ОРИГИНАЛЬНАЯ СТАТЬЯ

EPICARDIAL ADIPOSE TISSUE VOLUME AND DISTRIBUTION IN CHRONIC HEART FAILURE PATIENTS WITH ATRIAL FIBRILLATION AND PRESERVED LEFT VENTRICULAR EJECTION FRACTION

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Purpose. Epicardial adipose tissue (EAT) is thought to play an important role in the development and progression of cardiovascular diseases. However, the diagnostic and prognostic role of EAT measurement in patients with atrial fibrillation (AF) and heart failure (HF) coexistence is still unclear. The aim of the present study was to investigate the volume and distribution of EAT and their correlation with level of B-type natriuretic peptide (BNP) as well-established HF biomarker.

Material and methods. 69 patients with symptomatic HF and AF underwent cardiac computed tomography (CT) before catheter ablation (CA). The BNP levels, total and peri-atrial EAT volumes were evaluated. The study cohort was divided into two groups according to the BNP level: BNP≥105 pg/ml, n = 37 («AF with HF») and BNP<105 pg/ml, n=32 («AF without HF»).

Results. The median peri-atrial EAT volume was higher in the «AF with HF» group compared with «AF without HF» group (52.1 [40;59] ml vs 45.6 [35;56] ml, respectively). Twenty-one (57%) out of 37 patients with BNP ≥105 pg/ml had HF with preserved ejection fraction (HFpEF). In this cohort, total and peri-atrial EAT was associated with BNP ≥105 pg/ml (coefficient 0.33 [95% CI, 0.08 to 0.57], p = 0.011 and 0.16 [95% CI, 0.09 to 0.22], p < 0.001).

Conclusions. Cardiac CT for EAT assessment may be useful as an additional diagnostic tool of HFpEF in patients with AF. In patients with AF and HFpEF the EAT volume is associated with an increase of BNP level.

Keywords: Cardiac computed tomography; Epicardial adipose tissue; Heart failure; Atrial Fibrillation; Preserved left ventricular ejection fraction; B-type natriuretic peptide.

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ОБЪЕМ И РАСПРЕДЕЛЕНИЕ ЭПИКАРДИАЛЬНОЙ ЖИРОВОЙ ТКАНИ У ПАЦИЕНТОВ С ХРОНИЧЕСКОЙ СЕРДЕЧНОЙ НЕДОСТАТОЧНОСТЬЮ С СОХРАНЕННОЙ ФРАКЦИЕЙ ВЫБРОСА И ФИБРИЛЛЯЦИЕЙ ПРЕДСЕРДИЙ

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Цель исследования. Установлено, что эпикардиальная жировая ткань (ЭЖТ) играет важную роль в развитии и прогрессировании сердечно-сосудистых заболеваний. Однако, диагностическая и прогностическая роль измерения ЭЖТ у пациентов с наличием фибрилляции предсердий (ФП) и хронической сердечной недостаточностью (ХСН) все еще не ясна. Целью настоящего исследования стало изучение объема и распределения ЭЖТ и их корреляции с уровнем мозгового натрийуретического пептида В-типа (МНУП) как хорошо изученного биомаркера ХСН.

Материалы и методы. 69 пациентам с симптоматической ХСН и ФП была проведена компьютерная томография (КТ) сердца перед катетерной аблацией (КА). Были оценены уровень МНУП, общий и околопредсердный объемы ЭЖТ. Исследуемая когорта была разделена на две группы в соответствии с уровнем МНУП ≥ 105 пг/мл, n = 37 («ФП с ХСН») и МНУП < 105 пг/мл, n=32 («ФП без ХСН»).

Результаты. Средний объем околопредсердной ЭЖТ был выше в группе «ФП с ХСН» по сравнению с группой «ФП без ХСН» (52,1 [40;59] мл против 45,6 [35;56] мл соответственно). У 21 из 37 (57%) пациентов с МНУП ≥105 пг/мл имело место ХСН с сохраненной фракцией выброса (СНсФВ). В этой когорте больных объемы общей и околопредсердной ЭЖТ были связаны с МНУП ≥105 пг/мл (угловой коэффициент 0,33 [95% ДИ от 0,08 до 0,57], p = 0,011 и 0,16 [95% ДИ от 0,09 до 0,22], p < 0,001 соответственно).

