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CLINICAL STUDY

Screening diagnosis of dementia in patients following heart failure decompensation is associated with a higher relative wall thickness

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ABSTRACT

BACKGROUND: The usefulness of echocardiographic characteristics for dementia prediction in patients with heart failure decompensation (HFD) is not determined. Therefore, we sought to investigate the echocardiographic features of patients with HFD and screening diagnosis of dementia (SDD).

METHODS: 139 patients aged over 65 years were hospitalized with the diagnosis of HFD. Clinical characteristics and echocardiographic characteristics were recorded during hospitalization. SDD was defined based on the result of ALFI– MMSE of < 17 points.

RESULTS: Patients with SDD were older (p = 0.013), had thicker IVSd (p = 0.021), thicker PWd (p = 0.005) and had a higher RWT (0.40 vs 0.35, p = 0.004) than patients without SDD, without differences in LVMI (p = 0.13). There was no correlation between RWT and LVMI (r = −0.01, p = 0.88). In the multivariate analysis, an older age (β = −0.116, 95% CI −0.224 – −0.008, p = 0.035, per year) and a higher RWT (β = −0.069, 95% CI −0.137 – −0.002, p = 0.045, per 0.01) influenced a lower ALFI-MMSE. For a prediction of SDD, the RWT reached the area under a ROC curve of 0.67 (95% CI 0.56–0.77, p = 0.004 with sensitivity of 60% and specificity of 70% for RWT of ≥ 0.375).

CONCLUSIONS: Apart from age, RWT reflecting left ventricular geometry changes but not hypertrophy was independently but moderately associated with SDD in patients following HFD *(Tab. 4, Fig. 1, Ref. 35)*. Text in PDF *www.elis.sk*

KEY WORDS: dementia, heart failure, decompensation, echocardiography, relative wall thickness.

Introduction

Chronic heart failure (HF) is one of the most serious medical problems in a contemporary society. Its prevalence ranges from 1 to 2 % of overall population in the United States and Europe, reaches around 64 million people within over 1.2 million patients in Poland (1, 2). Moreover, the risk of HF development is growing during aging and equals 28.5 % for women and 33 % for men over 55 years (3). Due to the population aging, in the next few years HF will become the 21st century epidemy basing on the prognoses which showed that the amount of patients affected by the HF increases by 25 % (4). In this context the knowledge about comorbidity and complications of HF is very important to provide effective and complex treatment that allow to improve long-term outcomes and patients' quality of life out of hospital care (5).

The relationship between HF and dementia is currently intensively investigated. Recent systematic review and meta-analysis showed that HF increases the risk of dementia and cognitive impairment by 60 % (6) with the risk ratio of dementia in the HF population equal to 1.28 (95% confidence interval (CI) 1.15 to 1.43, $I^2 = 70.0$ %, $p < 0.001$) as compared with the non-HF group (7). Our recent findings indicate that the screening diagnosis of dementia (SDD) in patients following HF decompensation was associated with the higher prevalence of re-hospitalization (hazard ratio (HR) 2.22, 95% CI 1.23–4.01, p = 0.007) (8).

The pathophysiology and etiology of dementia in patients following HF decompensation is still not fully elucidated. Our previous findings have shown that the lower result of the questionnaire score was correlated with a history of stroke or transient ischemic

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attack (β=−0.29, p <0.001), peripheral arterial disease (β=−0.20, p=0.011) and lower glomerular filtration rate (β=0.24, p=0.009) (8) but there was no difference in terms of left ventricular (LV) ejection fraction between patients with and without a screening diagnosis of dementia. On the other hand, it was shown that reduced cerebral blood flow was associated with deteriorated LV ejection fraction (9, 10) stimulates neurons degeneration in older adults (11). Moreover, it was found that HF patients experienced cognitive improvement after heart transplantation potentially due to cardiac function normalization (12).

