Gazi Med J 2026;37(2):209-214

DOI: http://dx.doi.org/10.12996/gmj.2026.4624

Subclinical Right Ventricular and Atrial Dysfunction in Heart Failure with Preserved Ejection Fraction: A Speckle Tracking Comparison

Korunmuş Ejeksiyon Fraksiyonlu Kalp Yetersizliğinde Subklinik Sağ Ventrikül ve Sağ Atriyum Disfonksiyonu: Benek Takibi Yöntemi ile Karşılaştırmalı Bir Değerlendirme

Yakup Yalçın[1], Özden Seçkin[2], Serkan Ünlü[2], Betül Ayça Yamak[3], Mustafa Cemri[2], Mehmet Rıdvan Yalçın[2]

[1]Department of Cardiology, Hakkâri State Hospital, Hakkâri, Türkiye
[2]Department of Cardiology, Gazi University Hospital, Ankara, Türkiye
[3]Department of Cardiology, Hopa State Hospital, Artvin, Türkiye

ABSTRACT

Objective: Functional involvement of the right heart in heart failure (HF) with preserved ejection fraction (HFpEF) has gained increasing attention; however, early functional changes may not be adequately detected using standard echocardiographic techniques. The purpose of this work was to assess ventricular and atrial performance in individuals with HFpEF by combining conventional echocardiographic evaluation with deformation-based strain analysis.

Methods: In this cross-sectional study, patients with HFpEF hospitalized for acute HF between January 2020 and January 2022 were evaluated. All patients had a left ventricular (LV) EF of ≥50% and underwent comprehensive transthoracic echocardiographic assessment. The structure and function of the right ventricular (RV) and right atrium were analysed using conventional echocardiographic measurements, Doppler and tissue Doppler indices, and speckle-tracking–derived strain parameters. Findings were compared with those of an age- and sex-matched control group.

Results: LV dimensions and systolic function were similar between the HFpEF and control groups. In contrast, patients with HFpEF exhibited significantly larger RV diastolic and right atrial end-systolic areas. Conventional RV functional parameters demonstrated limited sensitivity for detecting early dysfunction. Two-dimensional (2D) speckle-tracking echocardiography revealed significantly reduced RV global longitudinal strain and free-wall strain in HFpEF patients. Additionally, right atrial reservoir and contraction strain values were significantly lower, whereas conduit strain values did not differ between groups.

ÖZ

Amaç: Korunmuş ejeksiyon fraksiyonlu kalp yetersizliğinde (HFpEF) sağ kalp tutulumu giderek daha fazla önem kazanmaktadır; ancak erken dönemde ortaya çıkan fonksiyonel bozukluklar, konvansiyonel ekokardiyografik parametrelerle saptanamayabilir. Bu çalışmada, HFpEF tanılı hastalarda sağ ventrikül ve sağ atriyum fonksiyonlarının, konvansiyonel ekokardiyografi ve iki boyutlu benek takibi yöntemiyle elde edilen miyokardiyal deformasyon parametreleri kullanılarak değerlendirilmesi amaçlanmıştır.

Yöntemler: Bu kesitsel çalışmada, Ocak 2020–Ocak 2022 tarihleri arasında dekompanse kalp yetersizliği nedeniyle hastaneye yatırılan HFpEF tanılı hastalar değerlendirildi. Tüm hastaların sol ventrikül ejeksiyon fraksiyonu ≥%50 idi ve kapsamlı transtorasik ekokardiyografik inceleme yapıldı. Sağ ventrikül ve sağ atriyumun yapısal ve fonksiyonel özellikleri; konvansiyonel ekokardiyografik ölçümler, Doppler ve doku Doppler parametreleri ile iki boyutlu benek takibi yöntemiyle elde edilen strain değerleri kullanılarak analiz edildi. Bulgular, yaş ve cinsiyet açısından benzer özelliklere sahip kontrol grubu ile karşılaştırıldı.