Выводы. Оценка объема и распределения ЭЖТ по данным КТ сердца может быть полезна в качестве дополнительного диагностического инструмента СНсФВ у пациентов с ФП. У пациентов с ФП и СНсФВ объем ЭЖТ связан с повышением уровня МНУП.

Ключевые слова: КТ сердца, эпикардиальная жировая ткань, сердечная недостаточность, фибрилляция предсердий, мозговой натрийуртический пептид.

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Introduction.

Chronic heart failure (HF) is one of the main health care problems worldwide. According to the Framingham study, the incidence of HF increases with the age [1]. At the same time, other factors may also affect the development of HF, especially in patients with preserved left ventricular ejection fraction (HFpEF) and HF. A common precipitant of HFpEF is atrial fibrillation (AF) [2].

For many years, HF was defined as systolic dysfunction (reduced ventricular ejection fraction), which was determined by echocardiography or cardiac magnetic resonance imaging (CMR). The diagnosis of HF is facilitated by determination of biomarkers, such as B-type natriuretic peptide (BNP) and N-terminal pro B-type natriuretic peptide (NT-proBNP) [3]. Patients with clinically HF symptoms and AF but with BNP levels < 105 pg/ml do not 'officially' have a diagnosis of HF, and physicians are advised to actively seek an alternative tool for HF diagnosis [4]. However, BNP levels may increase in multiple clinical scenarios such as renal failure, right ventricular dysfunction due to pulmonary diseases, and diastolic ventricular dysfunction with hypertrophy [5]. Thus, other markers of HF to facilitate initial assessment and future progression would be valuable for initiation of targeting appropriate treatment in this population. Recently published studies provided provocative findings regarding the relationship between epicardial adipose tissue (EAT) volumes in patients with a variety of cardiac conditions and in the prognosis for cardiovascular events [6, 7, 8].

Therefore, the aim of the present study was to define the association between EAT volumes as a new marker of HF and BNP level in patients with AF, HF clinical phenotype and preserved or reduced left ventricular systolic function.

Methods.

The present study was single-center and observational in design. The protocol of the study was reviewed and approved by the E. Meshalkin National Medical Research Center institutional review board and ethical committee and was conducted according to the Declaration of Helsinki. All included patients signed an informed consent form for participation in this study.

Sixty-nine consecutive patients with symptomatic, drug refractory AF and clinical findings of HF at least New York Heart Association (NYHA) II, who were scheduled for catheter ablation according to published guidelines, were included [3]. Patients with previous history of ablation or cardiac surgery procedure, severe comorbidities, valvular heart disease, myocardial infarction or revascularization procedure < 12 months prior to enrollment, NYHA class IV congestive HF were not included. The AF type was defined as paroxysmal if the patient had ECG with sinus rhythm during one week before including in the study with the history of AF episodes less than one week, all other types AF were defined as non-paroxysmal and included persistent and long-standing persistent AF. All patients underwent clinical examination, including echocardiography and cardiac computed tomography (CT). The natriuretic peptide BNP level was analyzed as an established marker of HF.

Echocardiography.

The assessment of the key echocardiographic parameters included: right and left ventricular systolic function, left atrium diameter and valvular functions.

Patients with left ventricular ejection fraction (LVEF) ≥ 50% were defined as HF with preserved ejection fraction (HFpEF) and LVEF < 50% as HF with systolic dysfunction [5].

CT scanning protocol.

For all patients, cardiac CT (320-row detector CT system Aquilion One, Toshiba, Japan) was performed with 3D reconstructed images as described previously in details [8]. In brief, images were acquired in volume acquisition mode with 120 kV tube voltage, 0.35-s gantry rotation time and tube current from 40 to 580 mAs depending on automatic tube current modulation. Iodinated contrast medium with a 350 mgI/ml iodine concentration was injected in antecubital vein using the biphasic protocol (70-85 ml contrast agent followed by a 30-35 ml mixture consisting of 30% contrast agent and 70% normal saline, respectively) at 5-6 ml/s rate. All CT data sets were reconstructed in the mid-diastolic phase (70-80% R–R interval) with a section thickness of 1.0 mm (reconstruction increment, 1.0 mm) using an iterative reconstruction algorithm.

EAT volume measurements.