The hypothesis about the link between cardiac function and/or its remodeling and dementia diagnosis in patients following HF exacerbation has not yet been undoubtedly proven. Considering inconclusive findings of the previous studies, we sought to investigate the echocardiographic features of patients following HF decompensation with subsequent SDD.

Methods

Study population

Of 687 patients hospitalized in years 2008–2017 in reference cardiology with the diagnosis of HF decompensation, 139 patients who had performed well in terms of quality echocardiographic measurements during index hospitalization, agreed to contribute into the current study. All enrolled patients participated in a telephone-based interview and provided complete answers to questionnaires including cognitive function assessments. Patients were not eligible for inclusion if they refused any psychiatric evaluation, if they had a history of deafness, complaints of hearing impairments or an inability for unrestricted communication by the phone or if the quality of echocardiographic assessment during hospitalization was low. Most of the patients who agreed to participate were unwilling to be evaluated in-person by a psychiatrist. The study protocol was in compliance to the Declaration of Helsinki and was approved by the local Ethics Committee (Consent No. 1072.6120.271.2018).

Baseline characteristics

Patients' age, gender, anthropometric measurements, comorbidities, history of cardiovascular events, previous revascularization, as well as New York Heart Association (NYHA) class were documented during index hospitalization.

The prior stroke and transient ischemic attack (TIA) were diagnosed in accordance with American Heart Association and American Stroke Association guidelines (13, 14). A clinical suspicion of peripheral artery disease (PAD) was stated with the ankle-brachial index – the proportion of the blood pressure at the dorsal artery of foot, to the blood pressure at the brachial artery. The result of ankle-brachial index calculation, lower than 0.9 was noted as abnormal (15). In that case, the Doppler and an ultrasound examination of the lower limb vessels was performed to confirm the diagnosis. Glomerular filtration rate (GFR) was calculated according to the Cockcroft-Gault formula. Renal failure was diagnosed when creatinine clearance was lower than 60 ml/min.

Echocardiographic assessment

The two-dimensional transthoracic echocardiography was performed at rest in a left decubitus position in accordance with the American Society of Echocardiography and European Association of Echocardiography recommendations (16) by a trained physician between the second and fourth day of hospitalization using a Vivid S5 ultrasound (GE, Solingen, Germany) equipped with multi-frequency harmonic transducer 3Sc-RS (1.3–4.0 MHz). The size of the heart cavities and their function, as well as heart valves function have been assessed (17). A relative wall thickness (RWT) in this study was expressed as a ratio of doubled posterior wall diameter and LV end-diastolic diameter.

Tab. 1. Baseline characteristics.

	Patients with SDD n = 42	Patients without SDD n = 97	p
Age, years	76.5 (69.0–81.0)	70.0 (66.0–77.0)	0.013
Male gender, %	25 (59.5)	66 (68.0)	0.33
Body mass index, kg/m^2	28.8 (25.8–30.8)	29.5 (26.5–33.7)	0.54
Body surface area, m^2	2.0 (1.7–2.1)	1.9 (1.8–2.1)	0.80
NYHA class on admission III/IV	30 (71.4)	61 (62.9)	0.33
The type of HF			
HFrEF, %	24 (57.1)	64 (66.0)	
HFmrEF, %	6 (14.3)	12 (12.4)	0.60
HFpEF, %	12 (28.6)	21 (21.7)	
Systolic blood pressure, mmHg	135 (123–148)	128 (113–155)	0.59
Diastolic blood pressure, mmHg	77 (65–87)	79 (70–89)	0.20
Cardiovascular risk factors:			
renal failure, %	24 (57.1)	33 (34.0)	0.018
diabetes mellitus, %	18 (42.9)	37 (37.1)	0.74
hyperlipidemia, %	36 (85.7)	70 (72.2)	0.06
hypertension, %	38 (90.5)	88 (90.7)	0.96
peripheral arterial disease, %	10 (23.8)	12 (12.4)	0.14
smoking, %	19 (45.2)	34 (35.1)	0.34
Previous history of:			
atrial fibrillation, %	28 (66.7)	46 (47.4)	0.057
myocardial infarction, %	15 (35.7)	37 (38.1)	0.94
percutaneous coronary intervention, %	15 (35.7)	24 (24.7)	0.26
coronary artery bypass surgery, %	6 (14.3)	14 (14.4)	0.81
stroke, %	4 (9.5)	7 (7.2)	0.44
cancer, %	6 (14.3)	10 (10.3)	0.34
chronic obstructive pulmonary disease, %	4 (9.5)	13 (13.4)	0.37
The length of hospitalization, days	7 (3–11)	5 (3–9)	0.25
Follow–up, months	41 (33–77)	41 (32–60)	0.43