Bulgular: Sol ventrikül boyutları ve sistolik fonksiyon parametreleri HFpEF ve kontrol grupları arasında benzerdi. Buna karşılık, HFpEF grubunda sağ ventrikül diyastolik alanı ve sağ atriyum sistol sonu alanı anlamlı olarak daha büyüktü. Konvansiyonel sağ ventrikül fonksiyon parametrelerinin erken fonksiyonel bozukluğu saptamadaki duyarlılığı sınırlıydı. İki boyutlu (2B) benek takibi ekokardiyografisi ile HFpEF hastalarında sağ ventrikül global longitudinal strain ve serbest duvar strain değerlerinin anlamlı olarak azaldığı saptandı. Ayrıca sağ atriyum

Cite this article as: Yalçın Y, Seçkin Ö, Ünlü S, Yamak BA, Cemri M, Yalçın MR. Subclinical right ventricular and atrial dysfunction in heart failure with preserved ejection fraction: a speckle tracking comparison. Gazi Med J. 2026;37(2):209-214

Address for Correspondence/Yazışma Adresi: Yakup Yalçın, Department of Cardiology, Hakkâri State Hospital, Hakkâri, Türkiye
E-mail / E-posta: yakupyalcn@gmail.com
ORCID ID: orcid.org/0000-0002-8034-5847

Received/Geliş Tarihi: 12.01.2026
Accepted/Kabul Tarihi: 09.03.2026
Publication Date/Yayınlanma Tarihi: 31.03.2026

ABSTRACT

Conclusion: 2D speckle tracking echocardiography enables detection of subclinical RV and right atrial dysfunction in patients with HFpEF, which may not be apparent on conventional echocardiographic assessment. Incorporating myocardial deformation analysis into routine evaluation may provide incremental insight into right heart involvement in this patient population.

Keywords: Heart failure, right ventricular, right atrium, preserved ejection fraction

ÖZ

rezervuar ve kontraksiyon fazı strain değerleri düşük bulunurken, kondüit fazı strain değerlerinde gruplar arasında anlamlı fark izlenmedi.

Sonuç: 2B benek takibi ekokardiyografisi, HFpEF hastalarında konvansiyonel ekokardiyografik değerlendirme ile saptanamayabilecek subklinik sağ ventrikül ve sağ atriyum disfonksiyonunu ortaya koyabilmektedir. Miyokardiyal deformasyon analizinin rutin değerlendirmeye eklenmesi, bu hasta grubunda sağ kalp tutulumunun daha kapsamlı biçimde değerlendirilmesine katkı sağlayabilir.

Anahtar Sözcükler: Kalp yetersizliği, sağ ventrikül, sağ atriyum, korunmuş ejeksiyon fraksiyonu

INTRODUCTION

Heart failure (HF) is a condition in which characteristic clinical manifestations arise as a consequence of underlying disturbances in cardiac structure and/or function. Epidemiological evidence shows that the frequency of HF increases substantially with advancing age, affecting more than 10% of individuals over 70 years. In developed countries, this age-related increase continues to make a major contribution to the overall burden of cardiovascular disease (1,2).

While the prognostic and clinical relevance of right ventricular (RV) function is well recognised in patients with HF with reduced ejection fraction (HFrEF), interest in the role of the RV has more recently expanded to include HF with preserved EF (HFpEF) (3).

Structural and functional changes affecting the left ventricular (LV), whether they are a cause or a consequence of HF, can gradually alter RV geometry and function. With disease progression, these interactions may drive RV remodeling, ultimately resulting in deterioration of RV structure and performance and, in advanced stages, the development of RV failure (4).

Evaluation of RV function using conventional echocardiographic approaches remains challenging, primarily because of the ventricle's intricate structural characteristics and non-uniform geometry. Although cardiac magnetic resonance imaging (cMRI) is considered a reference technique for detailed evaluation of RV structure and function, its routine use in daily clinical practice remains constrained by limited availability and practical cconsiderations (5).

Although LV diastolic dysfunction forms the cornerstone of HFpEF diagnosis, increasing evidence suggests that RV and right atrial dysfunction may influence symptom severity and haemodynamic burden, and may potentially affect clinical outcomes. However, subclinical right-sided involvement may remain undetected using conventional echocardiographic parameters. Therefore, advanced myocardial deformation imaging may provide additional mechanistic insight beyond diagnostic confirmation.

