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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Prognostic value of septal E/(E'×S') ratio in predicting cardiac death in patients with heart failure

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Abstract

Background: A new tissue Doppler index, E/(E'×S'), including the early diastolic transmitral/mitral annular velocity (E/E') ratio and systolic mitral annular velocity (S'), has a good accuracy in predicting left ventricular filling pressure.

Aim: To investigate the value of E/(E'×S') measured at different sites of the mitral annulus to predict cardiac death in patients with heart failure (HF).

Methods: Echocardiography was performed in 342 consecutive hospitalised patients with HF, in sinus rhythm, at hospital discharge and after one month. Velocities were determined at septal and lateral mitral annular sites, and average values obtained. E/(E'×S') worsening was defined as a value greater than the value determined at discharge. The end point was cardiac death.

Results: During the follow-up period (35 ± 8.8 months), cardiac death occurred in 52 (15.2%) patients. Septal E/(E'×S') at hospital discharge presented the largest area under receiver operating characteristic (ROC) curve to predict cardiac death (0.85, 95% CI 0.79–0.90, $p < 0.001$). A statistical comparison of the ROC curves demonstrated no significant differences between septal and average E/(E'×S') ($p = 0.54$), but the accuracy of septal E/(E'×S') was better compared to the other analysed echocardiographic parameters [E/(E'×S'), E/E', S', etc., all $p < 0.05$]. The optimal septal E/(E'×S') cut-off was 3.03 (75% sensitivity, 83% specificity). Before discharge, 96 (28.1%) patients presented septal E/(E'×S') > 3.03. Cardiac death was significantly higher in patients with E/(E'×S') > 3.03 (39 deaths, 40.2% vs. 13 deaths, 5.3%, $p < 0.001$). Patients with septal E/(E'×S') > 3.03 at discharge and worsening after one month presented the worst prognosis in the overall population.

Conclusions: Septal E/(E'×S') is a powerful predictor of cardiac death in patients with HF.

Key words: tissue Doppler imaging, mitral annulus velocity, prognostic, heart failure, cardiac death

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INTRODUCTION

Despite great advances in the management of heart failure (HF) responsible for a significant improvement in patient survival, the mortality rate remains high [1]. The poor outcome associated with left ventricular (LV) dysfunction results in the need to obtain prognostic information as soon as possible. Echocardiography plays an important role in this context, and LV ejection fraction (LVEF) is the most frequently used parameter for risk stratification in these patients [2]. Some studies have demonstrated that tissue Doppler imaging (TDI) parameters were capable of adding prognostic information to predict cardiac death in major cardiac diseases, such as HF [3–7], acute coronary syndrome [8, 9], acute myocardial infarction [10], and hypertension [11].

The early diastolic transmitral velocity/early mitral annular diastolic velocity ratio (E/E') has been proposed as the best single Doppler predictor for evaluating LV filling pressure [12, 13] and as a good predictor of cardiac death [4, 5, 8, 10]. Recently, a new TDI index, E/(E'×S'), that associates a marker of diastolic function (E/E') and a parameter that explores LV systolic performance (systolic mitral annular velocity, S'), had been shown to be useful to assess the LV filling pressure in a heterogeneous population of cardiac patients, regardless of LVEF [14]. The site of the mitral an-

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nulus where pulsed TDI parameters should be recorded is a controversial issue [15]. We believe that a precise assessment of prognosis in patients with cardiac diseases must take into account parameters that explore global LV function. Therefore, we investigated the value of E/(E′×S′) ratio measured at different sites of the mitral annulus to predict cardiac death in patients with HF.

METHODS

Patients

We analysed prospectively 500 consecutive patients with HF, in sinus rhythm, hospitalised at our clinic between December 2006 and October 2007. Patients with inadequate echocardiographic images, cardiac pacemaker/defibrillator, significant primary valvular heart disease, acute coronary syndrome at inclusion, coronary revascularisation during follow-up, congenital heart disease, severe pulmonary disease, malignant neoplasia or renal failure, were excluded. The remaining 342 patients formed our study group. The study complied with the Declaration of Helsinki and was approved by the local research ethics committee.

