The effect of paraaortic fat tissue thickness measured by transthoracic echocardiography on diastolic function in young individuals

Genç bireylerde transtorasik ekokardiyografi ile ölçülen paraaortik yağ doku kalınlığının diyastolik fonksiyon üzerine etkisi

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ABSTRACT

Aim: The aim of this study is to evaluate the relationship between paraaortic adipose tissue (PAT) thickness measured by transthoracic echocardiography and left ventricular diastolic function parameters in the young age group.

Material and Methods: This cross-sectional study included a total of 254 individuals aged 18–55 who visited the cardiology outpatient clinic. Participants' detailed medical histories were obtained, and body mass index (BMI), body surface area (BSA), and routine biochemical tests were recorded. Ejection fraction, left ventricular mass index, and diastolic function were assessed using transthoracic echocardiography. PAT thickness was defined as a hypoechoic space 2 cm above the sinotubular junction of the ascending aorta and measured in millimetres using echocardiography. The IBM SPSS program was used for statistical analyses, and correlation, univariate, and multivariate regression analyses were performed between parameters.

Results: Diastolic dysfunction was detected in 27.1% of participants (n=69). In the diastolic dysfunction group, age (p < 0.001), body mass index (p = 0.005), body surface area (p = 0.043), and PAT thickness (9.09 ± 4.26 mm vs. 6.91 ± 4.57 mm; p = 0.003) were significantly higher. Additionally, left atrial diameter (p = 0.016), aortic diameter (p < 0.001), relative wall thickness (p = 0.003), and left ventricular mass index (p = 0.012) were also significantly increased in this group. In univariate regression analysis, PAT (OR = 1.10; 95% CI: 1.03–1.19; p = 0.003), age (OR = 1.12; 95% CI: 1.05–1.21; p < 0.001), hypertension (OR = 2.78; 95% CI: 1.49–5.17; p = 0.001), BMI (OR = 1.08; 95% CI: 1.02–1.16; p = 0.009), and RDW (OR = 1.15; 95% CI: 1.01–1.31; p = 0.032) were significantly associated with diastolic dysfunction. However, in multivariate analysis, only age remained an independent predictor

ÖZ

Amaç: Bu çalışmanın amacı, genç yaş grubunda transtorasik ekokardiyografi ile ölçülen paraaortik adipoz (PAT) kalınlığı ile sol ventrikül diyastolik fonksiyon parametreleri arasındaki ilişkinin değerlendirilmesidir.

Gereç ve Yöntemler: Kesitsel olarak tasarlanan bu çalışmaya, kardiyoloji polikliniğine başvuran 18–55 yaş arası toplam 254 birey dahil edilmiştir. Katılımcılardan detaylı tıbbi geçmiş alınmış, vücut kütle indeksi (BMI), vücut yüzey alanı (BSA) ve rutin biyokimyasal testler kaydedilmiştir. Transtorasik ekokardiyografi kullanılarak ejeksiyon fraksiyonu, sol ventrikül kas kütle indeksi ve diyastolik fonksiyonlar değerlendirilmiştir. PAT kalınlığı, çıkan aortun sinotübüler bileşkesinin 2 cm üzerindeki hipoekoik boşluk olarak tanımlanmış ve ekokardiyografi ile milimetre cinsinden ölçülmüştür. İstatistiksel analizler için IBM SPSS programı kullanılmış, parametreler arasında korelasyon, univariate ve multivariate regresyon analizleri uygulanmıştır.

Bulgular: Katılımcıların %27,1'inde (n=69) diyastolik disfonksiyon saptanmıştır. Diyastolik disfonksiyon grubunda yaş (p < 0,001), beden kütle indeksi (p = 0,005), vücut yüzey alanı (p = 0,043) ve PAT kalınlığı (9,09 ± 4,26 mm vs. 6,91 ± 4,57 mm; p = 0,003) anlamlı olarak daha yüksekti. Ayrıca bu grupta sol atriyum çapı (p = 0,016), aort çapı (p < 0,001), relatif duvar kalınlığı (p = 0,003) ve sol ventrikül kütle indeksi (p = 0,012) de anlamlı şekilde artmıştı. Univariate regresyon analizinde PAT (OR = 1,10; %95 GA: 1,03–1,19; p = 0,003), yaş (OR = 1,12; %95 GA: 1,05–1,21; p < 0,001), hipertansiyon (OR = 2,78; %95 GA: 1,49–5,17; p = 0,001), BMI (OR = 1,08; %95 GA: 1,02–1,16; p = 0,009) ve RDW (OR = 1,15; %95 GA: 1,01–1,31; p = 0,032) diyastolik disfonksiyonla anlamlı ilişkiliydi. Ancak multivariate analizde yalnızca yaş bağımsız prediktör olarak kaldı (p = 0,045; OR = 1,089; %95 GA: 1,002–1,183). Korelasyon