EAT volume measurements were performed on a dedicated workstation (GE Advantage 4.7, US) by a single observer (NN) with 5 years of experience in cardiac CT blinded to clinical data. The fat between the visceral layer of the pericardium and the surface of the heart was defined as EAT [9]. EAT was separated from pericardial fat by manually tracing pericardial contour every 5-10 slices below the start point and software automatically tracing out the segments in between selected slices. The start point for pericardial tracing was set at the bifurcation of the pulmonary trunk and

the inferior point at the end of the pericardial sac. Adipose tissue voxels within the traced areas were identified using a threshold attenuation value range from – 190 to 0 Hounsfield units, according to the previously published study [10]. The voxels in each slice were summed to determine the total EAT volume. Thereafter, the peri-atrial EAT volume was manually segmented from the total EAT that was obtained by deleting EAT volume off the ventricular side anterior to the mitral annulus and the right atrial side anterior to the right superior pulmonary vein, and then from the lower side of the coronary sinus from the total EAT, leaving the EAT surrounding the left atrium (LA) [11]. The peri-atrial to total EAT volume ratio (P/T) was calculated. The intra-observer variability was calculated using intra-class correlation coefficient (ICC).

B-type natriuretic peptide.

BNP sampling was performed on the same day of the CT scan. BNP concentration was measured using an immunochemical analysis (ARHITECT i1000SR, ABBOTT LTD, US). According to HF guidelines BNP cut-off point for sinus rhythm is 35 pg/mL and for patients with AF – 105 pg/mL, below these levels the probability of having HF was extremely low [5]. In the present study the BNP ≥ 105 pg/ml was a cut-off for “AF with HF” group and BNP<105 was defined as “AF without HF”.

Catheter ablation procedure.

Eligible patients underwent CA using 3D non-fluoroscopic navigation system (CARTO, Biosense Webster, Inc., Diamond Bar, CA, USA) targeting circumferential pulmonary vein isolation with conformation of the exit and entrance block at the end of the procedure.

Statistical analysis.

Normally distributed data are presented as means (standard deviation). Variables with skewed distributions were expressed as medians (interquartile range, IQR). Differences between two groups were compared with unpaired t-test or Wilcoxon signed-rank test. Categorical data are presented as absolute values (percent). Fisher exact test was used to compare categorical data between groups.

Linear regression was used to assess associations between two continuous variables and results are presented as regression coefficients (95% confidence interval, CI) with associated p values. Logistic regression was used to demonstrate an association between EAT volumes and dichotomized BNP, with the cut-off of 105 pg/ml.

The BNP level, EAT volumes, LVEF and LA diameter were tested in the univariable and multivariable Cox proportional hazards regression model as potential predictors of AF recurrence during the 6-month follow-up. A p value < 0.05 was considered statistically significant. All analyses were done using STATA (Stata/IC 12.1, Statacorp, USA. URL https://www.stata.com/) and R statistical software (R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org).

Results.

Sixty-nine patients (30 females, median age of 62 [57; 66] years) with AF and HF corresponding to NYHA II functional class or higher were included. The median BNP level was 114.1 [48; 181] pg/ml in the entire cohort. 37 (54%) out of 69 patients had BNP ≥ 105 pg/ml (so called “AF with HF” patients). The number of patients with coronary artery disease (CAD) and non-paroxysmal AF was higher in “AF with HF” group compared with “AF without HF” group. Patients in “AF with HF” group had larger mean LA diameter than patient from “AF without HF” group (5.9±0.6 vs 5.6±0.6, p=0.04). The median peri-atrial EAT volume was higher in “AF with HF” group compared with “AF without HF” group (52.1 [40; 59] ml vs 45.6 [35; 56], p=0.007, respectively). The intra-observer measurements for total EAT volume and peri-atrial EAT volume were highly reliable (ICC = 0.96, p < 0.01 and 0.89, p < 0.01, respectively). 45 (65.2%) patients had LVEF>50%, 8 (11.6%) patients - 49-40% and 16 (23.2%) patients <40%. Patients with heart failure with middle reduced ejection fraction (HFmrEF) and reduced ejection fraction (HFrEF) were merged as systolic dysfunction due to small sample size. The detailed baseline characteristics of the study cohort are presented in Table 1.