Echocardiography

At hospital discharge and in a reasonably stable clinical condition, all patients underwent an echocardiographic examination with an ultrasonographic system (Vivid 7 General Electric, Milwaukee, WI, USA) equipped with multifrequency transducer. LVEF was calculated from apical two- and four-chamber views using a modified Simpson's rule. The severity of mitral regurgitation was assessed from the apical views using the proximal convergence method; the regurgitant orifice area (ROA) and the regurgitant volume were determined. Transmitral flow patterns were recorded from apical four-chamber windows with 4–5 mm pulsed-sample Doppler volume placed between mitral valve tips in diastole during five consecutive cardiac cycles. Maximal velocities of E and late transmitral flow (A) waves were measured during end-expiratory apnoea; the velocities were recorded for five consecutive cardiac cycles, and the results were averaged. The global myocardial index (GMI) was determined using Doppler time intervals measured from mitral inflow and LV outflow Doppler tracings as the sum of isovolumic contraction and relaxation time divided by the ejection time [16]. Pulsed Doppler signals were recorded at a horizontal sweep of 100 mm/s.

The TDI programme was set in pulsed-wave Doppler mode [17]. Motion of mitral annulus was recorded in the apical four-chamber view at a frame rate of 80 to 140 frames per second. A 4–5 mm sample volume was positioned sequentially at the lateral and septal corners of the mitral annulus. The peak early (E′) and late (A′) diastolic mitral annular velocities were determined. The peak mitral annular systolic velocity (S′) was defined as the maximum velocity during systole, excluding the isovolumic contraction. All velocities were recorded for five consecutive cardiac cycles during end-expiratory apnoea, and the results were averaged. All TDI signals were recorded at horizontal time sweep set at 100 mm/s. The average of the velocities from the septal and lateral site of the mitral annulus was calculated. E/E′ and E/(E′×S′) were determined. TDI measurements were repeated one month after hospital discharge (30 ± 3 days). Worsening of E/(E′×S′) was defined as a value greater than the previous value determined at discharge. All measurements were performed by an experienced echocardiographer.

The inter- and intra-observer variabilities for E/E′, S′ and E/(E′×S′) were examined. Measurements were performed in a group of 30 randomly selected subjects by one observer at two separate times and by two investigators who were unaware of the other's measurements and of the study time point.

Clinical outcome

Patients were followed for ≥ 24 months. Cardiac death was regarded as the study end point. The cause of death was determined from hospital documentation, information from attending physicians and death certificate. Cardiac death was defined as either a death directly related to cardiac disease, mainly congestive HF, or sudden death.

Statistical analysis

Data was expressed as mean ± standard deviation (SD) for continuous variables and as proportions for categorical variables. Continuous variables were compared between groups using unpaired *t* test (variables with normal distribution) or Mann-Whitney U test (non-normally distributed variables). Proportions were compared using χ^2 test and Fischer's exact test. Receiver operating characteristic (ROC) curves for predicting cardiac death were determined for different parameters and area under the ROC curves (AUC) were compared. Patients who died of non-cardiac causes were censored at the time of death. Event-free survival was estimated by the Kaplan-Meier method using a time to cardiac death approach. A p value < 0.05 was considered significant. Intra-observer variability and inter-observer variability for E/E′, S′ and E/(E′×S′) were measured by the intraclass correlation coefficient and by the coefficient of variation (CV) with the root-mean-square method. We used SPSS, version 18.0 (SPSS Inc., Chicago, IL, USA) as statistical software.

RESULTS

The current study included 342 consecutive patients (mean age 62 ± 12.7 years; 108 women), in sinus rhythm, hospitalised for HF between December 2006 and October 2007. The mean LVEF was 41.6 ± 14.4%. The aetiology of HF was coronary artery disease (233 patients), non-ischaemic cardiomyopathy (77 patients), and systemic hypertension