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(p = 0.045; OR = 1.089; 95% CI: 1.002–1.183). In correlation analysis, PAT correlated with age (r = 0.41; p < 0.001), BMI (r = 0.33; p < 0.001), BSA (r = 0.37; p < 0.001), LA diameter (r = 0.34; p = 0.012), RWT (r = 0.33; p = 0.014), and LVMI (r = 0.35; p = 0.009), while a negative correlation was found with the E/A ratio (r = −0.39; p < 0.001).

Conclusion: Para-aortic adipose tissue thickness, which can be measured by transthoracic echocardiography, has been found to be associated with diastolic dysfunction in young individuals. However, PAT is not an independent predictor independent of traditional risk factors such as age and obesity. These results suggest that adipose tissue around the aorta may play a role in the pathophysiology of diastolic dysfunction and may be considered a risk marker in the subclinical period.

Keywords: Para-aortic adipose tissue, diastolic dysfunction, echocardiography, heart failure, preserved, cardiac remodelling

analizinde PAT, yaş (r = 0,41; p < 0,001), BMI (r = 0,33; p < 0,001), BSA (r = 0,37; p < 0,001), LA çapı (r = 0,34; p = 0,012), RWT (r = 0,33; p = 0,014) ve LVMI (r = 0,35; p = 0,009) ile pozitif korelasyon gösterirken, E/A oranı ile negatif korelasyon saptandı (r = −0,39; p < 0,001).

Sonuç: Transtorasik ekokardiyografi ile ölçülebilen paraaortik adipoz doku kalınlığı, genç bireylerde diyastolik fonksiyon bozukluğu ile ilişkili bulunmuştur. Ancak PAT, yaş ve obezite gibi geleneksel risk faktörlerinden bağımsız bir prediktör değildir. Bu sonuçlar, aort çevresindeki adipoz dokunun diyastolik disfonksiyon patofizyolojisinde olası bir rolü olabileceğini ve subklinik dönemde risk belirteci olarak değerlendirilebileceğini düşündürmektedir.

Anahtar Kelimeler: Paraaortik adipoz doku, diyastolik disfonksiyon, kalp yetmezliği, korunmuş, ekokardiyografi, kardiyak remodelling

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Highlights

- Paraaortic adipose tissue (PAT) thickness on echocardiography was significantly higher in individuals with diastolic dysfunction.
- PAT thickness positively correlated with age, BMI, and left ventricular mass index, while showing a negative correlation with the E/A ratio.
- While significant in univariate analysis, PAT was not an independent predictor of diastolic dysfunction when adjusted for age and obesity.
- PAT may serve as a useful, non-invasive risk marker for identifying subclinical diastolic dysfunction in young individuals.

INTRODUCTION

Heart failure has become a significant public health issue due to its increasing prevalence and mortality worldwide. Heart failure with preserved ejection fraction (HFpEF), one of the subtypes of heart failure, is particularly common in older individuals, but in recent years it has also been detected at a notable rate in younger age groups (1,2). The pathophysiology of HFpEF is based on left ventricular diastolic dysfunction. Diastolic dysfunction is characterized by impaired filling of the left ventricle, increased filling pressures, and stiffening of the ventricular wall (3). This deterioration may remain subclinical for a long time before symptomatic heart failure develops; therefore, early diagnosis and risk classification are of vital importance in terms of being able to change the clinical course (4). Subclinical diastolic dysfunction can be described as an insidious condition because it is usually asymptomatic and presents with very vague symptoms. Therefore, early detection of subclinical diastolic dysfunction, which is a precursor to preserved ejection fraction heart failure with a mortality rate similar to that of preserved ejection fraction heart failure, in young individuals will allow the condition to be controlled at a reversible stage.