Association between EAT volumes and BNP levels in the entire cohort Neither total EAT nor peri-atrial EAT was significantly associated with BNP levels (coefficient 0.06 [95% CI, -0.02 to 0.14], p=0.1 and 0.02 [95% CI, -0.006 to 0.06], p=0.1 respectively). Also, there was no significant association between total EAT or peri-atrial EAT and BNP levels ≥ 105 pg/ml (coefficient- 0.006 [95% CI, -0.12 to 0.11], p=0.92 and 0.003 [95% CI, -0.04 to 0.05], p=0.9 respectively).

Association between EAT volumes and BNP levels ≥ 105 pg/ml in patients with preserved and reduced LVEF.

Twenty-one (57%) out of 37 patients with BNP ≥ 105 pg/ml had HFpEF. In this cohort, total and peri-atrial EAT was statistically significant associated with BNP ≥ 105 pg/ml (coefficient 0.33 [95% CI, 0.08 to 0.57], p=0.011 and 0.16 [95% CI, 0.09 to 0.22], p < 0.001 respec-

Table №1. Baseline characteristics of the study cohort.

Characteristic	All patients n=69	Patients with BNP ≥ 105 pg/ml n=37 ("AF with HF")	Patients with BNP < 105 pg/ml n=32 ("AF without HF")	p value *
Age, years	62 [57;66]	62 [58;65]	62 [56;67]	0.72
Male, n (%)	39 (56.5)	22 (59.5)	17 (53.1)	0.63
BMI, kg/m^2	30.1±4.1	30.2±3.92	30±4.43	0.88
Hypertension, n (%)	57 (82.6)	29 (78.4)	28 (87.5)	0.36
Diabetes, n (%)	5 (7.2)	4 (10.8)	1 (3.1)	0.36
CAD, n (%)	29 (42)	17 (46)	12 (37.5)	0.62
AF duration, months	49 [18;94]	32 [15;94]	57.5 [27;92]	0.27
Paroxysmal AF, n (%)	31 (45)	10 (27)	21 (65.6)	0.002
Non-paroxysmal AF, n (%)	38 (55)	27 (73)	11 (34.4)	0.002
NYHA II FC, n (%)	58 (84)	30 (81.1)	28 (87.5)	0.52
NYHA III FC, n (%)	11 (16)	7 (18.9)	4 (12.5)	0.52
CHADS2VASC2≥ 2, n (%)	62 (89.8)	33 (89.2)	29 (90.6)	>0.99
LA diameter, cm	5.8±0.6	5.9±0.6	5.6±0.6	0.04
LVEF, %	58 [41;65]	57 [36;65]	61 [50;65]	0.14
LVEF ≥ 50%, n (%)	45 (65.2)	21 (56.8)	24 (75)	0.13
LVEF < 50%, n (%)	24 (34.8)	16 (43.2)	8 (25)	0.13
BNP, pg/ml	114.1[48;181]	170.7 [133;276]	46.4 [27;59]	<0.001
Total EAT, ml	155 [124;183]	159 [142;203]	139 [116;181]	0.06
Peri-atrial EAT, ml	52.1 [40;59]	52.2 [46;62]	45.6 [35;56]	0.007
P/T EAT ratio	0.34[0.29;0.37]	0.35 [0.31;0.38]	0.31 [0.28;0.37]	0.11

Legend of abbreviation: BNP – B-type natriuretic peptide; HF – heart failure; BMI – body mass index; CAD – coronary artery disease; AF – atrial fibrillation; NYHA – New York Heart Association; FC – functional class; LA – left atrium; LVEF – left ventricular ejection fraction; EAT – epicardial adipose tissue; P/T – peri-atrial/total.

tively) (Fig. 1). No statistically significant association was observed between EAT volumes and BNP level ≥ 105 pg/ml in patients with systolic dysfunction (n=16).

Association between EAT volumes and LVEF.

In the entire cohort, both total and peri-atrial EAT volume were statistically significantly associated with LVEF (coefficient -0.39 [95% CI, -0.74 to -0.03], p=0.031 and coefficient -1.02 [95% CI, -1.9 to -0.16], p=0.02). No significant association was found between any EAT volume and any LVEF in patients (n=37) with BNP ≥ 105 pg/ml. Neither total EAT nor peri-atrial EAT was statistically significant associated with systolic dysfunction (n=16). Two typical cases are presented in Figure 2.

Association between EAT volumes and BNP ≥ 105 pg/ml in patients with preserved LVEF.