Table 1. Baseline characteristics of the study group

Characteristics	Survivors (n = 290)	Cardiac death (n = 52)	P
Clinical characteristics			
Age [years]	61.8 ± 12.7	64.1 ± 10.9	0.22
Female/male gender	90/200	18/34	0.61
Body mass index [kg/m^2]	25.3 ± 3.9	28.2 ± 5.8	0.44
Heart rate [bpm]	75 ± 16	78 ± 22	0.47
Mean arterial pressure [mm Hg]	97.2 ± 13.9	94.4 ± 15.8	0.51
Diabetes mellitus	123 (42.4%)	28 (53.8%)	0.13
Coronary artery disease	188 (64.8%)	32 (61.5%)	0.65
Non-ischaemic cardiomyopathy	74 (25.5%)	12 (23.1%)	0.72
Systemic hypertension	28 (9.7%)	8 (15.4%)	0.12
Previous myocardial infarction	143 (49.3%)	20 (38.4%)	0.15
Related to the LAD	55 (18.9%)	6 (11.5%)	0.19
Related to the LCCA	46 (15.9%)	6 (11.5%)	0.42
Related to the RCA	34 (11.7%)	5 (9.6%)	0.66
Related to the LAD + LCCA	5 (1.7%)	2 (3.8%)	0.32
Related to the LAD + RCA	3 (1.0%)	1 (1.9%)	0.58
NYHA class I/II/III/IV	18/141/118/13	3/27/16/6	0.16
NT-proBNP [pg/mL]	2,534 ± 3,026	6,253 ± 6,048	< 0.001
Therapy in admission			
Beta-blocker	254 (88.1%)	44 (84.6%)	0.55
ACEI/ARB	276 (95.8%)	47 (90.4%)	0.16
Diuretics	237 (81.7%)	50 (96.1%)	0.001
Digoxin	64 (22.2%)	20 (38.4%)	0.02
Nitrates	188 (64.9%)	36 (69.2%)	0.53
Echocardiographic indices			
LV end-diastolic volume index [mL/m^2]	83 ± 34	115 ± 36	0.004
LV end-systolic volume index [mL/m^2]	47 ± 26	76 ± 22	0.008
LVEF [%]	43 ± 14	34 ± 15	0.001
Left atrial volume [mL]	88 ± 41	118 ± 49	< 0.001
Indexed left atrial volume [mL/m^2]	45 ± 23	65 ± 28	< 0.001
Systolic pulmonary artery pressure [mm Hg]	39 ± 14	48 ± 18	0.001
Global myocardial index	0.59 ± 0.43	0.72 ± 0.45	0.07
Mitral regurgitant orifice area [mm^2]	26.9 ± 9.8	35.9 ± 7.9	0.03
Mitral regurgitant volume [mL]	37 ± 14	48 ± 21	0.02
E [cm/s]	79 ± 25	101 ± 33	< 0.001
E/A ratio	1.14 ± 0.75	1.66 ± 1.09	0.002
E-deceleration time [ms]	173 ± 75	160 ± 91	0.36
Average E' [cm/s]	7.4 ± 2.6	5.5 ± 1.7	< 0.001
Average S' [cm/s]	6.9 ± 2.7	5.1 ± 1.9	< 0.001
Average E/E' ratio	10.9 ± 4.06	18.7 ± 5.93	< 0.001
Average E/(E'×S') ratio	1.57 ± 1.02	3.67 ± 1.71	< 0.001

A — late transmitral flow velocity; ACEI — angiotensin converting enzyme inhibitor; ARB — angiotensin receptor blocker; E — early diastolic transmitral flow velocity; E' — early mitral annular diastolic velocity; EF — ejection fraction; LAD — left anterior descending coronary artery; LCCA — left circumflex coronary artery; LV — left ventricular; NT-proBNP — N-terminal pro-B type natriuretic peptide; NYHA — New York Heart Association; RCA — right coronary artery; S' — systolic velocity of mitral annulus

(32 patients). Mitral annular velocities from TDI were recordable at both sites in all 342 patients.

During the follow-up period (35 ± 8.8 months), cardiac death occurred in 52 (15.2%) patients. Compared to patients who did not develop cardiac death, patients who developed cardiac death had at hospital discharge significantly higher N-terminal pro-B-type natriuretic peptide levels and pulmonary artery systolic pressures, larger left atrial (LA) and LV, lower LVEF, E′ and S′ velocities, and higher values for regurgitant volume, ROA, E, E/A, E/E′ and E/(E′×S′). In addition, there was no difference with regard to the distribution of age, gender, aetiology of HF, heart rate, mean arterial pressure, body mass index, New York Heart Association class, medication (regarding beta-blocker, angiotensin converting enzyme inhibitor/angiotensin receptor antagonist and nitrates), E-deceleration time, and GMI. Characteristics of the patients study group at inclusion are presented in Table 1.

Figure 1 shows the ROC curves to predict cardiac death for the analysed echocardiographic parameters at discharge. The area under the ROC curve was maximal for septal E/(E′×S′) (AUC = 0.85, $p < 0.001$) followed by average E/(E′×S′) (AUC = 0.84, $p < 0.001$) and lateral E/(E′×S′) (AUC = 0.80, $p < 0.001$) (Table 2). A statistical comparison of the ROC curves demonstrated no significant differences between septal and average E/(E′×S′) ($p = 0.54$), but the accuracy of septal E/(E′×S′) was significantly different compared to lateral E/(E′×S′) ($p = 0.008$), septal S′ ($p = 0.03$) and average E/E′ ($p = 0.005$), respectively. The optimal septal E/(E′×S′) cut-off was 3.03 with a sensitivity of 75% and a specificity of 83%.