Data are shown as number (percentage) or median (interquartile range), HFrEF – heart failure with reduced ejection fraction, HFmrEF – heart failure with mid-range ejection fraction, HFpEF – heart failure with preserved ejection fraction, NYHA – New York Heart Association, SDD – screening diagnosis of dementia.

Screening psychiatric evaluation

Patients participated in a two-step telephone follow-up. During the first phone call, the patient was asked for permission to contribute to the study and the second appointment was made. To avoid the influence of confounding factors, the second discussion was conducted in a domestic environment.

The cognitive function was assessed with the Adult Lifestyles and Function Interview telephone version of the Mini-Mental State Examination (ALFI-MMSE) (8, 18). The translation into Polish followed by translation back into English was performed prior to the psychological and psychiatric consultations. A score of less than 17 points out of 22 was considered as a positive screening diagnosis of dementia (SDD) according to the instruction of the original version of the scale.

Statistical analysis

Statistical analysis was performed with Statistica 13.1 software (StatSoft, Tulsa, Oklahoma, USA). Continuous variables were expressed as a median (interquartile range), whereas categorical variables as a number (percentage). Continuous variables were first checked for normal distribution by the Shapiro-Wilk test and were then compared by Student's t-test or U Mann-Whitney test if distribution was normal or different than normal, respectively. Categorical variables were analyzed through chi-square test or a Fisher exact test. All independent variables with their potential for confounding both the exposure and the outcome and a lack of significant correlation with other variables were included in the multivariate model in order to find independent determinants of the results of ALFI-MMSE score. Receiver operating characteristic (ROC) curves and the Youden index were used to determine the optimal cut-off value of posterior wall diameter and interventricular septum, and their sensitivity and specificity in prediction of screening diagnosis of dementia. A two-sided P-value of less than 0.05 was considered statistically significant.

Results

Based on the result of the ALFI-MMSE questionnaire, 42 patients (30.2 %) fulfilled the criteria of the SDD while 97 (69.7 %) participants were allocated to the group without SDD. The median overall result of the ALFI-MMSE score performed within 41 (interquartile range 32–65) months following index hospitalization in both groups was 14.0 (11.0–16.0) and 20.0 (19.0–21.0), respectively ($p < 0.001$).

Baseline characteristics

The baseline characteristics are shown in Table 1. Patients with SDD were older than those without SDD ($p=0.013$). There were no differences in terms of gender, body mass index, and body surface area. There were also no differences in a median value of recorded systolic and diastolic blood pressure, the severity of heart failure symptoms expressed in NYHA class, and the duration of hospitalization.

The prevalence of cardiovascular risk factors such as diabetes mellitus, hyperlipidemia, hypertension, peripheral arterial disease and smoking was comparable. GFR was significantly lower in the SDD group ($p=0.021$) than in subjects without SDD; therefore, renal failure was more often diagnosed in patients with SDD (57.1 vs 34.0 %, $p=0.018$) as compared to survivors without SDD. The median ALFI-MMMS score was also similar in patients with and without prior strokes (18 (9–20) vs 19 (16–21) points, $p=0.32$).