In recent years, the impact of adipose tissue on the cardiovascular system have begun to be better understood. In particular, the epicardial, pericardial, and paraaortic fat tissues surrounding the heart and large vessels are defined not only as passive structures that store energy, but also as metabolically active organs that secrete various proinflammatory cytokines, adipokines, and prooxidant substances (5,6). These tissues can negatively affect diastolic function by reducing ventricular compliance through mechanisms such as local inflammation, oxidative stress, and myocardial fibrosis (7).

Para-aortic adipose tissue is a fatty tissue located around the thoracic aorta that can be measured non-invasively using transthoracic echocardiography. Various studies have shown that the thickness of fat in this region is associated with metabolic syndrome, atherosclerosis, and endothelial dysfunction (8, 9). However, particularly in the younger age group, the relationship between para-aortic fat tissue and left ventricular diastolic function has not yet been sufficiently investigated.

This study aims to evaluate the relationship between paraaortic adipose tissue thickness measured by transthoracic echocardiography and diastolic dysfunction parameters in a young patient group. In this context, it will be investigated whether paraaortic fat tissue can be an early indicator of subclinical diastolic dysfunction. It is anticipated that

the data obtained will contribute to the literature in terms of early risk classification, the development of preventive strategies, and prognostic evaluation.

MATERIAL and METHODS

This study was designed as a cross-sectional study to investigate the possible relationship between the two-dimensional measurement (mm) of paraaortic adipose tissue, as measured by echocardiography, and left ventricular diastolic parameters. Patients who visited the Cardiology outpatient clinic over a 4-month period were evaluated for inclusion in the study. All patients aged 18-55 years were evaluated for inclusion in the study, and individuals with active infection, active malignancy, a history of intervention for coronary artery disease (coronary artery bypass surgery, percutaneous coronary intervention), any mediastinal surgery, and valve replacement surgery were excluded from the study.

The number of individuals to be included in the study was calculated using the G*Power program. The primary variable used in calculating the estimated sample size was the measurement of para-aortic tissue in millimetres. When the sample size was calculated using Student's paired t-test with 95% power, $\alpha=0.05$ probability of error, and Cohen's effect size "medium," it was determined that the study should be completed with at least 208 patients. Based on these data, it was planned to include at least 240 participants who agreed to participate in the study.

A detailed medical history will be obtained from all individuals enrolled in the study, and accompanying cardiovascular, renal, and endocrine diseases and characteristics (hypertension, diabetes mellitus, coronary artery disease, chronic renal failure, alcohol and tobacco use, and medications used) will be recorded. Body mass index, height, and weight values (body weight/height squared (kg/m2), body surface area was calculated according to the formula BSA (m2) ¼ ([Height (cm) x Weight (kg)]/3600)1=2. Routine biochemical tests, lipid profiles, thyroid function tests, and hemogram data were recorded for all individuals. Glomerular filtration rate was calculated using the eGFR formula.

Participants underwent transthoracic echocardiography (Philips Affiniti 50 S4-2 Probe system, Andover, USA) using a 2.5-3.25 MHz transducer in accordance with the recommendations of the American Society of Echocardiography. The ejection fraction was calculated using the modified Simpson method. Left ventricular mass was calculated according to the Deveroux formula (0.8 × (1.04 × [(left ventricular end-diastolic diameter + interventricular septal thickness + posterior wall thickness) ³ - left ventricular end-diastolic diameter) + 0.6). The left ventricular mass index was calculated by dividing the left ventricular mass by the body surface area. A left ventricular mass index >95 g/m² in women and >115 g/m² in men was considered indicative of left ventricular hypertrophy. Relative wall thickness was calculated using the formula "2 × (posterior wall thickness / left ventricular end-diastolic diameter)," and left ventricular geometry was defined in four categories. Diastolic functions were calculated and recorded according to the 2016 ASE-EACVI diastolic function recommendation guidelines.

PAT was defined as a hypoechoic space in front of the aorta, 2 cm above the sinotubular junction at the end of systole (Figure 1). HU measurements in sample tomographic evaluations showed that this tissue was adipose tissue. Inter-observer consistency was calculated using Cohen's kappa value, and significant coherence was demonstrated ($\kappa=0.8406$).

All individuals included in the study were informed about the study in accordance with the ethical principles for research involving human subjects as stated in the Second Declaration of Helsinki, and written informed consent forms were obtained. The study was approved by Karabuk University Non-Interventional Clinical Research Ethics Committee (Date/Number: 2025/07/28 - 2025/2436).