Patients were divided into two groups according to septal E/(E′×S′) at hospital discharge: group I consisted of patients with septal E/(E′×S′) ≤ 3.03 (246 patients, 71.9%), and group II of patients with septal E/(E′×S′) > 3.03 (96 patients, 28.1%). Cardiac death was significantly higher in group II than in group I (39 patients, 40.2% vs. 13 patients, 5.3%, $p < 0.001$). Kaplan-Meier analysis showed that the survival rate during follow-up was significantly higher in group I than in group II (log rank, $p < 0.001$) (Fig. 2A). To investigate the possible impact of LVEF, patients with LVEF ≥ 50% (113 patients, 33.04%) and with LVEF < 50% (229 patients, 66.96%) were analysed separately. In both groups, the survival rate was significantly higher in patients from group I than in group II, as shown by Kaplan-Meier plots (Fig. 2B, C).

One month after hospital discharge, we identified worsening of septal E/(E′×S′) ratio in 101 (29.5%) patients. Of these patients, 43 (12.6%) presented at hospital discharge a value of septal E/(E′×S′) greater than 3.03. The subgroup of patients with an initial septal E/(E′×S′) ratio > 3.03 and worsening after one month presented the worst prognosis in the overall population, and in those with reduced LVEF (all $p < 0.05$). In the small subgroup of patients with preserved LVEF, the worsening of septal E/(E′×S′) had not influenced the survival rate (Fig. 3).

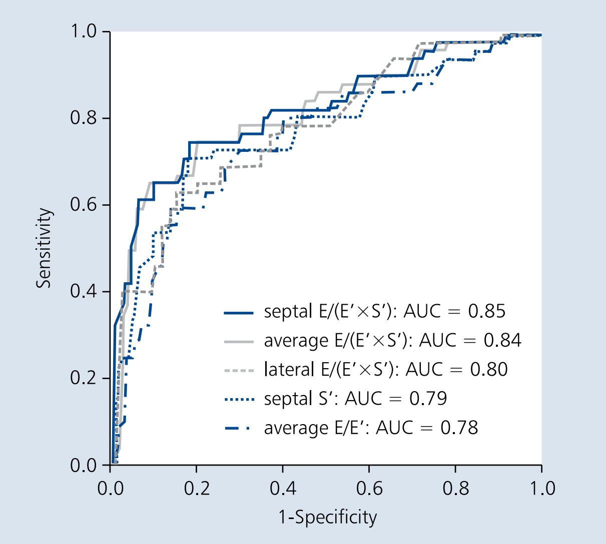


Figure 1. The receiver-operator characteristic (ROC) curves for septal, lateral and average E/(E′×S′) ratio, septal S′ and average E/E′ at hospital discharge to predict cardiac death; AUC — area under ROC curve; E — early diastolic transmitral velocity; E′ — early mitral annular diastolic velocity; S′ — systolic mitral annular velocity; 95% CI — 95% confidence interval

The intra-observer intraclass coefficients for septal E/E′, septal S′ and septal E/(E′×S′) were 0.94 (CV 2.7%), 0.92 (CV 3.2%), and 0.92 (CV 3%), respectively. The inter-observer intraclass coefficients for septal E/E′, septal S′ and septal E/(E′×S′) were 0.92 (CV 2.8%), 0.90 (CV 3.1%), and 0.89 (CV 3.3%), respectively.

DISCUSSION

Our study tested multiple sampling of the mitral annulus in patients with HF and highlighted the convenience of using septal E/(E′×S′) as a prognostic marker in this clinical setting.

HF is a challenging health issue affecting an increasing number of individuals in the overall population. Although major developments have been made in the management of HF, mortality remains high [1]. Thus, risk stratification in patients with HF is of tremendous importance. Numerous studies have shown the prognostic impact of conventional echocardiographic parameters (LVEF [18], LV volumes indices [18], LA size [19, 20], E/A [21], GMI [16], etc.) in patients with HF. In addition, in recent years, a handful of studies of the prognostic value of TDI parameters to predict cardiac death have been published [2, 5, 6, 8–11]. This new technique does not require tracing of endocardial contours, unlike LV volumes and LVEF [18]. Wang et al. [22] showed in a heterogeneous population of cardiac patients that both S′ and E′ velocities were predictors of cardiac mortality on univariate analysis but E′ velocity was marginally superior on multivariate analysis. Another study reported that S′ wave was a strong independent predictor of cardiac death in popula-

Table 2. Area (AUC) under the receiver operating characteristic curves for predicting cardiac death and 95% confidence intervals (CI) for the analysed echocardiographic parameters

