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Relationship between Increased Epicardial Fat Tissue and Aortic Diameter: May be an Indicator of Hypertension Complications

Epikard Yağ Dokusu Artışı ile Aort Çapı Arasındaki İlişki: Hipertansiyon Komplikasyonlarının Göstergesi Olabilir

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Abstract

Aim: Epicardial fat tissue (EFT) refers to the adipose tissue on the myocardium's surface and beneath the visceral pericardium. It participates in the endocrine system as well as the myocardium's energy metabolism. This study aimed to investigate the potential of EFT as a noninvasive marker for hypertension (HT) complications associated with aortic dilatation.

Material and Method: The study's control (CONT) group consisted of 70 patients with normal blood pressure and the HT group consisted of 82 patients with higher blood pressure. EFT was assessed by two-dimensional echocardiography from the parasternal long axis and compared between the CONT and the HT groups.

Results: The EFT thickness in the HT group was considerably higher than in the CONT (5.7±1.9 vs 4.0±1.3, p<0.05). In multivariate regression analysis, white coat blood pressure (p<0.05, 95% CI 0.827-0.935), ejection fraction (p<0.05, 95% CI 1.033-1.495), and EFT (p<0.05, 95% CI 0.413-0.807) were found to be independent variables in the separation of HT and CONT groups. EFT thickness had a sensitivity of 73.2 and a specificity of 57.1% at a cut-off value of 4.15. EFT was significantly correlated with sinus valsalva (r2=0.08, p<0.05), sinotubular junction (r2=0.06, p<0.05), and aorta ascendence diameter (r2=0.07, p<0.05), respectively. EFT among HT subgroups, no differences were identified.

Conclusion: EFT can be a marker revealing an increased risk of HT-related complications.

Keywords: hypertension, morphometry, biomarker, epicardial fat tissue, complications

Öz

Amaç: Epikardiyal yağ dokusu (EFT), miyokardın yüzeyinde ve visseral perikardın altındaki yağ dokusunu ifade eder. Endokrin sisteme ve miyokardın enerji metabolizmasına katılır. Bu çalışma, aort dilatasyonu ile ilişkili hipertansiyon (HT) komplikasyonları için EFT'nin non invaziv bir belirteç olma potansiyelini araştırmayı amaçlamıştır.

Gereç ve Yöntem: Çalışmanın kontrol (CONT) grubunu tansiyonu normal olan 70 hasta, HT grubunu ise tansiyonu yüksek olan 82 hasta oluşturdu. EFT parasternal uzun eksenden iki boyutlu ekokardiyografi ile değerlendirilerek CONT ve HT grupları arasında karşılaştırıldı.

Bulgular: HT grubunda EFT kalınlığı CONT'ye göre oldukça yüksekti (5,7±1,9 vs 4,0±1,3, p<0,05). Çok değişkenli regresyon analizinde ofis kan basıncı (p<0,05, %95 CI 0,827-0,935), ejeksiyon fraksiyonu (p<0,05, %95 CI 1,033-1,495) ve EFT (p<0,05, %95 CI 0,413-0,807) HT ve CONT gruplarının ayrılmasında bağımsız değişkenler olduğu bulunmuştur. EFT kalınlığının duyarlılığı 73,2, özgüllüğü ise 4,15 kesme değerinde %57,1 idi. EFT sırasıyla sinüs valsalva (r2=0.08, p<0.05), sinotubüler bileşke (r2=0.06, p<0.05) ve aort çıkış çapı (r2=0.07, p<0.05) ile anlamlı düzeyde koreleydi. HT alt grupları arasında EFT'de herhangi bir farklılık tespit edilmedi.

Sonuç: EFT, HT ile ilişkili komplikasyon riskinin arttığını ortaya koyan bir belirteç olabilir.

Anahtar Kelimeler: hipertansiyon, morfometri, biyobelirteç, epikardiyal yağ dokusu, komplikasyonlar

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INTRODUCTION

Hypertension (HT) is characterized by a rise in blood pressure. This major public health issue significantly contributes to preventable morbidity and mortality.[1] Salt sensitivity affects 50% to 60% of individuals, who are more likely to develop hypertension (HT).[2] More than half of the population over the age of 60 has HT, and the prevalence rises with age.[3] This means that in 2025 there may be up to 1.5 billion HT patients, an increase of almost 20% from the current number of patients.[4] Additionally, HT alters the tissue's structural and functional properties. For instance, it has an impact on certain vascular structure characteristics. HT causes changes at all levels of circulation, from the large arteries to the microcirculation. Finding these variations can help determine cardiovascular risk. Recent clinical trials have demonstrated that these alterations are reversible, at least when treated with antihypertensive medication.[5] Vascular remodeling brought on by chronically high systemic arterial blood pressure is facilitated by HT-related vascular dysfunction. This mechanism is described as causing changes in all arterial layers, from the endothelium to the perivascular adipose tissue.[6] The structural alteration in HT following the remodeling of the large and small arteries has been studied from a pathophysiological perspective.[7]

