NILAI DIAGNOSTIK DAN PROGNOSTIK DARI FUNGSI SISTOLIK DAN DIASTOLIK VENTRIKEL KANAN PADA INFARK MIOKARD INFERIOR

THE DIAGNOSTIC AND PROGNOSTIC VALUE OF RIGHT VENTRICLE SYSTOLIC AND DIASTOLIC FUNCTION IN INFERIOR MYOCARDIAL INFARCTION

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ABSTRAK

Keterlibatan ventrikel kanan (RV) meningkatkan mortalitas dan morbiditas pada infark miokard inferior (MI). Data mengenai keegunaan pencitraan Doppler jaringan berdenyut (TDI) dalam diagnosis disfungsi RV pada elevasi segmen ST MI (STEMI) jarang. Penelitian ini mengevaluasi signifikansi diagnostik dan prognosis fungsi sistolik dan diastolik RV dibandingkan kriteria diagnostik RVMI elektrokardiografi klasik pada kelompok pasien ini. Pasien berturut-turut dengan STEMI inferior akut dan akut dinilai secara prospektif. RVMI didefinisikan sebagai elevasi segmen ST ≥ 0,1 mV pada timbal V4R. Ekokardiografi dengan TDI dilakukan dalam 24 jam sejak timbulnya gejala. Dari 31 pasien (usia rata-rata 56,39 ± 9,02 tahun), RVMI ditemukan pada 18 (37%). Analisis multivariat menunjukkan bahwa dua variabel-fungsi sistolik RV dan diastolik, merupakan prediktor independen prognosis di rumah sakit. Sensitivitas dan spesifisitas fungsi sistolik RV masing-masing 94,4% dan 69,2%. Sedangkan fungsi diastolik RV masing-masing 44% dan 76,9%. Fungsi sistolik RV memprediksi diagnosis EKG RVMI dengan sensitivitas dan spesifisitas yang relatif tinggi. Fungsi diastolik RV memprediksi diagnosis EKG RVMI dengan sensitivitas yang relatif rendah namun memiliki spesifisitas tinggi.

Kata kunci: Pencitraan Doppler jaringan, infark miokard RV, infark miokard inferior

ABSTRACT

Right ventricular (RV) involvement increases mortality and morbidity in inferior myocardial infarction (MI). There are sparse data on the usefulness of pulsed tissue Doppler imaging (TDI) in the diagnosis of RV dysfunction in ST segment elevation MI (STEMI). This study evaluate the diagnostic and prognostic significance of RV systolic and diastolic function compared to classical electrocardiographic RVMI diagnostic criteria in this group of patients. Consecutive patients with first, acute, inferior STEMI were prospectively assessed. The RVMI was defined as an ST-segment elevation ≥ 0.1 mV in lead V4R. Echocardiography with TDI was performed within 24 h of the onset of symptoms. Out of 31 patients (mean age 56.39 ± 9.02 years), RVMI was found in 18 (37%). Multivariate analysis showed that two variables—RV systolic and diastolic function, were independent predictors of in-hospital prognosis. Sensitivity and specificity the RV systolic function were 94,4% and 69,2%, respectively. While RV diastolic function were 44% and 76,9%, respectively. RV systolic function predict ECG diagnosis of RVMI with relatively high sensitivity and specificity. RV diastolic function predict ECG diagnosis of RVMI with relatively low sensitivity but with high specificity.