The analysis of laboratory tests revealed a similar distribution of myocardial necrosis markers, biochemical markers of severity of HF, and other cardiovascular risk factors in both compared groups. Patients with SDD, however, had lower hemoglobin levels ($p=0.041$) and hematocrit levels ($p=0.034$) as compared to subjects without SDD (Tab. 2).

Tab. 2. Laboratory results.

	Patients with SDD n = 42	Patients without SDD n = 97	p
NT-proBNP, pg/ml	1682.5 (2593.0–23466.9)	2030.0 (898.0–4550.0)	0.77
White blood cell count, $x10^9$/l	7.3 (5.7–8.8)	7.0 (12.4–14.6)	0.55
Hemoglobin, g/dl	12.9 (11.8–14.3)	13.6 (12.4–14.6)	0.041
Hematocrit, %	38.1 (35.8–42.8)	40.8 (28.3–43.8)	0.034
Platelets, 10^3/µl	200.0 (174.0–231.0)	205.0 (161.0–242.0)	0.71
High sensitivity troponin T, ng/ml	0.021 (0.02–0.06)	0.023 (0.02–0.04)	0.7
Alanine transaminase, U/l	23.5 (20.0–30.0)	22.0 (16.0–31.0)	0.22
Aspartate transaminase, U/l	26.0 (21.5–32.0)	22.0 (19.0–30.0)	0.09
Glucose, mmol/l	6.1 (5.1–7.3)	6.1 (5.4–7.1)	0.71
Sodium, mmol/l	141.0 (139.0–143.0)	141.0 (138.0–143.0)	0.89
Potassium, mmol/l	4.4 (4.1–4.7)	4.4 (4.1–4.8)	0.57
Creatinine, umol/L	1.18 (1.00–1.46)	1.07 (0.92–1.28)	0.08
Glomerular filtration rate, ml/min	48.1 (35.5–64.3)	59.9 (45.6–75.7)	0.021
D-dimer, ng/ml	622.0 (281.5–1293.0)	544.0 (347.0–1106.0)	0.84
Total cholesterol, mmol/l	3.9 (3.0–4.2)	3.8 (3.0–4.5)	0.96
Low-density lipoprotein, mmol/l	2.2 (1.7–2.8)	2.2 (1.7–2.8)	0.97
High-density lipoprotein, mmol/l	1.1 (0.9–1.3)	1.2 (0.9–1.5)	0.07
Triglycerides, mmol/l	1.2 (0.9–1.8)	1.1 (0.8–1.5)	0.20

Data are shown as median (interquartile range), NT-proBNP – N-terminal prohormone of brain natriuretic peptide, SDD – screening diagnosis of dementia.

The echocardiographic characteristics of SDD patients

The results of echocardiographic assessment have been shown in Table 3. Patients with SDD were characterized by higher end-diastolic interventricular septal diameter ($p=0.021$) and end-diastolic posterior wall diameter ($p=0.005$) without significant differences in both end-diastolic ($p=0.19$) and end-systolic ($p=0.19$) left ventricular diameters. Patients with screening diagnosis of cognitive impairment also had a higher RWT ($p=0.004$) and higher aortic valve peak gradient ($p=0.013$) than patients without SDD but LV mass index was not significantly different in both groups ($p=0.13$). There were no significant differences in terms of LV systolic and diastolic function, atrial sizes, right ventricular size and function as well as the function of mitral, tricuspid and pulmonary valves (Tab. 3).

Tab. 3. The echocardiographic characteristics of the studied patients.