Participants were grouped and analysed primarily based on their diastolic function. The IBM SPSS program was used for all statistical analyses. (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp). The normality of continuous variables was assessed by visually examining the histograms and Q-Q plots of the data and by the Shapiro-Wilks test. Continuous variables that showed a normal distribution were presented as mean (±standard deviation), continuous variables that did not show a normal distribution were presented as median (interquartile range), and categorical variables were presented as number and percentage. Continuous variables following a normal distribution between the two groups were compared using the Student's t-test, those not
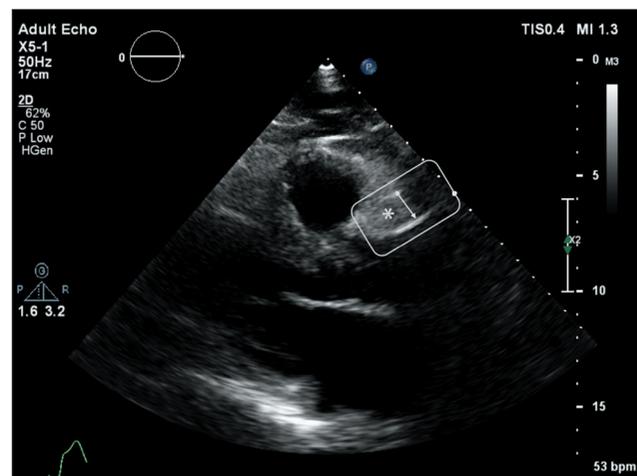

Figure 1: Echocardiographic measurement of paraaortic adipose tissue in the parasternal long-axis view

following a normal distribution using the Mann-Whitney U test, and categorical data using the chi-square or Fisher's exact test. Pearson or Spearman tests were used to evaluate the correlation of paraaortic adipose tissue with possible parameters. Univariate and multivariate regression analysis was applied to compare possible predictors for all parameters. In all comparisons, a two-tailed p-value <0.05 was considered statistically significant.

RESULTS

A total of 254 cases were included in the study. Of the participants, 33.1% (n=84) were female and 66.9% were male. Diastolic dysfunction was absent in 185 cases (72.8%) and present in 69 cases (27.1%) (Table 1).

The prevalence of hypertension was higher in the diastolic dysfunction group (71.0% vs. 45.4%; p=0.001). The use of RAAS inhibitors (44.9% vs. 23.8%; p=0.008), calcium channel blockers (24.6% vs. 10.2%; p=0.020), and beta blockers (21.6% vs. 8.1%; p=0.012) was also significantly higher. The mean age was significantly higher in the dysfunction group (47.0±6.71 vs. 39.5±9.90; p<0.001). In addition, body mass index (BMI) (30.93±4.13 vs. 28.83±4.81; p=0.005) and body surface area (BSA) (2.05±0.19 vs. 1.98±0.20; p=0.043) were significantly higher (Table 1).

The glomerular filtration rate calculated using MDRD was found to be lower in the diastolic dysfunction group (105.91±6.53 vs. 110.74±8.02; p=0.021). No significant differences were found in other biochemical parameters.

RDW values were significantly higher in the dysfunction group (15.14±2.68 vs. 14.38±1.93; p=0.032) (Table 2).

In the dysfunction group, aortic diameter (33.48±3.14 vs. 31.25±3.41; p<0.001), left atrium diameter (35.06±2.99 vs. 33.60±4.01; p=0.016), relative wall thickness (0.51±0.07 vs. 0.48±0.07; p=0.003), and left ventricular mass values (198.19±44.26 vs. 177.19±54.91; p=0.012) were significantly higher. In terms of diastolic function indicators, the A wave was higher in the dysfunction group (84.07±18.02 vs. 67.60±15.22; p<0.001), and the E/A ratio was lower (0.93±0.26 vs. 1.24±0.31; p<0.001). Additionally, E/E'lat, E/E'med, and E/E' values were significantly higher, while E', E'lat, and E'med values were significantly lower (all p<0.001).