Aorta is a vital component of the circulatory system, responsible for distributing oxygenated blood throughout the body. Its unique anatomical structure and elastic properties enable it to regulate blood pressure and ensure a continuous flow of blood to meet the metabolic demands of various tissues and organs.[8] Long-term HT is associated with remodeling of the aortic wall. It can result in structural changes, including increased collagen deposition and alterations in the extracellular matrix, making the aorta less elastic and more susceptible to aortic dilation, as an HT-associated complication.[9]

Moreover, the pathophysiology of critical HT provides insight into circulating biomarkers because they are recognized to help figure out causation, diagnosis, progression, and therapy efficacy.[10] This method can lessen problems and slow the spread of the disease. As a result, all of this data offers a biomarker prediction for the diagnosis of HT-associated complications. As early identification of high-risk patients is advantageous, blood pressure control and other findings may postpone or prevent the start of cardiovascular disease. The involvement of cardiac biomarkers in the prognostic assessment of patients with HT is valuable since they may become aberrant long before the onset of cardiovascular disease.[11] Since current biomarkers have a poor ability to predict future HT risk, it has been suggested that a multi-biomarker technique may be helpful for HT prediction.[12] The development of new, additional biomarkers is crucial in this regard.

EFT is regarded as one of the new anatomical indicators in terms of tissue, even though anatomical magnetic resonance techniques had previously been proposed as a biomarker in neurological investigations.[13] EFT is referred to as the visceral fat depot of the heart and has distinctive anatomical characteristics.[14] Its thickness can be seen and evaluated using echocardiography, which also has minimal costs, easy accessibility, and good reproducibility. The thickness of the EFT on an echocardiogram represents the deposition of myocardial fat and visceral fat inside the trunk. It was found that there may be a connection between HT and EFT accumulation.[15] Therefore, EFT might aid in identifying patients with HT. EFT has been found to be a predictor of adult cardiovascular disease.[16] This study investigated the morphometric, biochemical, blood pressure, and demographic data of HT patients and explored the biomarker of EFT.

MATERIAL AND METHOD

Study Groups

We used file and image records from retrospective archive scanning for our study. Subjects were divided into HT (n=82) and CONT (n=70) groups. The University of Health Sciences ethical committee granted permission to conduct the study (ethics committee number: 22/465).

Demographic and Blood Analysis

Demographic data includes age, weight, pulse, 24-hour monitoring-blood pressure (the result of 24-hour monitoring with blood pressure Holter, day-and-night), instant white coat blood pressure, measurement of EFT thickness, measurement of the perpendicular distance of the echo-free area adjacent to the right ventricular free wall to the right ventricular wall, measurement of the end-diastolic image, measurement of the aortic annulus, measurement of the sinus valsalva, sinotubular junction, measurement of aorta ascending diameters, measurement of end-systolic and end-diastolic diameters of atria and ventricles, measurement of the interventricular septum and left ventricular posterior wall thickness, measurement of mitral E and A waves and E/A ratio, aortic and pulmonary flow rates, pulmonary artery pressure, biochemistry test parameter results, and complete blood count parameters. The left ventricular mass index was calculated according to the Devereux formula,[17] and the ejection fraction was calculated according to Simpson's method.[18] Echo measurements of the left ventricular septum, posterior wall, end-diastolic diameter, end-systolic diameters, and ejection fraction from the parasternal long axis with M-mode were shown in **Figure 1**.