	Patients with SDD n = 42	Patients without SDD n = 97	p
Aortic valve peak gradient, mmHg	9.0 (6.3–22.0)	7.0 (5.0–9.8)	0.013
Aortic valve separation, mm	18.0 (16.0–19.0)	18.0 (16.5–20.0)	0.32
Aortic annulus, mm	25.0 (23.0–27.0)	24.0 (22.0–26.0)	0.33
Ascending aorta, mm	36.0 (34.0–40.0)	36.5 (33.0–40.0)	0.88
LV mass, g	238.3 (206.9–309.7)	233.1 (177.0–304.3)	0.39
LV mass index, g/m^2	131.3 (111.9–153.9)	114.5 (95.7–148.4)	0.13
Interventricular septal diastolic diameter, mm	12.0 (10.0–13.0)	11.0 (9.0–12.0)	0.021
Posterior wall diastolic diameter, mm	11.0 (9.5–12.0)	10.0 (9.0–11.0)	0.005
LV end-diastolic diameter, mm	54.0 (51.0–61.0)	57.0 (50.0–63.0)	0.19
LV end-systolic diameter, mm	38.0 (33.0–47.0)	42.0 (32.0–54.0)	0.19
Relative wall thickness	0.40 (0.35–0.47)	0.35 (0.30–0.43)	0.004
LV ejection fraction, %	40.0 (25.0–50.0)	37.0 (25.0–47.0)	0.35
E/A	0.9 (0.6–1.2)	0.7 (0.5–1.2)	0.35
Mitral valve mean gradient, mmHg	1.0 (0.9–1.8)	1,0 (1.0–1.6)	0.97
Mitral valve vena contracta, mm	4.5 (3.0–5.0)	4.0 (3.0–5.0)	0.49
Deceleration time, ms	255.0 (208.0–300.0)	214.0 (176.5–250.0)	0.10
Acceleration time, ms	90.0 (73.0–100.0)	92.5 (80.0–111.5)	0.30
Pulmonary valve maximal velocity, m/s	0.7 (0.5–0.9)	0.8 (0.6–0.9)	0.61
Pulmonary trunk, mm	24.0 (21.0–26.0)	23.0 (21.0–26.0)	0.43
Right ventricular diastolic diameter, mm	32.0 (29.0–37.0)	33.0 (30.0–37.0)	0.34
Right ventricular systolic pressure, mmHg	40.5 (34.0–47.0)	39.0 (30.0–48.0)	0.44
Tricuspid annular plane systolic excursion, mm	19.0 (15.0–21.0)	18.0 (15.0–21.0)	0.62
Tricuspid valve vena contracta, mm	5.0 (4.0–6.0)	5.5 (4.0–7.0)	0.32
Left atrial diameter, mm	48.0 (44.0–52.0)	47.0 (43.0–53.0)	0.67
Left atrial area, cm^2	29.0 (25.0–34.0)	28.0 (24.1–33.0)	0.24
Right atrial area, cm^2	26.0 (20.0–30.5)	23.0 (20.0–28.5)	0.55
Inferior vena cava, mm	18.5 (14.0–22.0)	18.5 (16.0–23.0)	0.69

Data are shown as median (interquartile range), SDD – screening diagnosis of dementia, LV – left ventricular.

LV mass index was correlated with the thickness of interventricular septum (r=0.54, p <0.001), the thickness of LV posterior wall (r=0.48, p <0.001), LV end-diastolic diameter (r=0.59, p <0.001) and with LV end-systolic diameter (r=0.50, p <0.001) but not with RWT (r=−0.01, p=0.88). RWT was correlated with LV ejection fraction (r=0.53, p <0.001). In patients with RWT <0.24, 0.24–0.44 and >0.44, 1 (10 %), 28 (28.3 %) and 12 (38.7 %) patients had SDD, respectively (p=0.22).

The determinants of screening diagnosis of dementia

Before inclusion to the multivariate model with the ALFI-MMSE score as a dependent variable, all significant correlations have been identified. Hemoglobin level was inversely correlated with age (r=−0.29, p=0.001) and creatinine level (r=−0.33, p <0.001). Patient's age was inversely correlated with LV mass (r=−0.20, p=0.03), LV diastolic diameter (r=−0.35, p <0.001), LV systolic diameter (r=−0.36, p <0.001) and positively correlated with LV ejection fraction (r=0.34, p <0.001). Additionally, the thickness of interventricular septum and the thickness of the posterior wall correlated each other (r=0.59, P <0.001). In the multivariate analysis, an older age (β=−0.116, 95% confidence interval (CI) −0.224 – −0.008, p=0.035, per 1 year) and a higher RWT (β=−0.069, 95% CI −0.137 – −0.002, p=0.045, per 0.01) independently influenced the lower value of the overall ALFI-MMSE score.