Keywords: *tissue Doppler imaging, RV myocardial infarction, inferior myocardial infarction*

INTRODUCTION

Right ventricular (RV) myocardial infarction (MI) occurs in 30–50% of patients with inferior MI (Goldstein, 2002). It is caused mainly by proximal right coronary artery (RCA) lesion (Bowers *et al*., 2002). The RVMI leads to RV dysfunction that increases early mortality and morbidity independently of the degree of left ventricular dysfunction (Kukla *et al*., 2006). Rapid, accurate assessment of RV function is of great importance, as it provides not only prognostic information measure but also allows proper modification of therapy. The RVMI diagnosis remains a challenge, since there is no gold standard ready to use in an emergency clinical setting. Standard echocardiography allows morphological, haemodynamic, and functional

assessment of the RV, but has limited value because of the asymmetric, pyramidal shape of the RV and nonconcentric contraction which makes geometric assumptions difficult (Rudski *et al*., 2010). A number of echocardiographic indices have been investigated, including regional contractility, cavity size, myocardial performance index, and tricuspid annular plane excursion (Piestrzeniewicz *et al*., 2006). Previous study are available on the usefulness of pulsed wave TDI in the diagnosis of RVMI in patients with inferior MI, but there are sparse and conflicting data on the usefulness of RV myocardial velocities derived from TDI in this group of patients (Hsiao *et al*., 2010). The aim of this study was to evaluate the diagnostic and prognostic significance of RV systolic and diastolic function compared to classical electrocardiographic RVMI diagnostic criteria in this group of patients.

METHODS

This study was designed and conducted prospectively. Consecutive patients with first, acute, inferior STEMI with standard echocardiographic examination and echocardiography performed within 24 hour of the onset of symptoms, were eligible. The diagnosis of inferior STEMI was based on the European Society of Cardiology (ESC) criteria: chest pain lasting > 30 min, characteristic ST-segment elevation of ≥ 0.1 mV in two or more inferior derivation (leads II, III, aVF) on ECG, and an increase in biomarkers: troponin I or creatine kinase (CK)-MB (Van de Werf *et al*., 2003). Patients with a history of previous MI, pulmonary embolism, chronic obstructive pulmonary disease, documented pulmonary hypertension, permanent atrial fibrillation, His bundle branch blocks, moderate or severe valvular diseases, or poor quality echocardiographic imaging were excluded. All patients gave their written consent. The study was approved by the hospital ethics committee.

Standard 12-lead ECG was performed immediately upon arrival at the Emergency Department. Right chest ECG used for RVMI diagnosis was recorded immediately in emergency room. The RVMI was defined as an ST-segment elevation ≥ 0.1 mV in lead V4R according to ESC recommendations (Van de Werf *et al*., 2003). All ECG were assessed by an independent cardiologist, blinded to clinical, and echocardiographic data.

Standard echocardiographic examination with TDI was performed within 24 hour of the onset of symptoms in all patients. Examinations were performed using Vivid I with phased-array 1.8–3.6 MHz transducer, harmonic imaging, equipped with TDI technology. Echocardiographers were blinded to clinical and ECG parameters. All measurements were performed according to the recommendations of the American Society of Echocardiography. Measurements of RV and right atrium diameters, fractional area change of RV, change of inferior vena cava diameter during respiration, and assessment of RV wall motion abnormalities were included in standard echocardiographic examination. Left ventricular ejection fraction (LVEF) was calculated according to modified Simpson's rule.

For all parameters, descriptive statistics were calculated (mean and SD for continuous variables and frequency tables for categorical variables). Variables were compared using ANOVA, Kruskal-Wallis non-parametrical ANOVA, t-Student test, Mann-Whitney test, chi square test or Fisher exact test where appropriate.

A logistic regression analysis was used to evaluate the predictive value of selected clinical and echocardiographic parameter factors for the presence of ECG changes specific for RVMI diagnosis. The included factors were: age, systolic blood pressure, diastolic blood pressure, standard echocardiographic parameters reflecting RV function (RV EF, fractional area change of RV, TAPSE, mitral propagation) and TDI parameters (SmRV, EmRV, myocardial performance index). Model used in the analysis was pre-specified based on the current knowledge of RV dysfunction. For RV myocardial velocities, values below median were used.