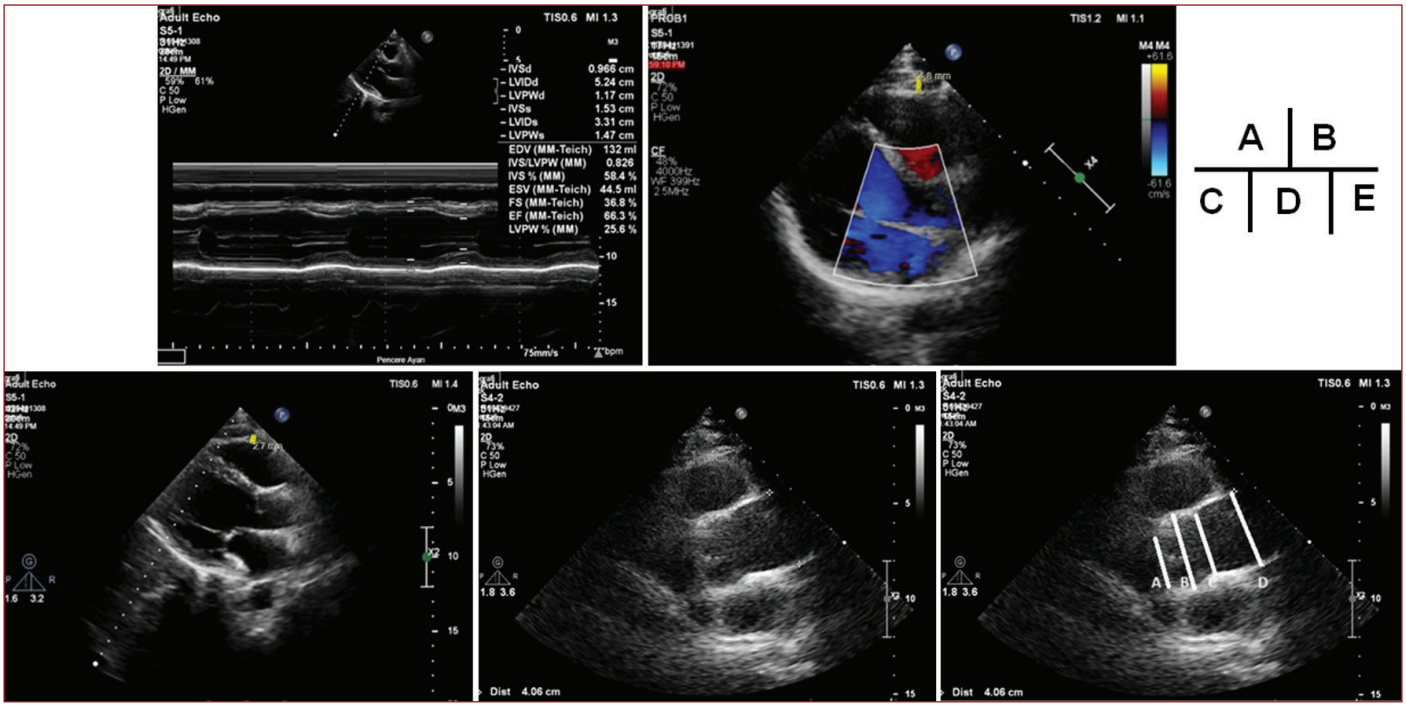

Figure 1. A) Echo measurements of the left ventricular septum, posterior wall, end-diastolic diameter, end-systolic diameters, and ejection fraction from the parasternal long axis with M-mode. B) Measurement of epicardial fat tissue from the parasternal long axis at the level of the aortic valve projection from the RV free wall at the end of diastole. Measured 4.8 mm in the sample. C) Measurement of epicardial fat tissue from the parasternal long axis at the level of the aortic valve projection from the RV free wall at the end of diastole. Measured 2.7 mm in the sample. D) Measurement of the ascending aorta. E) The way of the measurement is shown as below. A: Aortic root; B: Sinus valsalva; C: Sinotubular junction; D: Ascending aorta.

Statistical Analysis

Kolmogorov-Smirnov test was used to determine how the variables were distributed. To analyze the quantitative independent data, independent sample t-test, and Mann-Whitney u-test were utilized. The dependent data were analyzed using the Wilcoxon test and the paired-sample t-test. When analyzing qualitative independent data, the chi-square test was utilized, and the Fischer test was used when the chi-square test requirements were not met. The ROC curve was used to investigate the level and cut-off value. With the use of univariate and multivariate logistic regression, the effect level was examined. Program BMI SPSS 21.1 was used for the analysis.

RESULTS

All study participants who applied to the hospital are listed in **Table 1**. The study's candidates' age range between 18 and 89 years. 65 men (42.8%) and 87 women (57.2%) were the participants in our study. Triglyceride, creatine, uric acid, (C-reactive protein) CRP, (aspartate aminotransferase) AST, and (alanine aminotransferase) ALT were statistically significantly higher in the HT group compared to the CONT group ($p<0.05$). Complete blood count test results showed that the HT group had greater levels of RBC, HGB, HCT, monocytes, and monocytes/HDL than the CONT group ($p<0.05$). HDL value, TSH, and neutrophil count were lower in the HT group than in the CONT group ($p<0.05$) (**Table 1**).