MATERIALS AND METHODS

Study Design and Population

A cross-sectional cohort design was used to investigate adults with HFpEF who were hospitalized for acute HF. Consecutive patients aged 18 years or older admitted to the Cardiology Department of Gazi University between January 2020 and January 2022 diagnosed with acute HF were screened for eligibility. Patients who underwent standard TTE examination and demonstrated an LV EF of at least 50% were included. At the time of hospital admission, all enrolled participants were in New York Heart Association class III or IV.

Patients with prosthetic heart valves or insufficient echocardiographic image quality were not included in the analysis. Before enrolment, all participants were informed about the study procedures and provided written consent to take part. Clinical evaluations and therapeutic interventions were performed in accordance with current scientific evidence and established clinical practice guidelines.

HFpEF was identified based on established diagnostic criteria. In this framework, HFpEF was defined by the presence of typical HF symptoms and signs, LV EF of at least 50%, and objective findings of structural and/or functional abnormalities consistent with LV diastolic dysfunction (6).

This study was approved by the Ethics Committee of Gazi University (approval number: 216, date: 27.12.2021).

Echocardiographic Imaging Protocol and Speckle Tracking Analysis

All TTE studies were performed by an experienced cardiologist with a Vivid E95 ultrasound system. All echocardiographic examinations were performed during hospitalization for acute HF, after initial clinical and haemodynamic stabilization. Image acquisition was performed to include a minimum of three consecutive cardiac cycles, and all recordings were subsequently analysed offline using EchoPAC software (GE Healthcare, Chicago, IL, USA).

Measurements of LV end-systolic and end-diastolic dimensions, chamber volumes, and LV EF, as well as left atrial diameters and area, were obtained in accordance with current TTE guidelines.

RV size was characterized by linear measurements and by quantification of systolic and diastolic areas obtained from an RV-focused apical four-chamber (A4C) view. The RV fractional area change (RVFAC) was derived by calculating the difference between systolic and diastolic areas, normalizing the resulting measurement to the diastolic area, and reporting the results as percentages. Tricuspid annular plane systolic excursion (TAPSE) was determined in the A4C view using M-mode imaging, with the cursor positioned at the lateral tricuspid annulus.

The myocardial performance index (MPI) was derived as the ratio of total isovolumetric time to ejection time using both pulsed-wave Doppler and tissue Doppler techniques. Doppler TTE evaluation included assessment of the RV outflow tract velocity and of tricuspid inflow velocities obtained from the A4C view. Tissue Doppler measurements were performed at the lateral tricuspid annulus in the A4C view. With the sample volume positioned between the tricuspid valve leaflets, E- and A-wave velocities, the E/A ratio, and deceleration time were recorded. Systolic annular velocity (S') and diastolic annular velocities were also measured at the lateral tricuspid annulus using tissue Doppler imaging. In addition, peak systolic velocity during the isovolumetric contraction phase was assessed at the same site.

The longitudinal and transverse dimensions of the right atrium (RA) were assessed from the A4C view. Longitudinal measurements were recorded along the axis extending from the centre of the tricuspid valve to the midpoint of the superior RA wall, whereas transverse measurements were performed at the mid-atrial level along a line drawn from the lateral RA wall toward the interventricular septum. The RA area was measured in the A4C view during ventricular systole, corresponding to the phase of maximal atrial size, with careful exclusion of the systemic venous inflow sites and atrial appendage. The Inferior vena cava diameter and its respiratory variability were evaluated using the subcostal approach. Measurements of the RV outflow tract were obtained at end-diastole from the parasternal short-axis view, and the RV septal wall thickness was measured during diastole from the parasternal long-axis view.

For speckle-tracking analysis, dedicated apical views optimized for visualization of the RV and RA were acquired. To assess RV myocardial deformation, at least 15 reference points were manually positioned along the endocardial border, extending from the lateral tricuspid annulus to the septal tricuspid annulus, thereby defining the endocardial contour. Following identification of the myocardial region of interest, strain analysis was carried out with dedicated speckle tracking software. RV global longitudinal strain (RVGLS) and RV free wall longitudinal strain (RVFWS) were subsequently calculated. For RA strain analysis, tracking points were aligned with the R waves on the electrocardiogram to ensure a consistent temporal reference.