Echocardiographic parameter	AUC	95% CI	P
LVEF	0.68	0.58–0.78	0.001
Indexed left atrial volume	0.71	0.63–0.79	< 0.001
Pulmonary artery systolic pressure	0.64	0.55–0.73	0.004
Mitral regurgitant orifice area	0.62	0.54–0.70	0.01
Mitral regurgitant volume	0.58	0.50–0.67	0.01
Global myocardial index	0.63	0.54–0.72	0.004
LVEF ≤ 40% combined with E/E' > 15	0.75	0.65–0.82	< 0.001
E wave	0.66	0.58–0.75	0.001
A wave	0.65	0.56–0.74	0.001
E/A ratio	0.69	0.60–0.78	< 0.001
A' wave:			
Medial	0.61	0.54–0.72	0.006
Lateral	0.59	0.53–0.70	0.008
Average	0.65	0.54–0.75	0.003
E' wave:			
Medial	0.68	0.60–0.77	< 0.001
Lateral	0.67	0.61–0.75	< 0.001
Average	0.69	0.62–0.76	< 0.001
S' wave:			
Medial	0.79	0.72–0.85	< 0.001
Lateral	0.74	0.64–0.81	< 0.001
Average	0.77	0.69–0.84	< 0.001
E/E' ratio:			
Medial	0.77	0.68–0.86	< 0.001
Lateral	0.75	0.66–0.85	< 0.001
Average	0.78	0.69–0.87	< 0.001
E/(E'×S') ratio:			
Medial	0.85	0.79–0.90	< 0.001
Lateral	0.80	0.73–0.87	< 0.001
Average	0.84	0.77–0.91	< 0.001

A — peak late diastolic transmitral flow velocity; A' — peak late mitral annular diastolic velocity; E — peak early diastolic transmitral flow velocity; E' — peak early mitral annular diastolic velocity; LVEF — left ventricular ejection fraction; S' — peak systolic velocity of mitral annulus.

tions with systolic HF [18]. The E/E' ratio has been proposed as the best single Doppler predictor for evaluating LV filling pressure [12, 13] and a good predictor of cardiac death [4, 5, 8, 10, 20]. More recently, Hirata et al. [4] showed that a combined index including LVEF ≤ 40% and E/E' > 15 allowed the identification of patients at higher risk of cardiac outcome in patients with HF.