Table 1: Comparison of metabolic variables between hypertension and healthy control groups

Variable	Hypertension (n=82) Mean±SD	Control (n=70) Mean±SD	P-value
Fasting glucose (mg/dL)	118.2±41.8	106.4±18.3	0.306
Creatinine (µmol/L)	0.8±0.2	0.7±0.2	0.000***
eGFR (mL/min/1.73m²)	93.9±16.9	95.6±20.4	0.623
Urea (mmol/L)	30.8±9.9	28.8±9.6	0.150
Uric acid (mg/dL)	6.0±1.6	4.7±1.5	0.000***
CRP (mg/L)	4.7±5.7	3.2±4.4	0.001**
Total cholesterol (mg/dL)	209.0±39.3	212.6±43.9	0.596
HDL cholesterol (mg/dL)	43.1±11.2	53.0±13.4	0.000***
LDL cholesterol (mg/dL)	128.0±32.7	131.6±37.0	0.531
Triglyceride (mg/dL)	189.4±108.2	140.4±60.6	0.002**
HGB (g/dl)	14.3±1.7	13.2±1.7	0.000***
TSH (mIU/L)	1.7±1.2	2.1±1.2	0.038*
Free T4 (pmol/L)	15.9±2.3	16.4±2.3	0.166
AST (U/L)	22.1±9.4	17.2±8.1	0.000***
ALT (U/L)	28.3±19.5	17.1±10.0	0.000***
WBC	7.8±2.0	7.9±2.8	0.897
RBC	5.0±0.6	4.6±0.6	0.000***
Platelets	259.8±64.6	265.1±66.8	0.573
Monocyte	0.618±0.188	0.536±0.183	0.002**
Monocyte / HDL	0.015±0.006	0.011±0.005	0.000***
NLR	2.0±1.1	2.6±2.3	0.306

Abbreviation: SD, Standard deviation; BMI, Body mass index; eGFR, Estimated Glomerular Filtration Rate; CRP, C-reactive protein; HDL, high-density lipoprotein; LDL, low-density lipoprotein; HGB, Hemoglobin; TSH, thyroid stimulating hormone; AST, aspartate aminotransferase; ALT, alanine transaminase; NLR, neutrophil lymphocyte ratio. *p<0.05, **p < 0.01, ***p < 0.001.

Between the HT and CONT groups, the ages of the patients did not significantly differ. In the HT group, there were significantly more male patients than in the CONT group ($p<0.05$). In comparison to the CONT group, the HT group's weight and height were considerably higher ($p<0.05$). The BMI values were not substantially different between groups. In terms of heart rate, there was no discernible difference between the HT and CONT groups. The 24-hour mean systolic pressure in the HT group during white coat, 24-hour day, and 24-hour night was substantially greater than in the CONT group ($p<0.05$). White coat, 24-hour day, 24-hour night, and diastolic pressure in the HT group were substantially higher ($p<0.05$) than in the CONT group. The HT group's HDL, TSH, and MCV levels were considerably lower than those of the CONT group ($p<0.05$). The HT group had significantly higher values for triglycerides, creatinine, uric acid, CRP, AST, ALT, RBC, HGB, HCT, monocyte, eosinophil, and monocyte/HDL ($p<0.05$). Between the HT and CONT groups, there were no appreciable differences in LDL, total cholesterol, fasting glucose, eGFR, urea, sodium, potassium, free T4, WBC, platelet, neutrophil, lymphocyte, basophil, or NLR levels (**Table 2**).

Table 2. Comparison of various data between hypertension and healthy control groups.

Variable	Hypertension Mean±SD	Control Mean±SD	P-value
Age (years)	54.4±14.8	55.0±16.9	0.820
Gender (Male/Female)	53 / 29	12 / 58	0.000***
BMI (kg/m²)	29.7±5.3	28.2±4.7	0.186
Height (m)	1.7±0.1	1.6±0.1	0.000***
Pulse	75.6±12.6	74.1±13.4	0.146
Systolic pressure			
white coat	149.6±19.4	128.4±18.1	0.000***
24 hours of day	147.4±9.3	121.8±6.7	0.000***
24 hours night	139.6±13.3	113.0±13.9	0.000***
24 hours average	145.5±9.4	120.1±6.1	0.000***
Diastolic pressure			
white coat	89.6±10.1	78.5±8.4	0.000***
24 hours of day	90.4±8.9	73.5±6.8	0.000***
24 hours night	81.5±9.9	66.5±7.4	0.000***
24 hours average	88.4±8.6	71.8±6.5	0.000***

Abbreviation: SD, Standard deviation. *p<0.05, ***p < 0.001

The HT group's EFT thickness was substantially greater than the CONT group's ($p<0.05$) (**Figure 2**). Aortic root diameter, sinus valsalva diameter, sinotubular junction diameter, aorta ascendence diameter, left atrium diameter, left ventricular end-systolic diameter, left ventricular end-diastolic diameter, left ventricular posterior wall thickness, interventricular septum thickness, right ventricular end-diastolic diameter, body surface area, left ventricular mass, ejection fraction, pulmonary valve flow rates were significantly higher in the HT group ($p<0.05$). Right atrium end-diastolic diameter, mitral E wave, mitral A wave, mitral E/A, left ventricular mass index, aortic valve flow velocity, and pulmonary arterial pressure did not significantly change. The rates of aortic stenosis, aortic insufficiency, mitral stenosis, mitral insufficiency, tricuspid stenosis, and pulmonary stenosis remained stable (**Table 3**).