Posterior wall diameter reached the area under the ROC curve of 0.66 (95% CI 0.55–0.77, p=0.005) for prediction of SDD with cut-off value of ≥10.5 mm and sensitivity of 61% and specificity of 68 % (Fig. 1). Interventricular septum reached the area under the ROC curve of 0.63 (95% CI 0.53–0.73, p=0.021) for prediction of SDD with cut-off value of ≥11.5 mm and sensitivity of 57 % and specificity of 65 %. For prediction of SDD, the RWT reached the area under the ROC curve of 0.67 (95% CI 0.56–0.77, p=0.004) with sensitivity of 60 % and specificity of 70% for RWT of ≥0.375.

Discussion

The current study is the first report demonstrating that detailed echocardiographic assessment of patients after acute HF decompensation might be useful in prediction of subsequent screening diagnosis of dementia. Our findings indicate that, apart from age, a higher relative wall thickness was independently but moderately associated with SDD. As the coincidence of HF and dementia is undeniable, further research of indicators of this relationship is of clinical importance. Detection of subclinical cardiac functional and/or morphologic abnormalities with an easy available transthoracic echocardiography, can improve screening identification of acutely decompensated HF patients at high risk of dementia in the future.

The usefulness of echocardiographic parameters has already been widely examined in patients with symptoms of chronic HF (19). Left atrium enlargement, systolic and/or diastolic left ventricular dysfunction and increased LV mass have been associated with cardiogenic dementia. Previous studies have also emphasized that LV systolic dysfunction expressed as reduced LV ejection fraction promotes development of dementia in chronic HF patients (9, 10). Patients with a grade of III or IV according to the NYHA scale were characterized by a 31 % reduction of cerebral blood flow in

Tab. 4. The independent predictors of the ALFI-MMSE score.

Independent variables	Univariate model				Multivariate model			
	β	95% CI for β		P-value	β	95% CI for β		P-value
Age (per 1 year)	–0.156	–0.241	–0.071	<0.001	–0.116	–0.224	–0.008	0.035
Relative wall thickness (per 0.01)	–0.098	–0.164	–0.032	0.004	–0.069	–0.137	–0.002	0.045
Glomerular filtration rate (per 1 ml/min)	0.031	0.002	0.059	0.035	0.010	–0.023	0.043	0.561