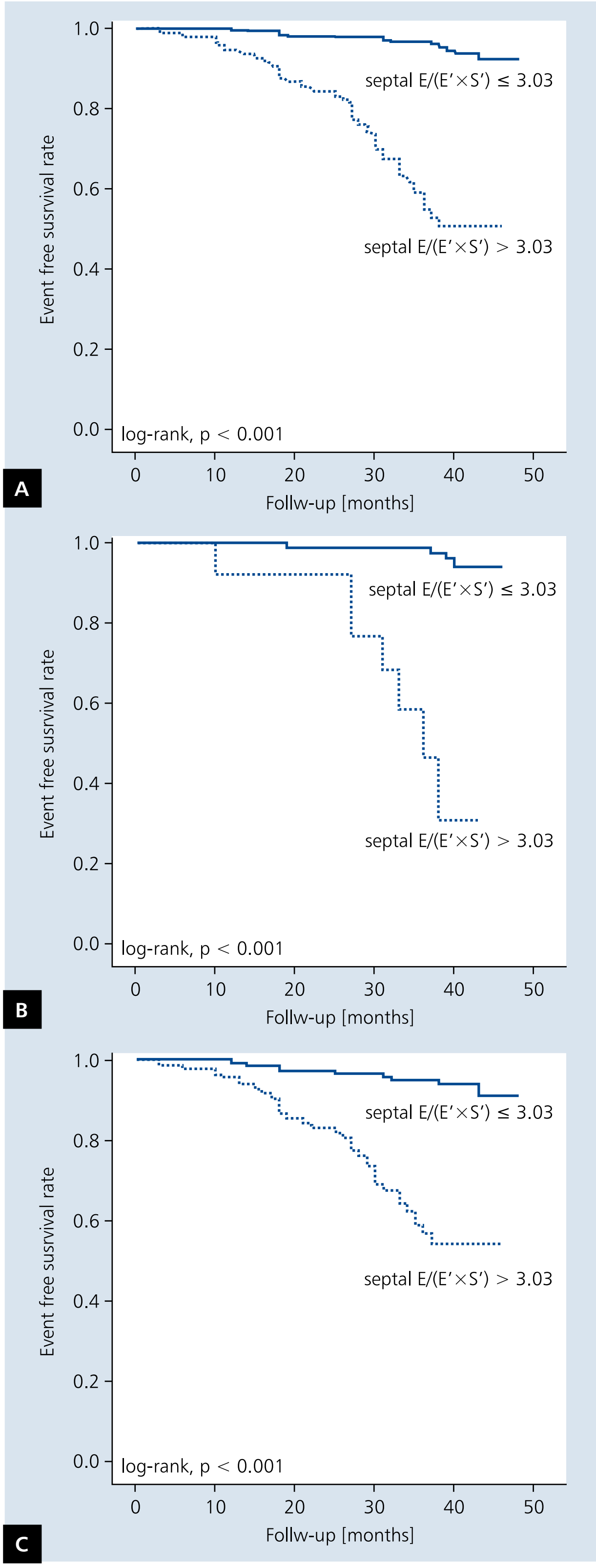
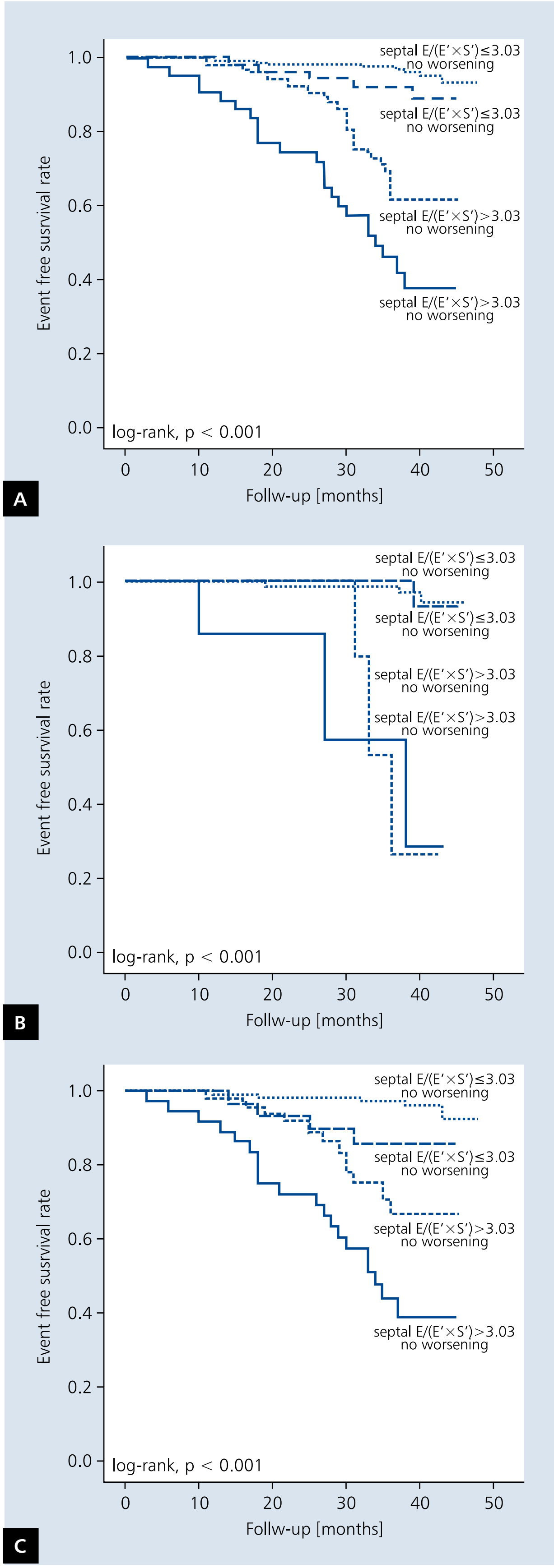


Figure 2. Kaplan-Meier survival curves in the overall population (n = 342) with heart failure (**A**), in those with preserved left ventricular ejection fraction (LVEF) ≥ 50% (n = 113, 33.04%) (**B**), and in those with reduced LVEF < 50% (n = 229, 66.96%) (**C**), according to septal E/(E'×S') ratio at hospital discharge below and above 3.03; abbreviations as in Table 2