Each ml increase in total and peri-atrial EAT volumes was associated with 1.03 (95% CI, 1.01 to 1.06, p=0.007) and 1.13 (95% CI, 1.04 to 1.23, p=0.002) odds of increased BNP (i.e., BNP ≥ 105 pg/ml). Discriminatory abilities of the total and peri-atrial EAT for BNP ≥ 105 pg/ml were not statistically different (p=0.52).

Predictors of AF recurrences.

Fifty-three (77%) patients underwent CA. In the 16 (23%) patients, CA was rescheduled or declined due to contraindications. The median follow-up was 6 [4;6] months. AF recurrences occurred in 13 patients (24.5%). In the univariable analysis for the entire cohort, no predictors of the AF recurrences were identified. 25 (47.2%) out of 53 with BNP ≥ 105 pg/ml with all LVEF underwent CA. There were no any AF predictors in this subgroup, irrespectively to LVEF.

Discussion.

The main findings of this study are the following: 1) the median peri-atrial EAT volume was higher in AF patients with BNP ≥ 105 pg/ml; 2) neither total EAT nor peri-atrial EAT was significantly associated with all BNP levels in HFpEF and patients with systolic dysfunction; 3) total and peri-atrial EAT volumes were significantly associated with BNP ≥ 105 pg/m in HFpEF patients with no association in patients with systolic dysfunction.

AF and HF are widespread cardiovascular conditions, which prevalence increases globally [1, 3]. Both diseases potentiate each other that results in worse outcome. AF can be a cause or consequence of HF and vice versa. Smit et al. demonstrated that patients, who developed AF first, had better prognosis rather than patients with first signs of HF [12]. The existing plasma

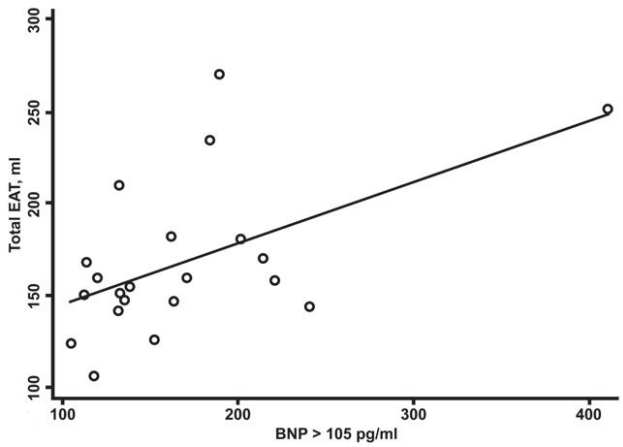

Fig. 1 a (Рис. 1 a)

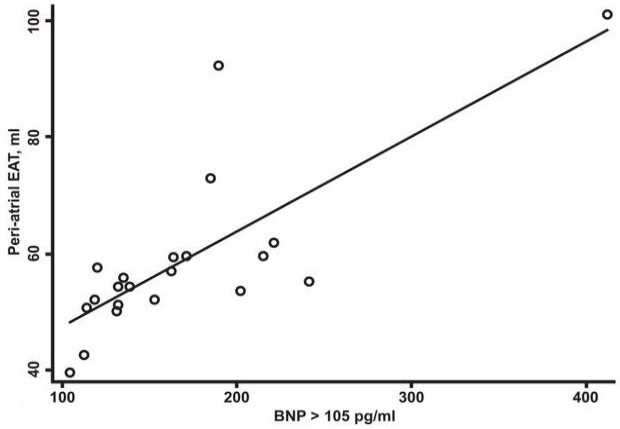

Fig. 1 б (Рис. 1 b)

Fig. 1. Diagrams.

A – Association between total EAT volume and BNP level ≥ 105 pg/ml. Each unit increase of BNP is associated with 0.33 in change increase in 1 ml of total EAT volume. B – Association between peri-atrial EAT volume and BNP level ≥ 105 pg/ml. Each unit increase of BNP is associated with 0.16 in change increase in 1 ml of peri-atrial EAT volume.

Рис. 1. Диаграммы.

А – Связь между объемом общей ЭЖТ и уровнем МНУП ≥ 105 пг/мл. Каждое увеличение уровня МНУП на 1 мл связано с увеличением объема общей ЭЖТ на 0,33 мл. В – Связь между объемом околопредсердной ЭЖТ и уровнем МНУП ≥ 105 пг/мл. Каждое увеличение уровня МНУП на 1 мл связано с увеличением объема околопредсердной ЭЖТ на 0,16 мл.