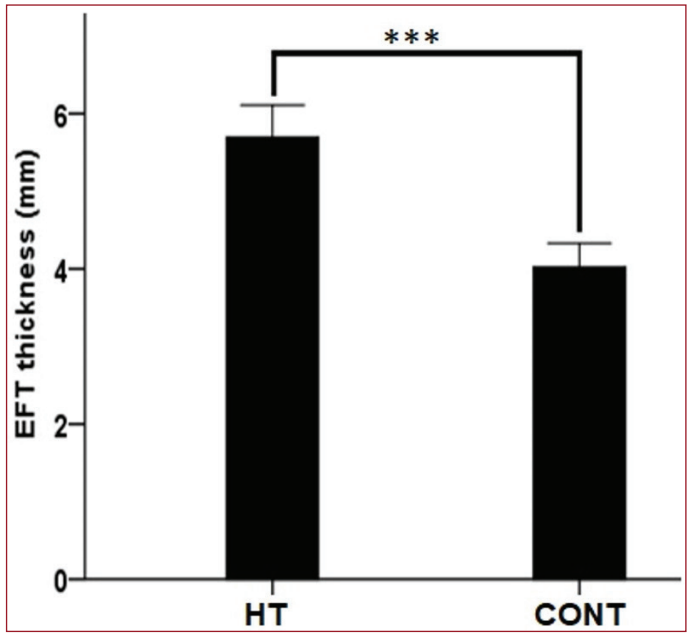

Figure 2. Comparison of epicardial fat tissue thickness between hypertension and control groups. EFT, epicardial fat tissue; HT, hypertension; CONT, control. ***p<0.000.

Table 3: Comparison of hypertension and healthy control in cardiac variables

Variable	Hypertension (n=82) Mean±SD	Control (n=70) Mean±SD	P-value
Left ventricular-end-systolic diameter (mm)	26.5±4.6	24.4±3.9	0.004**
Left ventricular-end-diastolic diameter (mm)	48.4±4.6	45.7±4.2	0.000***
Left ventricular posterior wall thickness (mm)	11.7±1.4	10.3±1.4	0.000***
Interventricular septum thickness (mm)	11.4±1.8	10.2±1.6	0.000***
Left atrium diameter (mm)	36.8±5.0	33.7±4.7	0.000***
Right atrium-end-diastolic diameter (mm)	33.7±4.4	32.2±5.0	0.050
Right ventricular-end-diastolic diameter (mm)	30.2±4.4	28.9±4.7	0.040*
Aortic ascending diameter (mm)	34.1±4.1	32.4±4.4	0.013*
Aortic root diameter (mm)	20.6±2.5	19.8±2.1	0.032*
Sinus valsalva diameter (mm)	36.9±4.2	34.9±4.5	0.002**
Sinotubular junction diameter (mm)	32.5±3.9	31.2±4.3	0.047*
Body surface area	1.99±0.39	1.65±0.28	0.000***
Ejection fraction (%)	61.2±3.6	62.8±2.5	0.006**
Aortic valve flow rate	1.37±0.13	1.40±0.17	0.473
Pulmonary valve flow rate	1.02±0.17	0.98±0.17	0.014*
Pulmonary arterial pressure (mm Hg)	19.1±5.5	19.7±5.7	0569
Epicardial fat tissue thickness (mm)	5.7±1.9	4.0±1.3	0.000***
Aortic stenosis	0 (0.0%)	0 (0.0%)	1.000
Aortic insufficiency	10 (12.2%)	12 (17.1%)	0.387
Mitral A-wave (m/s)	0.80±0.24	0.74±0.21	0.155
Mitral E-wave (m/s)	0.78±0.25	0.78±0.21	0.710
Mitral E/A-wave ratio	1.04±0.40	1.13±0.42	0.114

Abbreviation: SD, Standard deviation. *p<0.05, **p < 0.01, ***p < 0.001.