Recently, we proposed a new TDI index including peak systolic velocity of mitral annulus (S′) and E/E′ ratio, E/(E′×S′), for the non-invasive assessment of patients with LV dysfunction, regardless of LVEF [14]. The site of the mitral annulus where pulsed tissue Doppler should be recorded is a controversial issue [15]. The lateral location of the TDI sample volume corresponds to the longitudinal motion of the sole LV, and is not influenced by right ventricular function [23]. Some cardiologists prefer sampling of the septal annulus because this site moves parallel to the ultrasound beam and is less influenced by the translation movement of the heart [24]. The present study has shown, for the first time, that septal E/(E′×S′) is a strong independent echocardiographic predictor of cardiovascular death in patients with HF. The survival rate was significantly higher in patients with septal E/(E′×S′) ≤ 3.03 at discharge than in the group with septal E/(E′×S′) > 3.03, regardless of LVEF. Because of the time-dependent changes in S′ and E/E′ [8], we tried to determine whether our new index obtained at the first TDI examination after hospital discharge is capable of providing complementary prognostic data. TDI measurements were repeated one month after hospital discharge at the patient's first visit requested by the outpatient clinical programme of HF control. Patients with an initial septal E/(E′×S′) > 3.03 and its worsening after one month presented the worst prognosis in those with reduced LVEF, but not in the small group with preserved LVEF.

Figure 3. Kaplan-Meier survival curves of patients classified according to the initial septal E/(E′×S′) value and to septal E/(E′×S′) worsening one month after hospital discharge; **A**. The overall population (342 patients): percentage of survival was 95.7% in patients with initial septal E/(E′×S′) ≤ 3.03 no worsening, 91.4% in patients with septal E/(E′×S′) ≤ 3.03 and worsening after one month, 71.7% in patients with septal E/(E′×S′) > 3.03 and no worsening, and 44.2% in those with initial septal E/(E′×S′) > 3.03 and worsening at one month, respectively; **B**. Patients with left ventricular ejection fraction (LVEF) ≥ 50% (113 patients, 33.04%): percentage of survival was 95.9% in patients with initial septal E/(E′×S′) ≤ 3.03 and no worsening, 96.3% in patients with septal E/(E′×S′) ≤ 3.03 and worsening after one month, 50% in patients with septal E/(E′×S′) > 3.03 and no worsening, and 42.9% in those with initial septal E/(E′×S′) > 3.03 and worsening at one month, respectively; **C**. Patients with LVEF < 50% (229 patients, 66.96%): percentage of survival was 95.7% in patients with initial septal E/(E′×S′) ≤ 3.03 and no worsening, 87.1% in patients with septal E/(E′×S′) ≤ 3.03 and worsening after one month, 74.5% in patients with septal E/(E′×S′) > 3.03 and no worsening, and 44.4% in those with initial septal E/(E′×S′) > 3.03 and worsening at one month, respectively; E — early diastolic transmitral velocity; E′ — early mitral annular diastolic velocity; S′ — systolic mitral annular velocity

In our group of patients hospitalised for HF, 220 (64.3%) presented coronary artery disease. One possible explanation for the ability of septal E/(E′×S′) ratio to predict future cardiac deaths is that we are detecting occult myocardial ischaemia. When coronary disease causes regional hibernation of the myocardium, the E′ and S′ velocities drop. The velocities of septal annulus can be deteriorated more than in other annular sites in the presence of one-vessel or multi-vessel disease involving the left anterior descending and/or right coronary artery [15]. Those who went on to have coronary events may, therefore, have had a higher E/(E′×S′) ratio due to regional changes in myocardium, caused by subclinical coronary disease. In addition, velocity of septal annulus is conditioned by ventricular interaction, which can even be amplified under pathologic conditions involving the right ventricle.

The final mechanism of different cardiac diseases is probably the same one, i.e. ischaemia of LV subendocardial fibres, as suggested by Wang et al. [22]. TDI velocities derived from the mitral annulus primarily reflect longitudinal motion, due to the longitudinally directed fibres, which are found in the subendocardium. This may explain why E/(E′×S′) ratio is so useful for the assessment of the consequences of ischaemia, to which the subendocardium is particularly sensitive. The superiority of septal E/(E′×S′) ratio over the combined index LVEF ≤ 40% and E/E′ > 15 in our study can be attributed to the capacity of reduced S′ velocity to identify subclinical LV dysfunction. Analysing patients with preserved LVEF, Vinereanu et al. [25] have demonstrated that worsening of global LV diastolic dysfunction is associated with a progressive decline in longitudinal systolic function (S′). Our new TDI parameter associates an index of diastolic function (E/E′) and a marker that explores LV systolic performance (S′) and therefore may provide supplementary prognostic information compared to each index alone. The reproducibility and simplicity, together with the prognostic value of our new index, made it important to use in the routine procedure. TDI recordings should be given high priority in routine echocardiographic examinations of patients with HF.