PAT thickness was significantly higher in the diastolic dysfunction group (9.09±4.26 mm vs. 6.91±4.57 mm; p=0.003). Stage 1 dysfunction was present in 68.5% of the diastolic dysfunction group, while stage 2 dysfunction was present in 31.5%. When PAT values were examined within the diastolic dysfunction group, although they were higher in individuals with Grade 1 dysfunction (9.34±4.34 mm vs. 8.55±4.13), this was not statistically significant (p=0.534) (Table 3).

In univariate regression analysis, PAT, GFR, RDW, neutrophil, HT, BMI, age, LA, and AO variables were found to be significantly associated with diastolic dysfunction (all p<0.05). However, in multivariate analysis, only age remained an independent predictor (p=0.045, OR: 1.089, 95% CI: 1.002–1.183) (Table 4).

Table 1: Demographic Parameters of Study Population

	Total (n=254)	Diastolic Dysfunction Absent (n=185)	Diastolic Dysfunction Present (n=69)	p value
Gender (female)	84 (33.1)	60 (32.4)	24 (34.7)	0.736
Age (years)	41.5±9.78	39.5±9.90	47.0±6.71	**<0.001**
Body-Mass Index (kg/m²)	29.4±4.72	28.83±4.81	30.93±4.13	**0.005**
Body Surface Area (m²)	2.00±0.20	1.98±0.20	2.05±0.19	**0.043**
Hypertension	133 (52.3)	84 (45.4)	49 (71.0)	**0.001**
Diabetes Mellitus	17 (6.5)	13 (7.0)	4 (5.7)	0.764
Hyperlipidemia	12(6.7)	8 (5.5)	4 (7.4)	0.610
Smoking	64 (25.2)	51 (27.5)	13 (18.8)	0.270
Alcohol	20 (7.9)	14 (7.5)	6 (8.7)	0.690
ACEI/ARB	75 (29.5)	44 (23.8)	31 (44.9)	**0.008**
Anti Hyperlypidemics	13 (5.1)	9 (4.8)	4 (5.7)	0.289
CCB	36 (14.1)	19 (10.2)	17 (24.6)	**0.020**
Beta Blockers	30 (11.8)	15 (8.1)	15 (21.7)	**0.012**
Aspirin	12 (4.7)	7 (3.8)	5 (7.2)	0.228
Oral Antidiabetics	17 (6.6)	11 (5.9)	6 (8.6)	0.343

All values are presented as mean value ± SD or n (%). **ACEI:** Angiotensin-Converting Enzyme Inhibitors, **ARB:** Angiotensin II Receptor Blockers, **CCB:** Calcium Channel Blockers

Table 2: Laboratory parameters of Study Population

	Total (n=254)	Diastolic Dysfunction Absent (n=185)	Diastolic Dysfunction Present (n=69)	p value
Glucose (mg/dL)	103.28±21.42	102.06±21.72	106.44±20.46	0.202
Urea (mg/dL)	28.09±7.58	28.26±7.87	27.66±6.82	0.620
Cre (mg/dL)	0.87±0.15	0.87±0.16	0.87±0.15	0.967
GFR (mL/min/1.73 m²)	109.40±7.92	110.74±8.02	105.91±6.53	**0.021**
ALT (U/L)	28.45±20.25	28.16±19.33	29.21±22.68	0.750
AST (U/L)	22.35±10.33	22.13±9.44	22.93±12.43	0.631
Na⁺ (mmol/L)	139.37±10.20	139.03±12.00	140.22±1.89	0.472
K⁺ (mmol/L)	4.39±0.37	4.41±0.39	4.35±0.32	0.338
Triglyceride (mg/dl)	169.711±101.43	164.46±105.18	181.05±90.65	0.346
Total Cholesterol (mg/dl)	199.82±45.10	198.17±45.61	204.23±43.83	0.411
LDL (mg/dl)	199.90±37.18	199.50±36.87	120.96±38.33	0.811
HDL (mg/dl)	47.59±12.76	47.27±12.45	48.46±13.63	0.568
WBC (10³/mL)	8.03±2.05	8.15±2.09	7.72±1.92	0.189
Haemoglobin (g/dL)	14.49±1.88	14.51±1.81	14.43±2.07	0.796
Platelet (10³/mL)	262.47±66.55	263.81±68.19	258.92±62.48	0.650
PDW (fL)	15.91±2.77	15.87±2.74	16.04±2.86	0.707
Plateletcrit (%)	0.23±0.57	0.23±0.58	0.23±0.53	0.495
Neutrophils (10³/mL)	4.76±1.66	4.90±1.70	4.39±1.52	0.057
Lymphocytes (10³/mL)	2.47±0.91	2.44±0.83	2.55±1.09	0.464
RDW (fL)	14.59±2.18	14.38±1.93	15.14±2.68	**0.032**
T3 (pg/mL)	2.98±0.41	3.00±0.43	2.93±0.36	0.380
T4 (ng/dL)	1.09±1.24	1.12±1.45	0.99±0.11	0.559
TSH (uIU/mL)	1.91±1.59	1.85±1.50	2.06±1.82	0.448