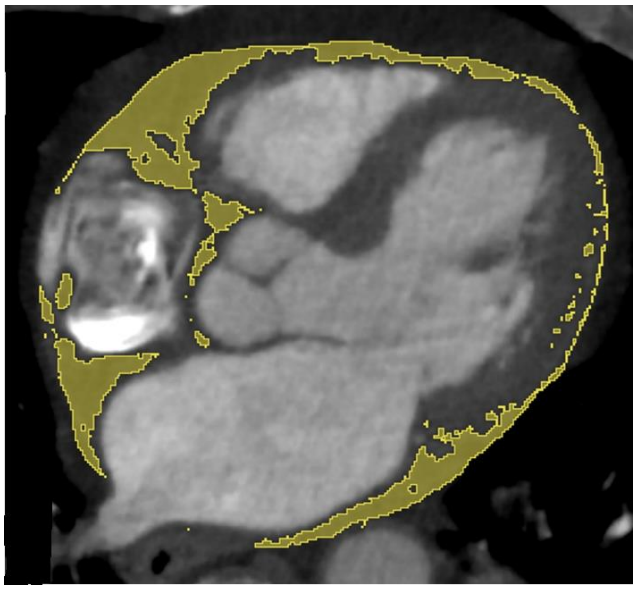

Fig. 2 a (Рис. 2 a)

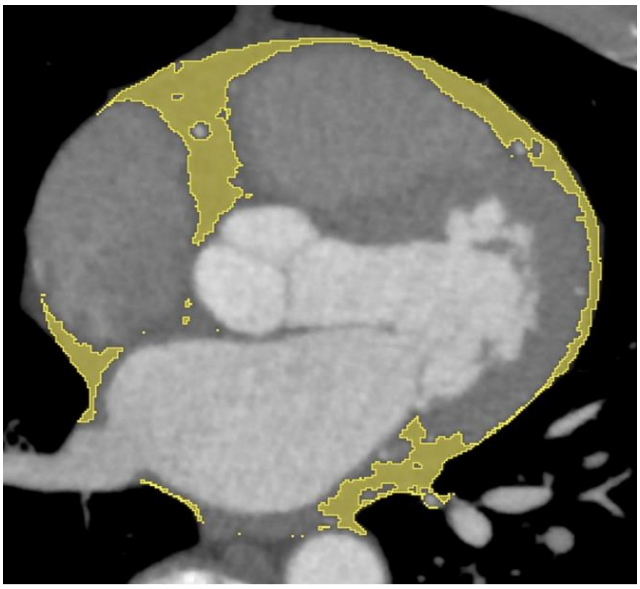

Fig. 2 б (Рис. 2 b)

Fig. 2. Contrast-enhanced cardiac computed tomography (CT) in axial plane. Two representative cases of epicardial adipose tissue (EAT) total volume measurements (areas in yellow depict traced EAT) in correlation with B-type natriuretic peptide (BNP) level and left ventricular ejection fraction (LVEF).

A – A 67-year-old male patient with total EAT volume = 234 ml, BNP level = 185 pg/ml and LVEF = 66%.

B – A 46-year-old male patient with total EAT volume = 110 ml, BNP level = 447 pg/ml and LVEF = 35%.

Рис. 2. КТ сердца с контрастированием, в аксиальной плоскости, демонстрирующие два репрезентативных случая корреляции объема общей ЭЖТ (область интереса выделена желтым цветом), уровня МНУП и ФВЛЖ.

А – У мужчины 67 лет объем общей ЭЖТ = 234 мл, МНУП = 185 пг/мл, ФВЛЖ = 66%.

Б – У мужчины 46 лет объем общей ЭЖТ = 110 мл, МНУП = 447 пг/мл, ФВЛЖ = 35%.

biomarkers, such as BNP and NT-proBNP are not a strong tool for HF early progression assessment due to influence of concomitant comorbidities [1, 5, 13]. Therefore, revealing additional early predictors of HF development or progression in AF patients is unmet needed, especially in HFpEF cohort.

Reduction of EAT volume as background of HF progression.