Limitations of the study

Our results should be considered in the context of several limitations. We deliberately did not use more sophisticated Doppler parameters that are difficult to record in daily practice: the time difference between the duration of the atrial reversal in the pulmonary vein (Ar) and mitral A-wave duration (Ar–A), colour M-mode mitral flow propagation velocity (Vp), E/Vp, the time difference between the onset of E and onset of E′ ($T_{E–E′}$), or the ratio between the isovolumic relaxation time and $T_{E–E′}$.

We have limited TDI measurements at two sites (medial and lateral mitral annulus) and we did not examine anterior and posterior velocities that might have provided additional information. The study centre functioned as a tertiary invasive centre and therefore the study population may not reflect a general population of patients with HF. Our study is a single-centre study and its reproduction in other centres or by multicentre studies would argue for its validity.

CONCLUSIONS

Our findings indicate that in patients with HF, in sinus rhythm, septal E/(E′×S′) ratio is an important independent long-term prognostic index of cardiac death.

An E/(E′×S′) value > 3.03 at hospital discharge can identify patients at high risk of cardiovascular death. In patients with reduced LVEF, worsening of an initial septal E/(E′×S′) > 3.03 after one month from hospital discharge identified the group with the worst prognosis.

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Conflict of interest: *none declared*

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Wartość prognostyczna przegrodowego wskaźnika E/(E'×S') w ocenie ryzyka zgonu sercowego u chorych z niewydolnością serca

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Streszczenie

Wstęp: Nowy wskaźnik E/(E'×S') stosowany w echokardiografii doplerowskiej, uwzględniający stosunek prędkości maksymalnej wczesnego napływu mitralnego do wczesnorozkurczowej prędkości pierścienia zastawki mitralnej (wskaźnik E/E') oraz prędkość ruchu pierścienia zastawki mitralnej w skurczu (S'), charakteryzuje się dużą dokładnością w prognozowaniu ciśnienia napełniania lewej komory.

Cel: Celem badania była ocena wartości wskaźnika E/(E'×S') mierzonego w różnych punktach pierścienia zastawki mitralnej w prognozowaniu ryzyka zgonu sercowego u pacjentów z niewydolnością serca (HF).

Metody: U 342 kolejnych chorych hospitalizowanych z powodu HF z rytmem zatokowym przeprowadzono badanie echokardiograficzne w momencie wypisania ze szpitala i miesiąc później. Zmierzono prędkości części przegrodowej i bocznej pierścienia zastawki mitralnej oraz obliczono wartości średnie. Pogorszenie w zakresie E/(E'×S') definiowano jako wartość większą niż uzyskana przy wypisie. Punktem końcowym był zgon sercowy.

Wyniki: W trakcie obserwacji (35 ± 8,8 miesiąca) odnotowano 52 przypadki zgonu sercowego (15,2% chorych). Przegrodowy wskaźnik E/(E'×S') przy wypisie ze szpitala okazał się najsilniejszym czynnikiem predykcyjnym zgonu sercowego, na co wskazuje największe pole pod krzywą ROC (*receiver operating characteristic*) (0,85; 95% CI 0,79–0,90; p < 0,001). Analiza statystyczna krzywych ROC nie wykazała istotnych różnic między przegrodowym i średnim wskaźnikiem E/(E'×S') (p = 0,54), jednak przegrodowy wskaźnik E/(E'×S') cechował się większą dokładnością niż pozostałe analizowane parametry echokardiograficzne [E/(E'×S'), E/E', S', itp., wszystkie p < 0,05]. Optymalna wartość progowa przegrodowego wskaźnika E/(E'×S') wynosiła 3,03 (czułość 75%, swoistość 83%). U 96 (28,1%) chorych wartość wskaźnika E/(E'×S') przed wypisaniem ze szpitala wynosiła > 3,03. Odsetek zgonów sercowych był istotnie wyższy u pacjentów, u których wskaźnik E/(E'×S') był większy niż 3,03 (39 zgonów, 40,2% *vs*. 13 zgonów; 5,3%; p < 0,001). Najgorsza prognoza spośród całej badanej populacji dotyczyła chorych, u których przegrodowy wskaźnik E/(E'×S') był większy niż 3,03 przy wypisie, a po miesiącu nastąpiło jego pogorszenie.

Wnioski: Przegrodowy wskaźnik E/(E'×S') jest silnym czynnikiem predykcyjnym zgonu sercowego u chorych z HF.

Słowa kluczowe: dopler tkankowy, prędkość pierścienia zastawki mitralnej, prognozowanie, niewydolność serca, śmierć sercowa

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