All values are presented as mean value ± SD. **ALT:** Alanine Aminotransferase, **AST:** Aspartate Aminotransferase, **GFR:** Glomerular Filtration Rate, **HDL:** High-Density Lipoprotein, **LDL:** Low-Density Lipoprotein, **PDW:** Platelet Distribution Width, **RDW:** Red Cell Distribution Width, **TSH:** Thyroid-Stimulating Hormone, **WBC:** White Blood Cell

Although PAT (para-aortic adipose tissue) was significant in univariate analysis (p=0.003), it was not identified as an independent risk factor for diastolic dysfunction in multivariate analysis (p=0.601, OR: 1.024, 95% CI: 0.937–1.120) (Table 4).

In correlation analyses, PAT showed positive correlations with age, BMI, BSA, AO, LA, RWT, and LVMI, and a negative correlation with the E/A ratio in the total group. Similar correlations were observed in the group without diastolic dysfunction, while in the group with dysfunction, correlations were particularly strong with BMI (r=0.299, p=0.028), BSA (r=0.370, p=0.006), LA (r=0.339, p=0.012), RWT (r=0.333, p=0.014), and LVMI (r=0.352, p=0.009) (Table 5).

DISCUSSION

This study investigated the relationship between paraaortic adipose tissue (PAT) thickness measured by transthoracic echocardiography and left ventricular diastolic function parameters in a young age group. The strengths of the study include its focus on a young population, adequate sample size, and the evaluation of detailed echocardiographic parameters. Our findings revealed that PAT thickness was significantly higher in the presence of diastolic dysfunction. However, no independent predictors other than age were identified in multivariate analyses. Correlation analyses have demonstrated positive relationships between PAT and BMI, BSA, left atrial diameter, relative wall thickness, and left ventricular mass index. Furthermore, the association of RDW, GFR, and left ventricular mass parameters with diastolic dysfunction indicates that diastolic dysfunction is influenced not only by mechanical factors but also by haematological and renal factors. This multidisciplinary relationship once again highlights the complexity of the pathophysiology of HFpEF (2, 4).

Experimental models have demonstrated that increased shear stress on the aorta contributes to vascular inflammation by triggering a proinflammatory process in the perivascular adipose tissue surrounding the aorta (10, 11). It has been demonstrated that increased shear stress stimulates

Table 3: Echocardiographip parameters of Study Population

	Total (n=254)	Diastolic Dysfunction Absent (n=185)	Diastolic Dysfunction Present (n=69)	p value
End Diastolic Diameter, Left Ventricle (mm)	45.00±3.08	44.90±3.20	45.30±2.3	0.418
End Systolic Diameter, Left Ventricle (mm)	27.83±2.70	27.76±2.73	28.04±2.64	0.520
Ejection Fraction (%)	62.90±6.05	63.05±5.94	62.50±6.38	0.571
Ascending Aorta (mm)	31.86±3.48	31.25±3.41	33.48±3.14	**<0.001**
Relative Wall Thickness (ratio)	0.49±0.07	0.48±0.07	0.51±0.07	**0.003**
Left Ventricle Mass (g)	182.86±52.97	177.19±54.91	198.19±44.26	**0.012**
Left Ventricle Mass Index (g/m^2)	91.74±25.65	89.92±27.41	96.66±19.61	**0.100**
Left Atrium (mm)	33.99±3.81	33.60±4.01	35.06±2.99	**0.016**
E wave (cm)	80.11±18.09	81.05±14.60	77.56±25.23	0.226*
A wave (cm)	72.05±17.85	67.60±15.22	84.07±18.02	**<0.001***
E/A (ratio)	1.16±0.33	1.24±0.31	0.93±0.26	**<0.001***
E' Lateral (mm)	12.34±3.16	13.09±3.15	10.31±2.12	**<0.001***
E' Medial (mm)	9.20±2.51	9.76±2.49	7.68±1.87	**<0.001***
E' (mm)	10.77±2.66	11.42±2.63	9.00±1.81	**<0.001***
E/E' (ratio)	7.69±1.88	7.31±1.50	8.72±2.38	**<0.001***
Deceleration Time (ms)	181.94±34.65	171.84±24.62	209.24±42.52	**<0.001***
Isovolumic Relaxation Time (ms)	75.49±8.12	74.85±7.62	77.33±9.70	0.235*
Paraaortic Adipose Tissue (mm)	7.49±4.58	6.91±4.57	9.09±4.26	**0.003**
Diastolic Dysfunction				
Grade 1		-	37 (68.5)	
Grade 2		-	17 (31.5)	