The diagnostic value of parameters in RVMI diagnosis was evaluated by calculating a receiver operating characteristics (ROC) curve. To evaluate the prognostic significance of RV myocardial velocities on the occurrence of the combined end-point in patients with inferior STEMI, multivariate logistic regression analysis was carried out. The included factors were: SmRV, EmRV, age, extent of MI expressed as peak troponin I, LVEF, ST segment elevation ≥ 0.1 mV in lead V4R. Events which occurred following echocardiography with TDI were enrolled into the analysis of prognosis. Analysis was carried out using SPSS 20.

RESULTS AND DISCUSION

The study group consisted of 31 consecutive patients, mean age 56.39 ± 9.02 years with first, acute inferior STEMI enrolled between 1 November 2014 and 31 December 2014. In 18 patients (37%), first STEMI within 24 h of the onset of symptoms and with RV localization was found. All patients fulfilled criteria for diagnosis of type I MI according to the new MI definition;[8] Exclusion criteria were found in 14 patients: severe aortic valve disease, permanent atrial fibrillation, severe chronic obstructive pulmonary disease, history of pulmonary embolism, His bundle branch block, poor quality of standard echocardiographic imaging and lack of sufficient medical documentation. The clinical characteristics of the study group are listed in Table 1.

Table 1 Patient characteristics

PARAMETER	All MI	RV MI (+)	RV MI (-)
Age	56.39 ± 9.02	55.89 ± 9,19	57,08 ± 9,09
Systolic Blood Pressure	130,22 ± 30,57	129,05 ± 28,73	119,15 ± 24,48
Diastolic Blood Pressure	80,39 ± 21,18	78,33 ± 20,82	73,23 ± 13,72
TAPSE	1,92 ± 0,56	1,87 ± 0,58	2,00 ± 0,53
S	0,12 ± 0,20	0,11 ± 0,33	0,13 ± 0,31
FAC RV	51,80 ± 15,95	51,27 ± 13,3	52,53 ± 19,6
TDI MPI	480,26 ± 184,12	475,77 ± 18,22	486, 56 ± 18,61
E/A RV	1,15 ± 0,5	1,08 ± 0,46	1,24 ± 0,45
EF RV	50,38 ± 10,47	44,33 ± 8,51	58,76 ± 6,3
Mitral Propagation	53,04 ± 42,02	57,02 ± 5,1	58,01 ± 5,05
S/D	1,15 ± 0,70	1,14 ± 0,51	1,16 ± 0,46

Multivariate analysis showed that two variables—RV systolic and diastolic function, were independent predictors of in-hospital prognosis (table 2). Sensitivity and specificity the RV systolic function were 94,4% and 69,2%, respectively. While RV diastolic function were 44% and 76,9%, respectively (figure 1 and 2).

Table 2 Multivariate analysis of the study

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3,841	1,551		2,477	,026
	Age	,000	,014	,002	,014	,989
	Systolic Blood Pressure	,004	,010	,159	,417	,683
	Diastolic Blood Pressure	-,004	,011	-,091	-,328	,748
	TAPSE	-,061	,258	-,046	-,235	,817
	S	1,014	,673	,281	1,506	,153
	FAC	-,005	,010	-,115	-,519	,611
	TDIMPI	9,176E-005	,001	,023	,134	,895
	EARV	,609	,285	,382	2,133	,050
	EF	-,055	,016	-,786	-3,388	,004
	MP	,001	,003	,068	,437	,668
	SD	-,008	,255	-,005	-,031	,976
	Sdur	,290	1,014	,058	,286	,779
	D	,482	2,135	,072	,226	,825
	A	,312	1,664	,039	,187	,854
	Adur	-,001	,002	-,101	-,427	,675