β – correlation coefficient, CI – confidence interval

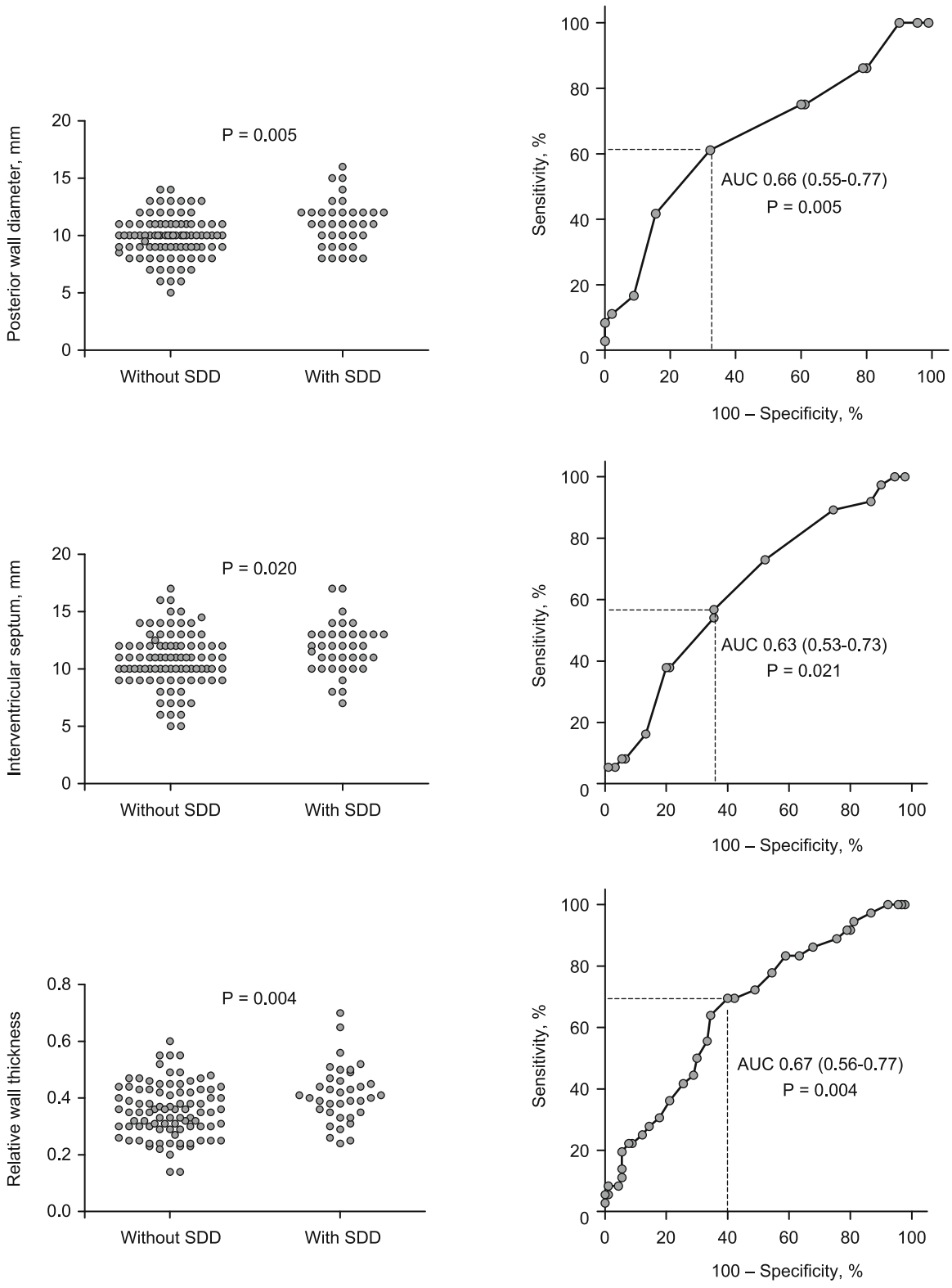

Fig. 1. The prognostic value of the posterior wall diameter, the interventricular septal diameter and a relative wall thickness for prediction of SDD. ROC – a receiver operating characteristic, SDD – screening diagnosis of dementia.

comparison to healthy ones (20). This observation suggests that the neurohormonal compensatory mechanisms in patients with severe symptoms of HF were insufficient to prevent diminished brain perfusion. In turn, among cognitively normal adults, subclinical reduction of LV ejection fraction was associated with increased levels of cerebrospinal fluid biomarkers of neurodegeneration like total-tau and phosphorylated-tau (11) indicating potential implications for changes in the brain later in life.

Since in our study there were no differences in global systolic LV function between groups with and without SDD, but as expected acutely decompensated patients in both groups had reduced or moderately reduced LV ejection fraction, our analysis went beyond contractility parameters. In the current study, patients with SDD were characterized by thicker end-diastolic interventricular septum, thicker LV posterior wall and a higher relative wall thickness. The indices of cardiac hypertrophy with a smaller left ventricle are typical for chronically increased afterload in hypertension, which is an established risk factor of dementia (19). Scuteri et al. have shown that among elderly patients, LV mass index was associated with cognitive decline and dementia, independently of blood pressure levels and large artery stiffness (21). In turn, Selvetella et al (22) found that hypertensive patients with concentric hypertrophy more often developed asymptomatic cerebrovascular damage (79 % of patients) as compared to patients with eccentric hypertrophy (62 % of patients). Moreover, by multivariable analysis, LV hypertrophy was found to be an independent predictor of the presence of ischemic lacunas.