Gender, size, and white coat, diastolic 24-hour day, diastolic 24-hour night, and diastolic 24-hour mean are all terms used to describe the systolic white coat. To distinguish between the groups with and without HT, the univariate model's mean values were investigated. Measurements were made for HDL, triglycerides, creatinine, uric acid, AST, ALT, RBC, HGB, HCT, monocyte, monocyte/HDL, and EFT thickness. Additionally, the aortic root diameter, sinus valsalva diameter, sinotubular junction diameter, aorta ascendence diameter, left atrium diameter, left ventricular end-diastolic diameter, left ventricular posterior wall thickness, and interventricular septum thickness was measured. The efficiency of body surface area left ventricular mass, and ejection fraction were also significantly high (p<0.05). In the multivariate model, a significant independent efficacy of sex, diastolic white coat, HDL, EFT thickness, and ejection fraction was observed in the groups with and without HT (p<0.05) (**Table 4**). Gender, weight, white coat, systolic 24-hour day, systolic 24-hour night, systolic 24-hour mean, diastolic 24-hour day, diastolic 24-hour night, diastolic 24-hour mean, HDL, triglyceride, creatinine, uric acid, AST, ALT, RBC, HGB, HCT, eosinophil, MCV, CRP, TSH, monocyte, monocyte/HDL, EFT thickness, aortic root diameter, sinus valsalva diameter, sinotubular junction diameter, aorta ascendence diameter, left atrium diameter, left ventricular end-diastolic diameter, left ventricular posterior wall thickness, interventricular septum thickness, body surface area, left ventricular mass, and ejection fraction significant effectiveness was observed (p<0.05) (**Table 5**).

Table 4. Analysis of data with univariate and multivariate model

	Univariate Model			Multivariate Model		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Gender	0.113	0.052-0.244	0.000***	0.194	0.069-0.548	0.002**
Weight	0.920	0.888-0.953	0.000***			
white coat (Systolic)	0.944	0.925-0.964	0.000***			
24 hours day (Systolic)	0.000	0.000-	0.975			
24 hours night (Systolic)	0.741	0.669-0.821	0.000***			
24 hours average (Systolic)	0.001	0.000->100	0.985			
white coat (Diastolic)	0.881	0.843-0.921	0.000***	0.879	0.827-0.935	0.000***
24 hours day (Diastolic)	0.749	0.682-0.822	0.000***			
24 hours night (Diastolic)	0.825	0.778-0.875	0.000***			
24 hours average (Diastolic)	0.737	0.668-0.813	0.000***			
HDL	1.071	1.037-1.106	0.000***	1.056	1.014-1.100	0.009**
Triglyceride	0.992	0.988-0.997	0.002**			
Creatinine	0.035	0.005-0.264	0.001**			
Uric acid	0.626	0.504-0.777	0.000***			
Subordinate	0.925	0.880-0.972	0.002**			
Lower	0.922	0.888-0.958	0.000***			
RBC	0.300	0.161-0.558	0.000***			
HGB	0.668	0.541-0.826	0.000***			
HCT	0.861	0.795-0.933	0.000***			
Monocyte	0.081	0.012-0.552	0.010*			
Monocyte / HDL	0.000	0.000-0.000	0.000***			
EFT thickness	0.529	0.412-0.679	0.000***	0.577	0.413-0.807	0.001**
Aortic root diameter	0.853	0.736-0.988	0.034*			
Sinus valsalva diameter	0.887	0.814-0.966	0.006**			
Sinotubular junction diameter	0.919	0.846-0.999	0.048*			
Aortic ascendance diameter	0.909	0.838-0.986	0.021*			
Left atrium diameter	0.871	0.809-0.939	0.000***			
Left ventricular end-systolic diameter	0.888	0.816-0.965	0.005**			
Left ventricular end-diastolic diameter	0.867	0.800-0.941	0.001**			
Left ventricular posterior wall thickness	0.475	0.352-0.640	0.000***			
Interventricular septum thickness	0.633	0.507-0.789	0.000***			
Body surface area	0.024	0.006-0.099	0.000***			
Left ventricular mass	0.981	0.973-0.989	0.000***			
Ejection fraction	1.187	1.056-1.335	0.004**	1.924	1.033-1.495	0.021*

Logistic Regression (Forward LR), Odds Ratio (OR), Confidence Interval (CI)

Table 5. Evaluation of data by ROC analysis to differentiate patients with hypertension.