All values are presented as mean value ± SD or n (%).*These parameters are used in the diagnosis of diastolic dysfunction.

Table 4: Regression analysis for diastolic dysfunction

	Univariate Analysis	Multivariate Analysis	
	p value	p value	OR (CI 95%)
Paraaortic Adipose Tissue (mm)	0.003	0.352	1.046 (0.951 - 1.150)
GFR (mL/min/1.73 m²)	0.001	0.454	1.036 (0.945 - 1.136)
RDW (fL)	0.041	0.102	1.147 (0.973 - 1.351)
Neutrophils (10³/mL)	0.059	0.065	0.775 (0.591 - 1.016)
Hypertension (n)	0.001	0.350	1.519 (0.632 - 3.648)
Body-Mass Index (kg/m²)	0.006	0.501	1.033 (0.940 - 1.135)
Age (years)	0.001	**0.045**	**1.089 (1.002 - 1.183)**
Left Atrium (mm)	0.017	0.968	0.998 (0.897 - 1.110)
Ascending Aorta (mm)	0.001	0.209	1.079 (0.958 - 1.215)

endothelial nitric oxide production, thereby facilitating vasodilation, whereas low or fluctuating shear stress increases inflammatory responses and cellular adhesion, leading to fibrosis and remodelling in the vessel wall (12). Therefore, hemodynamic loading does not remain limited to the internal parts of cardiac and vascular structures but also causes a series of structural changes in the tissues surrounding the aorta. In light of these data, it can be inferred that shear stress mediated by diastolic dysfunction may lead to a process involving inflammation, remodelling, and ultimately fibrosis around the aorta. Our study supports the existing literature on the effect of adipose tissue on cardiac structure and function. Previous studies have shown that epicardial and pericardial adipose tissues contribute to myocardial fi-

Table 5: Paraaortic adipose tissue correlations

	Total Group		Dysfunction Absent		Dysfunction Present	
	Pearson Correlation Coefficient	P	Pearson Correlation coefficient	P	Pearson Correlation coefficient	P
Age (years)	0.449	0.000	0.494	0.000	0.059	0.671
Body-Mass Index (kg/m²)	0.426	0.000	0.431	0.000	0.299	0.028
Body Surface Area (m²)	0.431	0.000	0.429	0.000	0.370	0.006
Ejection Fraction (%)	-0.071	0.316	-0.100	0.232	0.032	0.819
E/A (ratio)	-0.419	0.000	-0.371	0.000	-0.377	0.005
E/E' (ratio)	0.150	0.035	0.196	0.018	-0.110	0.429
Deceleration Time (ms)	0.245	0.000	0.137	0.099	0.237	0.084
Ascending Aorta (mm)	0.370	0.000	0.376	0.000	0.186	0.177
Left Atrium (mm)	0.312	0.000	0.275	0.001	0.339	0.012
Relative Wall Thickness (ratio)	0.316	0.000	0.268	0.001	0.333	0.014
Left Ventricle Mass Index (g/m²)	0.329	0.000	0.306	0.000	0.352	0.009

brosis, ventricular stiffness, and diastolic dysfunction by releasing inflammatory mediators (5-7). In our study, the finding that PAT is similarly associated with diastolic function parameters supports the metabolically active role of this tissue (13). This tissue is easy and inexpensive to visualize echocardiographically; therefore, demonstrating this association, particularly in the younger age group, suggests that it may be a risk marker in the subclinical period.