Statistical Analysis

Statistical analyses were performed using IBM SPSS software version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were reported as mean ± standard deviation or as median with minimum and maximum values, as appropriate. Categorical data were presented as counts and percentages. Between-group comparisons of continuous variables were performed using the Student's t-test, whereas categorical variables were compared using the chi-square test. Statistical significance was defined as a p-value ≤0.05.

RESULTS

A total of 94 patients with HFpEF were initially assessed for eligibility. Nineteen individuals were excluded because atrial fibrillation was present, and an additional 15 were excluded due to inadequate echocardiographic image quality for speckle-tracking analysis. Consequently, the final study cohort comprised 60 patients with HFpEF, with a mean age of 62.2 ± 14.3 years, 60% of whom were female.

Baseline demographic variables, comorbidities, and conventional echocardiographic parameters were comparable between the HFpEF and control groups (Table 1). Hypertension was the most prevalent comorbidity in the HFpEF cohort (96.7%), followed by hyperlipidaemia (61.7%) and diabetes mellitus (53.3%). LV dimensions, volumes, and indices of systolic performance showed no meaningful differences between the two groups (Table 2). Measures of left atrial size and volume were also similar. By contrast, the evaluation of the right-sided cardiac chambers demonstrated clear between-group differences.

Patients in the HFpEF group had significantly larger RV diastolic and RA end-systolic areas versus controls with p-values ≤ 0.002 for both comparisons (Table 3). Doppler-derived parameters demonstrated higher RV E and A velocities, an increased E/A ratio, and a higher MPI

Table 1. Patient demographics and baseline echocardiographic measurements.

Variables	HFpEF (n = 60)	Control (n = 60)	p-value
Age (year)	62.2 ± 14.3	61.6 ± 13.7	0.81
Sex (F/M)	36 (60%)/24(40%)	34 (57%)/26 (43.3%)	0.71
BMI (kg/m^2)	29.9 ± 4.9	28.8 ± 5.2	0.24
CAD (n, %)	9 (15)	10 (16.7)	0.83
DM (n, %)	32 (53.3)	29 (48.3)	0.58
HT (n, %)	58 (96.7)	55 (91.7)	0.24
HPL (n, %)	37 (61.7)	33 (55)	0.46
CKD (n, %)	11 (18.3)	7 (8.3)	0.31
Septum thickness (cm)	1.3 ± 0.4	1.2 ± 0.4	0.17
Posterior wall thickness (cm)	1.20 ± 0.4	1.1 ± 0.3	0.12
Aorta-sinotubular junction (cm)	3.4 ± 0.7	3.3 ± 0.8	0.47
Ascending aorta (cm)	3.9 ± 0.8	3.8 ± 0.7	0.46
LV mass index (g/m^2)	115 ± 31.6	109.9 ± 27.1	0.34

BMI: Body mass index, CAD: Coronary artery disease, CKD: Chronic kidney disease, DM: Diabetes mellitus, HFpEF: Heart failure with preserved ejection fraction, HPL: Hyperlipidaemia, HT: Hypertension, LV: Left ventricular, F: Female, M: Male.

in patients with HFpEF. Tissue Doppler analysis showed significantly lower E′, A′, and S′ velocities and a markedly elevated E/E′ ratio in the HFpEF group (all $p < 0.05$). TAPSE excursion was significantly reduced in HFpEF patients, whereas RVFAC did not differ significantly between the groups.

Assessment with speckle-tracking echocardiography demonstrated impaired RV deformation in patients with HFpEF. Both RVGLS and RVFWS were significantly lower in the HFpEF group compared with controls ($p = 0.015$ and $p = 0.003$, respectively; Table 4). Furthermore, RA reservoir and contraction-phase strain values were significantly reduced in HFpEF patients, whereas conduit-phase strain did not differ significantly between the two groups.

Table 2. Echocardiographic measurements of the left ventricular and left atrium.

