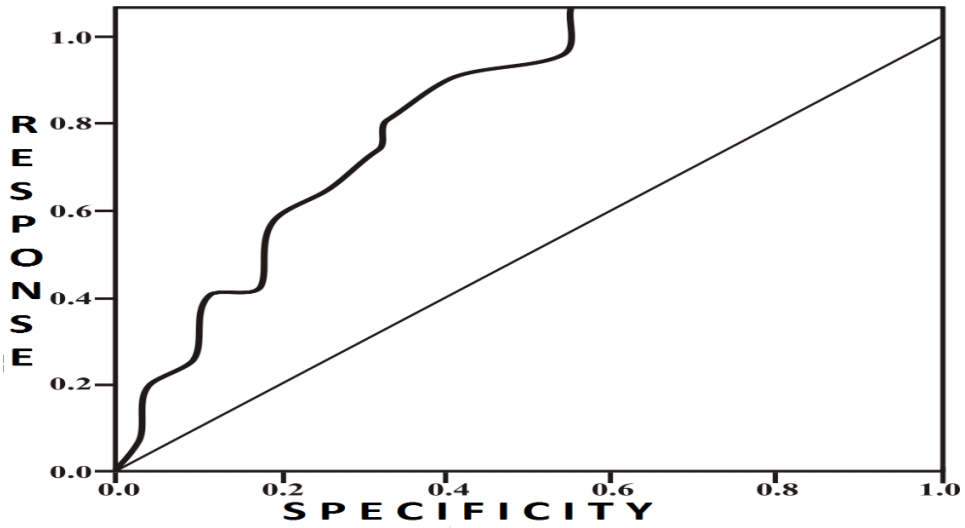
Remark. * - difference with comparison to patients without complicated disease flow, statistically reliable, p≤0,05.

In order to define prognostic value of the TEI index, its boundary point, beyond which risk of in-hospital complications development gets higher, we conducted ROC-analysis including into the model average TI value, when the patients were hospitalized. Square of the graph made up 0,93±0,09, 95% DI=0,85-0,96, for the boundary point ≥0,49 response 92% and specificity 84% are detected (picture 2).



Picture 2: ROC-graph for TEI-index (hospitalization)

During the conduction of ROC-analysis for EF LV, defined at the beginning of the disease, the square of the graph made up 0,73±0,07 with the indexes of response and specificity for EF values ≤44%, 90% and 58% correspondingly (picture 3).



Picture 3: ROC-graph for OF LV (hospitalization)

Thus, with almost the same response, TI turned out to be more specific, comparing to EF LV, marker of the acute flow of the myocardial infarction during the hospital stage.

5. Conclusions

Appearance of AMI↑ST is accompanied with distinct increase of TEI index, which points onto the expressed aggravation both of systolic and diastolic function of the left ventricle at the beginning of the disease. There is an inverse correlation of the medium force between TI and EF LV.

More distinct positive TI dynamics, comparing to EF LV, during the hospital stage certifies about the improvement of myocardial contractility and its diastolic filling.

Prognostic value of the TEI index related to the appearance of complications during the hospital stage of treatment is higher comparing to EF LV. TI value ≥0,49, defined during the first 24 hours of AMI, may be used with response of 92% and specificity of 84% to select the patients with the higher risk of in-hospital complications.

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