	Area under the curve	95% CI	p value
Gender	0.737	0.657-0.818	0.000
Weight	0.747	0.668-0.826	0.000
white coat (Systolic)	0.783	0.709-0.856	0.000
24 hours day (Systolic)	1.000	1.000-1.000	0.000
24 hours night (Systolic)	0.791	0.721-0.861	0.000
24 hours average (Systolic)	0.938	0.902-0.975	0.000
white coat (Diastolic)	0.883	0.828-0.938	0.000
24 hours day (Diastolic)	0.943	0.907-0.978	0.000
24 hours night (Diastolic)	0.738	0.659-0.817	0.000
24 hours average (Diastolic)	0.643	0.556-0.730	0.002
HDL	0.679	0.594-0.765	0.000
Triglyceride	0.703	0.619-0.787	0.000
Creatinine	0.650	0.562-0.738	0.001
Uric acid	0.598	0.508-0.688	0.038
CRP	0.707	0.624-0.790	0.000
TSH	0.753	0.677-0.830	0.000
AST	0.697	0.613-0.781	0.000
ALT	0.692	0.609-0.776	0.000
RBC	0.691	0.607-0.775	0.000
HGB	0.619	0.529-0.709	0.011
HCT	0.645	0.557-0.734	0.002
MCV	0.610	0.519-0.700	0.020
Monocyte	0.725	0.644-0.805	0.000
EFT thickness	0.755	0.680-0.830	0.000
Aortic root diameter	0.601	0.510-0.691	0.033
Sinus valsalva diameter	0.645	0.557-0.733	0.002
Sinotubular junction diameter	0.593	0.503-0.684	0.048
Aortic ascendance diameter	0.617	0.527-0.706	0.013
Left atrium diameter	0.673	0.588-0.759	0.000
Left ventricular end-systolic diameter	0.637	0.547-0.726	0.004
Left ventricular end-diastolic diameter	0.672	0.586-0.758	0.000
Left ventricular posterior wall thickness	0.751	0.673-0.828	0.000
Interventricular septum thickness	0.708	0.626-0.790	0.000
Right ventricular end-diastolic diameter	0.596	0.505-0.688	0.041
Body surface area	0.780	0.706-0.853	0.000
Left ventricular mass	0.769	0.696-0.843	0.000
Ejection fraction	0.614	0.524-0.703	0.016
P Vmax	0.614	0.523-0.704	0.016

ROC Curve

EFT thickness was significant [Area under the curve 0.755 (0.680-0.830)] ($p<0.05$) in the groups with and without HT. EFT thickness, at a cut-off value of 4.15; the sensitivity was 73.2; the positive estimate was 66.7%; the specificity was 57.1%, and the negative estimate was 64.5% (**Figure 3**). EFT thickness did not show a significant change according to the HT stage.

Pearson correlation analysis showed that sinus valsalva (r2=0.08, $p<0.05$), sinotubular junction (r2=0.06, $p<0.05$), and aortic ascendence diameters (r2=0.07, $p<0.05$) were significantly correlated with EFT, respectively (**Table 6**) (**Figure 3**).

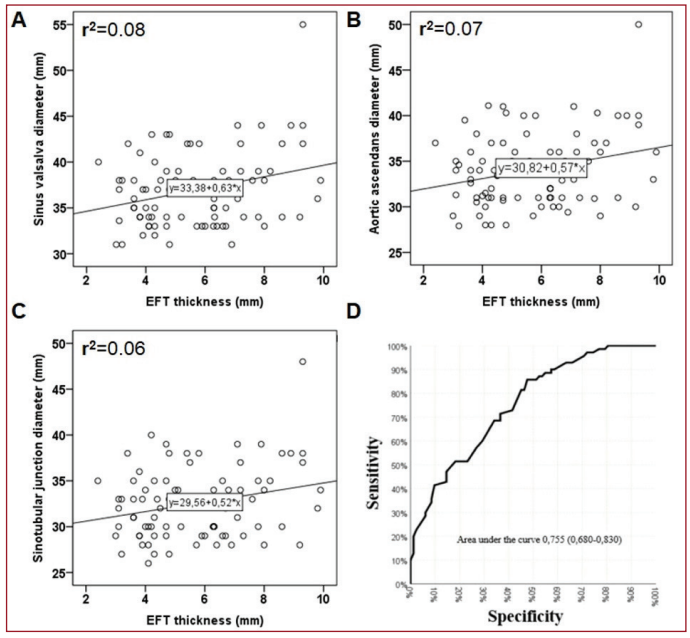

Figure 3. Correlation of EFT thickness with sinus valsalva (A), sinotubular junction (B), and aort ascendance diameters (C). Sensitivity and specificity values of epicardial fat tissue thickness for patients with hypertension (D). EFT, epicardial fat tissue thickness.

Table 6. Correlation (r2-value) of EFT thickness with sinus valsalva, sinotubular, and aort ascendance diameters.

Variable		r2	P-value
Sinus valsalva diameter	EFT thickness	0.08	0.009**
Sinotubular junction diameter	EFT thickness	0.06	0.022*
Aort ascendance diameter	EFT thickness	0.07	0.016*

Abbreviation: BMI, Body mass index. *$p<0.05$, **$p < 0.01$.