Variables	HFpEF (n=60)	Control (n=60)	p-value
Volume and size measurements			
LV end diastolic diameter (cm)	4.5 ± 0.7	4.4 ± 0.7	0.43
LV end-diastolic volume index (mL/m^2)	50.7 ± 14.1	49.6 ± 15.0	0.68
LV ejection fraction (%)	65.5 ± 5.6	64.9 ± 6.4	0.59
LA diameter (cm)	4.7 ±0.9	4.5 ± 0.8	0.20
LA area (cm^2)	19.9 ± 4.4	18.6 ± 4.7	0.12
LA volume index (mL/m^2)	33.9 ± 9.5	31.9 ±10.3	0.27

HFpEF: Heart failure with preserved ejection fraction, LA: Left atrium, LV: Left ventricular.

Table 3. Echocardiographic measurements of the right ventricular and right atrium.

Variables	HFpEF (n = 60)	Control (n = 60)	p-value
Volume and size measurements			
RV basal diameter (cm)	4.3 ± 0.9	4.1± 0.8	0.20
RV mid-cavity diameter (cm)	3.2 ± 0.6	3.1 ± 0.5	0.32
RV longitudinal diameter (cm)	6.9 ± 1.0	6.7 ± 0.9	0.25
RA longitudinal axis (cm)	4.9 ± 0.8	4.6 ± 0.9	0.056
RA short axis (cm)	4.0 ± 0.7	3.8 ± 0.7	0.12
RA end-systolic area (cm^2)	15.8 ± 4.0	13.6 ± 3.8	0.002
RV diastolic area (cm^2)	16.7 ± 4.0	14.1 ± 3.1	0.001
RV systolic area (cm^2)	10.2 ± 3.2	9.2 ± 3.1	0.08
RVFAC (%)	38.3 ± 9.2	41.2 ± 9.8	0.09
TAPSE (cm)	15.8 ± 3.8	18.1 ± 4.2	0.002
Doppler measurements			
E (m/s)	1.1 ± 0.3	0.8 ± 0.2	0.001
A (m/s)	0.6 ± 0.2	0.5 ± 0.2	0.007
E/A ratio	1.8 ± 0.5	1.6 ± 0.4	0.02
MPI	0.41 ± 0.13	0.36 ± 0.14	0.04
Deceleration time (ms)	229.5 ± 76.8	251 ± 91.4	0.16
Tissue Doppler measurements			
E′ (m/s)	10 ± 4	12 ± 4.2	0.007
A′ (m/s)	13 ± 4.9	15 ± 5.0	0.031
E′/A′	0.8 ± 0.3	0.7 ± 0.4	0.12
S′ (m/s)	9 ± 3	11 ± 4	0.002
E/E′	11.1 ± 2.9	8.5 ± 2.4	<0.001
MPI	0.43 ± 0.11	0.36 ± 0.2	0.019
ICA (m/s^2)	2.9 ± 0.9	3.4 ± 1.4	0.022

ICA: Isovolumetric contraction acceleration, HFpEF: Heart failure with preserved ejection fraction, MPI: Myocardial performance index, RA: Right atrium, RV: Right ventricular, RVFAC: Right ventricular fractional area change, TAPSE: Tricuspid annular plane systolic excursion

Table 4. Right ventricular and right atrial strain measurements.

Variables	HFpEF (n = 60)	Control (n = 60)	p-value
RVGLS (%)	-17.9 ± 3.9	-19.7 ± 4.1	0.015
RVFWS (%)	-19.2 ± 4.5	-21.8 ± 5.4	0.003
RA reservoir phase strain (%)	34.6 ± 9.8	39.5 ± 10.9	0.01
RA contraction phase strain (%)	-13.6 ± 5.8	-16.5 ± 6.2	0.009
RA conduit phase strain (%)	20.2 ± 8.1	22.9 ± 8.5	0.07

HFpEF: Heart failure with preserved ejection fraction, RA: Right atrium, RVGLS: Right ventricular global longitudinal strain, RV: Right ventricular, RVFWS: Right ventricular free wall strain.

DISCUSSION

RV and right atrial functions were evaluated in participants with HFpEF hospitalized for acute HF. Echocardiographic assessment at admission enabled the evaluation of ventricular and atrial performance during systolic and diastolic phases, with specific emphasis on advanced myocardial deformation imaging.