Ejection fraction is an established parameter for assessment of the LV systolic function that can be also a surrogate characteristic of the HF status. In our study, the EAT volume was significantly reduced in patients with LV systolic dysfunction compared with HFpEF. However, no significant linear association was found between any EAT volume and HFpEF or LV systolic dysfunction with BNP ≥ 105 pg/ml.

In the study of Doesch et al., the EAT volume in HFrEF patients was lower compared with healthy controls [14]. Another study, focused on patients with HFpEF and HFmrEF, demonstrated higher EAT volume in those patients who developed AF with an increase of myocardial biomarkers [15]. Controversially, Wu et al. demonstrated that EAT volume in patients with systolic dysfunction was significantly higher in patients with ventricular arrhythmias compared without no arrhythmias [16]. These data suggest potential EAT involvement in the progression of LV systolic dysfunction and arrhythmia disturbances, possibly due to the paracrine effect of EAT on HF compensation: adipocytes have recently been identified to be a major source of circulating miRNA via exosomal release [17].

Natriuretic peptides in HFpEF and AF.

Natriuretic peptides are the best biomarkers for predicting outcome in patients with HF and sinus rhythm. Plasma natriuretic peptide concentration assessment is recommended as an initial diagnostic test for screening for HF in patients with clinical symptoms of HF [4, 5]. However, it should be noted that there may be many causes of BNP elevations (eg, older age, renal dysfunction, atrial and

ventricular tachycardia) that lead to a decrease in their diagnostic accuracy.

Merino-Merino et al. showed that the threshold value of natriuretic peptides in patients with HF and AF should be higher than without AF [18]. Thus, an additional tool is needed to diagnose HFpEF in patients with AF. During the last decade, the influence of EAT volume on the pathogenesis of AF has been actively studied. Wong et al. evaluated EAT volume in 130 patients with AF prior to CA using MRI and showed that an increase in EAT volume was associated with the severity of AF and a high rate of arrhythmia recurrence after the CA procedure [19].

In our study, we did not find any predictors of AF recurrence after CA, including EAT, which may be due to the small sample size and relatively short follow-up period. However, we found a significant association between BNP and EAT volumes before the ablation procedure, and these data should be tested for further clinical application.

On the other hand, the level of BNP may be directly related to the type of AF. In a study by Plitt et al. it has been shown that the severity of AF, assessed using continuous outpatient rhythm monitoring for 1 week, is directly related to the level of natriuretic peptide [20]. In our study, the entire cohort of patients differed significantly in the type of AF. There were more patients with non-paroxysmal "AF with HF" group.

In addition, our group also found a relationship between sympathetic activity and EAT volume in the left atrium in patients with various types of “AF without HF” [8]. It is well known that AF and HF have the same pathogenesis with increased sympathetic activity, and EAT may play an important role in this process.

Thus, EAT volume estimation may be a good diagnostic tool in patients with AF and HF, in addition to other biomarkers.

The role EAT in different aspects of cardiovascular diseases.

The cardiac CT is a widely used imaging modality for preprocedural cardiac function assessment [21]. In several studies, cardiac CT was used to quantify EAT volume and demonstrated good reproducibility [22]. For instance, the effectiveness of SGLT2 inhibitors treatment was associated with decrease of EAT volume [22]. Another study demonstrated that presence of a substantial EAT volume correlated with a significant number of cardiovascular events even in patients with coronary calcium of zero during coronary CT angiography. These data emphasize the potential role of the cardiac CT as a tool for EAT measurement [23].

For many centers, cardiac CT is an available and routine procedure before CA. Using additional measurements of EAT could potentially predict HF progression, especially in patients with HFpEF. Further studies are needed to assess the prognostic role of EAT on HF progression after CA of AF.

Limitations.

The present study has several limitations. First, it was observational in design with a relatively small sample size. Second, we did not demonstrate the association between EAT volumes and AF recurrences during follow up, probably due to the limited number of HFpEF patients, who underwent CA and a short follow-up period. Finally, for EAT measures CT was used, not cardiac MRI, which can be considered the gold standard. However, unlike CT, MRI is not routinely available and is not widely used as a diagnostic tool before invasive procedures in patients with AF. Thus, the results of this study should be interpreted with such limitations.

Conclusions.

In patients with AF and clinically symptomatic HFpEF, EAT volume is associated with increase of BNP level. In this cohort, EAT volume measurements may be used as an additional tool for HF diagnosis. The direct interplay between BNP and increased EAT in patients with HF and AF needs further testing.

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