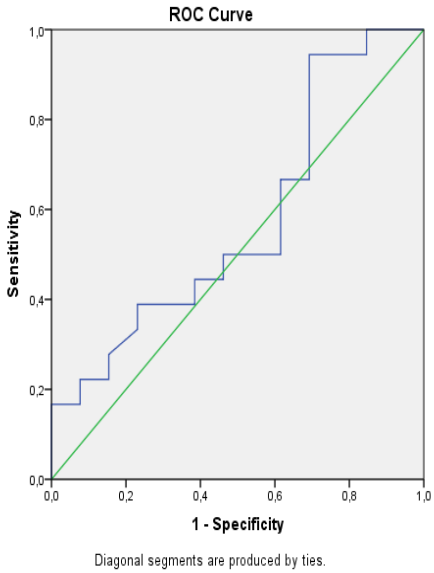

Figure 1 ROC curve of diastolic function

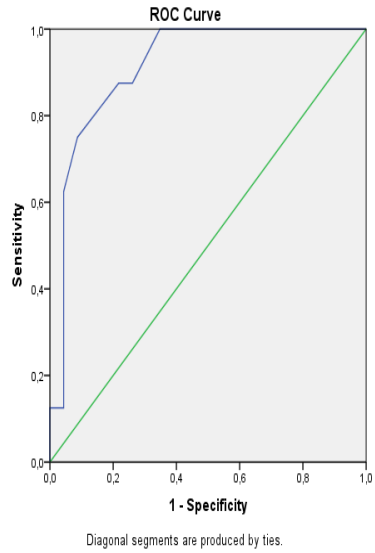

Figure 2 ROC curve of systolic function

This study showed the high value of RV systolic myocardial function in the diagnosis of acute RVMI in patients with inferior STEMI. In the case of RV, a fundamental role in generating stroke volume is played by the shortening of longitudinal fibres (Thygesen dan Alpert, 2007). Meluzin *et al* showed that a peak systolic velocity of tricuspid annulus correlates well with RVEF measured by MRI (Meluzin *et al*., 2001). Ueti *et al*. found a high correlation between RV systolic velocity and RVEF assessed by radionuclide ventriculography (Ueti *et al*., 2002). Right ventricular ischaemia or infarction can also lead to impairment of diastolic function. Decreased compliance and reduced filling of RV have been shown (Goldstein, 2002).

Standard echocardiography is the most widely available, semi-quantitative RV assessment modality, but is limited by the complex morphology of the RV and may be further challenged by poor acoustic windows (Kukla *et al*., 2006). This technical challenge could be overcome by using TDI with non-geometric indices of RV function. The reproducibility of measurements of RV myocardial velocities was high in this work, and this has also been found by other authors (Ueti *et al*., 2002). It was possible to keep high reproducibility in the acute phase of MI in suboptimal for echo examinations coronary care units settings (Meluzin *et al*., 2005). In this study, in every patient TDI measurements were possible, even if for technical reasons some standard echo measurements were not acceptable. Pulse wave TDI allowed simple, rapid, and quantitative measurements.

In our study, RV systolic, and diastolic function were found to be an independent predictor of early, in-hospital prognosis. This supports data showing that RV dysfunction is an independent prognostic parameter in patients with MI. The importance of RV function in the prognosis of various cardiopulmonary disorders is now well understood (Hsiao *et al*., 2010). Meluzin *et al* found that patients with symptomatic heart failure and systolic velocity of tricuspid annulus < 10.8 cm/s exhibited significantly worse event-free survival (Meluzin *et al*., 2003). In patients with inferior STEMI, RVMI leads to increased early mortality and morbidity (Kukla *et al*., 2006).

The major limitation of our study is the lack of a gold standard for the diagnosis of RVMI suitable for the early phase of hospitalisation in a coronary care units. We chose the ECG definition of RVMI, as recommended by ESC (Van de Werf *et al*., 2003), but this definition has its own limitations, mainly in terms of limited specificity and high dependence from a delay of examination from the onset of symptoms. This last problem was overcome by performing all diagnostic procedures within 24 hour. The known limitations of TDI: angle dependency, only long-axis function assessment and the consequence of tethering with other parts of the myocardium, are also applicable to our study.

CONCLUSION

RV systolic function predict ECG diagnosis of RVMI with relatively high sensitivity and specificity. RV diastolic function predict ECG diagnosis of RVMI with relatively low sensitivity but with high specificity

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