HFpEF has a rising prevalence and currently constitutes a substantial proportion of the total HF population. Although LV EF is preserved, HFpEF is associated with a significant clinical burden and adverse outcomes, highlighting the importance of identifying subclinical myocardial dysfunction at an early stage (7). TTE is the most widely used approach for the assessment of right heart structure and function, largely because of its broad accessibility, noninvasive nature, and suitability for serial evaluations (8). Nevertheless, accurate assessment of RV function remains challenging, mainly because of the ventricle's intricate geometry, intrathoracic position, and close anatomical interaction with the LV.

In daily clinical practice, a range of echocardiographic parameters – such as TAPSE, MPI, Doppler-based inflow velocities, and area-derived measurements – is routinely utilised. However, these measurements may fail to adequately capture subtle myocardial abnormalities, particularly at earlier stages of the disease process (9). In our study, LV dimensions and indices of systolic performance did not show meaningful differences between the groups, which is consistent with the defining characteristics of HFpEF. Similarly, conventional RV parameters reflecting contractile and filling function demonstrated limited ability to detect early right heart dysfunction, in line with previous reports (10,11).

In contrast, myocardial deformation analysis based on speckle tracking revealed impaired ventricular mechanics in patients with HFpEF. Both RVGLS and RVFWS were significantly lower in the HFpEF group compared with controls. These results suggest that deformation-based assessment can identify early alterations in systolic mechanics that may not be captured by conventional echocardiographic measures. Consistent with previous studies, strain parameters appear to provide a more sensitive reflection of intrinsic myocardial performance and may therefore represent early indicators of RV involvement in HFpEF (12-14).

Right atrial function was also assessed using speckle-tracking-based deformation analysis. In the HFpEF cohort, the reservoir and contraction strain components of the RA were significantly reduced, indicating early involvement of atrial myocardial mechanics. By contrast, strain during the conduit phase showed no meaningful difference between the study groups, a finding that may reflect its predominantly passive role in ventricular filling. Taken together, these observations highlight the complementary role of RA strain assessment in evaluating overall right-sided cardiac performance and suggest that atrial deformation indices may provide additional insight into the pathophysiological mechanisms underlying HFpEF.

Right atrial strain reflects the triphasic function of the atrium, including reservoir, conduit, and contraction phases. Reductions in reservoir and contraction strain observed in our study may indicate impaired atrial compliance and reduced booster pump function in the setting of elevated filling pressures in HFpEF. In contrast, the relatively preserved conduit strain may be explained by its more passive dependence on ventricular relaxation and loading conditions.

Although our study was not designed to assess long-term outcomes, previous investigations have demonstrated that RV dysfunction in HFpEF is associated with increased morbidity and mortality. The presence of subclinical impairment detected by strain imaging may therefore represent an earlier stage in the spectrum of right heart involvement. Whether these deformation abnormalities translate into adverse clinical outcomes remains to be determined. Prospective studies incorporating mortality and rehospitalization endpoints are warranted.

Study Limitations

This study has several limitations. First, its cross-sectional design did not allow for assessment of clinical outcomes such as mortality or rehospitalization; therefore, the prognostic significance of the observed strain abnormalities remains uncertain. Second, the relatively modest sample size may limit generalizability. In addition, cardiac evaluation was based solely on transthoracic echocardiography, and invasive haemodynamic measurements were not performed. Prospective studies incorporating longitudinal outcome data are needed to clarify the clinical implications of right-heart deformation abnormalities in HFpEF.

CONCLUSION

Deformation-based echocardiographic analysis identified significant changes in RVGLS, RVFWS, and atrial strain parameters in individuals with HFpEF that were not apparent on conventional echocardiographic measures. These observations indicate that myocardial deformation imaging offers incremental value beyond standard echocardiographic indices when evaluating right-sided cardiac involvement. Integration of ventricular and atrial strain analysis into routine echocardiographic practice may improve diagnostic precision and enable a more comprehensive characterization of right heart involvement in this population.

Ethics

Ethics Committee Approval: This study was approved by the Ethics Committee of Gazi University (approval number: 216, date: 27.12.2021).