In this study however, the differences between patients with and without SDD in both systolic as well as diastolic blood pressure and the diagnosis of hypertension were not relevant. Moreover, relative wall thickness recognized as a measure of hypertrophy (23) was not correlated with left ventricular mass index, and more than 78 % of the studied patients had its value within the normal range of less than or equal to 0.44. Therefore, our findings suggest that RWT in patients following acute HF decompensation with at least moderately reduced LV contractile function is not associated with LV hypertrophy but providing information about LV geometry (24) may improve and sometimes overtake prediction of SDD irrespectively of blood pressure monitoring and diagnosis of hypertension. Incorporation of LV geometry into the assessment of LV hypertrophy by Garg and Drazner (25) allowed to identification of patients at increased cardiovascular risk. In contrast, patients with LV dysfunction and extremely low RWT of less than 0.24 had 83 % increased risk for ventricular tachyarrhythmia and 68 % increase of ventricular tachyarrhythmia or death compared with patients with higher RWT (26). In our group only 1 patient had SDD with RWT of less than 0.24.

Previous studies revealed that degenerative aortic stenosis was associated with lower cerebral blood flow, but cognitive impairment was rather consequence of comorbidities in elderly patients (27). In our patients with SDD, the maximum aortic gradient was higher than in patients without SDD; nevertheless, in both groups this gradient was hemodynamically negligible. In patients with mild cerebrovascular disease, increased aortic root diameter was strongly related with both white matter lesions and impaired cognitive functioning (28). This issue requires further research, however, selected echocardiographic parameters on early phases of cardiovascular diseases might be helpful for prediction of subsequent cognitive deterioration.

Analyzed patients with SDD were characterized by lower hemoglobin levels and lower GFR. It was shown that anemia increases the risk of cognitive impairment (OR 4.268, 95% CI 1.898 – 9.593, $p < 0.001$) (29), probably intensifying the influence of low cerebral perfusion. In elderly patients without clinical dementia, low but also high hemoglobin levels were associated with worse performance on semantic memory and perceptual speed, but not the other specific cognitive functions (30). In turn, in a large meta-analysis, the diagnosis of chronic kidney disease increased the risk of cognitive decline by 60 % (31). Although in our study lower results of ALFI-MMSE score were correlated with lower GFR, the latter one was not an independent predictor of SDD. Undoubtedly, in patients following acute HF decompensation, renal dysfunction remains a therapeutic challenge as it modulates the diuretic response and its clinical importance for cognitive impairment must always be considered (32) especially in multiple morbidities and novel therapies among contemporary population (33, 34, 35).

Our study has several limitations. Firstly, the sample size is not large; however, it is the first such representative cohort of patients with severe symptoms of HF with extremely poor prognosis. Secondly, the results of the ALFI-MMSE questionnaire performed during the telephone follow-up were not verified in psychiatric examination, however conclusions were drawn carefully and only with regard to the screening diagnosis. Thirdly, in our analysis we did not collect data of patients' education that might had a significant impact on the overall ALFI-MMSE score. Finally, we did not perform a cerebral perfusion assessment, thus the association between SDD and discovered cardiac dysfunctions is only indirect.

Conclusions

Among survivors of acute HF decompensation, patients with subsequent SDD were characterized by a thicker interventricular septum, thicker left ventricular posterior wall, higher relative wall thickness and higher aortic valve peak gradient as compared to subjects without SDD. Apart from age, a higher relative wall thickness reflecting left ventricular geometry changes but not hypertrophy was independently but moderately associated with a greater likelihood of SDD. Our findings require further validation in a larger group of patients.

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