However, the fact that PAT is not an independent predictor in multivariate analysis indicates that traditional risk factors such as age and BMI play a more dominant role in the development of diastolic dysfunction. This suggests that the impact of paraaortic adipose tissue may be indirect and may progress in parallel with obesity and age. Indeed, the strong correlation between PAT and BMI and BSA in correlation analyses supports this hypothesis.

It has previously been demonstrated that the prevalence of diastolic dysfunction is increased in individuals with chronic kidney disease. Impaired kidney function contributes to structural remodelling of the myocardium through the accumulation of uremic toxins, activation of the renin-angiotensin-aldosterone system (RAAS), and chronic inflammation (14). These mechanisms negatively affect diastolic function by increasing ventricular stiffness (15). However, GFR levels are significantly lower in individuals exhibiting these effects. Although the GFR values observed in our study were statistically significantly lower in the diastolic dysfunction group, it should be noted that the GFR values of both groups were within the normal range. One of the primary reasons for this difference is the effect of the age factor due to formula calculations. The loss of the effect of the GFR value in the multiple analysis can be attributed to this.

The relationship between RDW values and cardiac function can actually be considered a result of the diastolic dysfunction that occurs. It is known that an increase in RDW is closely related to chronic inflammation and oxidative stress. This chronic inflammation affects erythropoiesis through inflammatory cytokines and causes changes in cell development and size, leading to an increase in RDW values. Today, RDW, whose clinical effects are increasingly recognized, has been reported to be associated with prognosis in individuals with heart failure, hypertension, cerebrovascular events, and coronary artery disease, with increased RDW values particularly predicting mortality risk in the HFpEF subgroup (16-19). It has been suggested that the RDW value may also have an effect in predicting diastolic dysfunction in cirrhotic cardiomyopathy (20). In conclusion, the detection of higher RDW values in individuals with diastolic dysfunction can be considered an indicator of an underlying subclinical inflammatory process. However, we believe that the fact that RDW was not identified as an independent predictor in multivariate analysis in our study is due to the more dominant effect of classic risk factors such as age and obesity. Nevertheless, we believe that RDW has the potential to contribute to the risk classification of diastolic dysfunction in clinical practice, as it is an easily accessible parameter that can be readily assessed in a routine blood count and does not require additional costs.

Limitations

Although the association between diastolic dysfunction and paraaortic adipose tissue has been successfully demonstrated, the cross-sectional and single center nature of the study design does not allow for causal interpretation, which is a significant limitation. Therefore, prospective and longi-

tudinal cohort studies that follow participants over a specific period of time are needed. Although measurements performed by transthoracic echocardiography are inexpensive, cost-effective, and readily available, they are operator-dependent. Furthermore, the lack of invasive measurements and the inability to demonstrate correlation with high spatial resolution examinations such as magnetic resonance imaging and computed tomography are other limitations of the method. The inability to demonstrate the biological activity of PAT using tissue biopsy or advanced imaging methods has resulted in mechanistically limited results.

Conclusion

The mechanical and biochemical processes initiated by shear stress on the aortic endothelium can cause significant changes not only in the vessel wall but also in the surrounding supporting tissues. This situation demonstrates that hemodynamic loading and the interaction of extravascular tissues must be evaluated together in the pathophysiology of aortic diseases. Paraaortic adipose tissue thickness, which can be easily assessed by transthoracic echocardiography, is associated with diastolic dysfunction in young individuals and may be a potential marker for early risk classification. Although RDW is a secondary endpoint in our study, the fact that we obtained results consistent with the literature indicates the homogeneity and value of the study's overall findings. Its place in clinical practice is questionable; our recommendations in this regard may guide general cardiovascular protection and follow-up in patients with additional risk factors. However, larger, prospective, and longitudinal studies are required to evaluate it as an independent predictor; therefore, it should be evaluated in conjunction with additional parameters such as obesity, hypertension, and age. Being kept in mind as a reminder that, in preserved ejection fraction heart failure, which still lacks universally accepted clear boundaries in terms of diagnostic criteria, the findings we present and discuss in this study have not been specified by us as gold standard methods. These findings are noteworthy in terms of causality and suggest that diastolic dysfunction may extend beyond the heart to affect the aorta and surrounding adipose tissue.

Author Contributions

Conflicts of Interest

The authors have no conflict of interest to disclose.

Ethical Approval

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