DISCUSSION

In our current investigation, our research unveiled significant findings regarding the relationship between EFT, HT, and various cardiovascular parameters. Our study indicated that EFT thickness was notably increased in HT patients, suggesting a potential link between HT and this adipose tissue depot. These findings were in line with the results of a meta-analysis that observed a tendency for HT patients to exhibit increased EFT thickness, particularly in proximity to the right ventricular wall.[19] This observation was further corroborated by a study demonstrating that EFT thickness was substantially larger in individuals with HT, reinforcing its potential role as a risk indicator for cardiovascular morbidity and HT.[20] Moreover, our research sheds light on a possible connection between the increase in EFT in hypertensive individuals and alterations in left ventricular-related parameters, such as posterior wall thickness, and end-diastolic diameter. In support of our findings, clinical studies had previously identified a correlation between EFT and left ventricular function.[21] Notably, our study also unveiled marked cardiac structural changes in hypertensive patients, including the enlargement of heart chambers and increased thickness

of the interventricular septum and posterior wall of the left ventricle. This phenomenon could be attributed to the impact of HT on the heart's structure and function, leading to cardiac remodeling, including chamber dilation. HT was recognized for its role in elevating arterial pressure, and the heart compensates for this increased pressure by adapting through structural changes. Left ventricular hypertrophy, characterized by thickening and enlargement of the left ventricle, was a common adaptation to hypertensive conditions.[22] Chronic HT could also affect the atria, potentially leading to left atrial dilation as the left ventricle becomes less compliant due to hypertrophy, resulting in increased atrial pressure. A similar process might occur in the right atrium if the right ventricle faces increased resistance in the pulmonary circulation.[23]

Furthermore, our research indicated a positive correlation between EFT thickness and the dilation of aortic structures such as the sinus of Valsalva diameter, sino-tubular junction, and aortic ascendence diameter. This relationship highlighted a potential link between EFT thickness and aortic dilation. In the long term, HT could induce structural changes in the aorta, rendering it more susceptible to dilation, a condition that could be attributed to HT itself.[24,25] Importantly, both HT and aortic dilation were independent risk factors for severe cardiovascular events, including aortic dissection, aortic rupture, and other life-threatening complications. When an individual presents with both HT and aortic dilation, their cumulative cardiovascular risk might be significantly higher than those with either condition in isolation.[26,27]

Our study also provided insights into metabolic parameters, revealing that they were notably higher in the HT group compared to the CONT group. The relationship between EFT and various metabolic parameters, such as triglycerides, creatinine, uric acid, CRP, AST, ALT, and specific blood cell counts, was an intriguing area of investigation in cardiovascular research. EFT was recognized to possess metabolic and inflammatory properties and could release bioactive molecules that might influence metabolic parameters and inflammation.[28] Notably, EFT was considered a potential source of pro-inflammatory molecules, and elevated EFT might contribute to systemic inflammation, as evidenced by higher CRP levels.[29] Furthermore, EFT's impact on the development of fatty liver could lead to increased AST and ALT levels.[30] The monocyte/HDL ratio, which serves as a marker of cardiovascular risk and inflammation, might also be influenced by EFT's pro-inflammatory properties, thus contributing to the observed association.[28]

However, it's important to acknowledge the limitations of our study. While our findings demonstrate associations between EFT, HT, cardiac parameters, and metabolic markers, it is essential to recognize that an association does not imply causation. Further research is required to establish a causal relationship and to elucidate the underlying mechanisms. Additionally, the clinical significance of these associations and their relevance to individual patient care would depend on various factors, including the strength of the association, the size of the effect, and whether these relationships hold in diverse and larger populations.

CONCLUSION

Our findings underscored the potential significance of EFT as a contributor to cardiovascular risk factors. Moreover, our study demonstrated that HT was associated with cardiac remodeling, characterized by an increase in the size of heart chambers. Furthermore, our findings suggested that EFT might play a role in metabolic dysregulation and inflammation, which were known contributors to cardiovascular disease.

In summary, our study highlights the importance of considering EFT as a potential player in the pathophysiology of HT and its associated metabolic disturbances. Future research endeavors aimed at unraveling the intricate interactions between EFT, metabolic parameters, and cardiovascular health are essential for advancing our understanding of these complex relationships and ultimately improving patient care and outcomes.

ETHICAL DECLARATIONS

Ethics Committee Approval: Our study was approved by the Ethics Committee of the University of Health Sciences, with the decision of the ethics committee numbered 22/465

Informed Consent: Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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