Informed Consent: Written informed consent was obtained from all participants.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Y.Y., Ö.S., S.Ü., B.A.Y., M.C., M.R.Y., Concept: Y.Y., Ö.S., S.Ü., B.A.Y., M.C., M.R.Y., Design: Y.Y., Ö.S., S.Ü., B.A.Y., M.C., M.R.Y., Data Collection or Processing: Y.Y., Ö.S., S.Ü., B.A.Y., M.C., M.R.Y., Analysis or Interpretation: Y.Y., Ö.S., S.Ü., B.A.Y., M.C., M.R.Y., Literature Search: Y.Y., Ö.S., S.Ü., B.A.Y., M.C., M.R.Y., Writing: Y.Y., Ö.S., S.Ü., B.A.Y., M.C., M.R.Y.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Brouwers FP, de Boer RA, van der Harst P, Voors AA, Gansevoort RT, Bakker SJ, et al. Incidence and epidemiology of new onset heart failure with preserved vs. reduced ejection fraction in a community-based cohort: 11-year follow-up of PREVEND. Eur Heart J. 2013; 34: 1424-31.
2. van Riet EE, Hoes AW, Wagenaar KP, Limburg A, Landman MA, Rutten FH. Epidemiology of heart failure: the prevalence of heart failure and ventricular dysfunction in older adults over time. A systematic review. Eur J Heart Fail. 2016; 18: 242-52.
3. Ghio S, Temporelli PL, Klersy C, Simioniuc A, Girardi B, Scelsi L, et al. Prognostic relevance of a non-invasive evaluation of right ventricular function and pulmonary artery pressure in patients with chronic heart failure. Eur J Heart Fail. 2013; 15: 408-14.
4. Mohammed SF, Hussain I, AbouEzzeddine OF, Takahama H, Kwon SH, Forfia P, et al. Right ventricular function in heart failure with preserved ejection fraction: a community-based study. Circulation. 2014; 130: 2310-20.
5. Tadic M. Multimodality evaluation of the right ventricle: an updated review. Clin Cardiol. 2015; 38: 770-6.
6. Pieske B, Tschöpe C, de Boer RA, Fraser AG, Anker SD, Donal E, et al. How to diagnose heart failure with preserved ejection fraction: the HFA-PEFF diagnostic algorithm: a consensus recommendation from the Heart Failure Association (HFA) of the European Society of Cardiology (ESC). Eur Heart J. 2019; 40: 3297-317.
7. McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: developed by the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC), with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2021; 42: 3599-726.
8. Schneider M, Binder T. Echocardiographic evaluation of the right heart. Wien Klin Wochenschr. 2018; 130: 413-20.
9. Galderisi M, Cosyns B, Edvardsen T, Cardim N, Delgado V, Di Salvo G, et al. Standardization of adult transthoracic echocardiography reporting in agreement with recent chamber quantification, diastolic function, and heart valve disease recommendations: an expert consensus document of the European Association of Cardiovascular Imaging. Eur Heart J Cardiovasc Imaging. 2017; 18: 1301-10.
10. Kjaergaard J, Snyder EM, Hassager C, Oh JK, Johnson BD. Impact of preload and afterload on global and regional right ventricular function and pressure: a quantitative echocardiography study. J Am Soc Echocardiogr. 2006; 19: 515-21.
11. Berglund F, Piña P, Herrera CJ. Right ventricle in heart failure with preserved ejection fraction. Heart. 2020; 106: 1798-804.
12. Rothschild E, Baruch G, Kaplan A, Laufer-Perl M, Beer G, Kapusta L, et al. The prognostic value of right ventricular strain and mechanical dispersion on mortality in patients with normal left ventricle function. Int J Cardiol. 2023; 372: 130-7.
13. Melenovsky V, Hwang SJ, Lin G, Redfield MM, Borlaug BA. Right heart dysfunction in heart failure with preserved ejection fraction. Eur Heart J. 2014; 35: 3452-62.
14. Obokata M, Reddy YNV, Borlaug BA. The role of echocardiography in heart failure with preserved ejection fraction: What do we want from imaging? Heart Fail Clin. 2019; 15: 241-56.