Araştırma Makalesi
Research Article

Cardiac Magnetic Resonance Imaging Findings of Epicardial Lipomatosis

EPİKARDİYAL YAĞLANMANIN KARDİYAK MANYETİK REZONANS GÖRÜNTÜLEME BULGULARI

Sedat ALTAY[1]

[1]İzmir Katip Çelebi Üniversitesi Atatürk Eğitim Ve Araştırma Hastanesi, Radyoloji Bölümü, Türkiye

ABSTRACT

Introduction: Epicardial lipomatosis (EL) is an increase in adipose tissue in the epicardial space. This study aimed to evaluate cardiac magnetic resonance imaging (CMR) findings and their effects on cardiac functions in patients with EL.

Methods: A total of 33 adult patients with detected EL were evaluated retrospectively. Patients were evaluated with right ventricular (RV) end-diastolic diameter (ED), RV ejection fraction (EF), left ventricular (LV) ED, LVEF, LV stroke volume, LV cardiac output, and LV cardiac index. Measurements were repeated intraobserver. Maximum epicardial fat thickness (EP) was measured from the thickest place in 2 and 4 chamber images. Data were compared with paired student t-test after the Kolmogorov-Smirnov normality test. EP and ventricular measurements were compared using Pearson's correlation coefficient.

Results: The RVED (r = 0.39), right ventricular ejection fraction (RVEF) (r = 0.35), and LVED (r = 0.31) data showed a moderate inverse correlation to the increased EP. A low correlation was found between the increased EP and other functional data of the right and left ventricles (r < 0.3). Intra-observer variability was (2.9 and 6.8%).

Conclusion: The increase in epicardial fat thickness was determined to have a low and moderate effect on the right and left heart functions.

Keywords: Heart, Magnetic Resonance Imaging, Ventricular Function, Pericardium, Adipose tissue

ÖZ

Amaç: Epikardiyal yağlanma (EL), epikardiyal boşlukta yağ dokusunun artmasıdır. Bu çalışmanın amacı EL hastalarında kardiyak manyetik rezonans görüntüleme (KMR) bulgularının ve kalp fonksiyonlarına etkilerinin incelenmesidir.

Sedat ALTAY
İzmir Katip Çelebi Üniversitesi, Atatürk Eğitim Ve Araştırma Hastanesi, Türkiye
E-posta: sedataltay@yahoo.com
https://orcid.org/0000-0003-1602-2717

DEU Tıp Derg 2021;35(2): 191- 199
J DEU Med 2021;35(2): 191 -199
doi: 0.5505/deutfd.2021.08216

Gönderim tarihi / Submitted: 27.03.2021
Kabul tarihi / Accepted: 17.05.2021

Gereç ve Yöntem: EL saptanan alan 33 erişkin hasta geriye dönük olarak değerlendirildi. Hastalar sağ ventrikül (RV) diyastol sonu çapı (ED), RV ejeksiyon fraksiyonu (EF), sol ventrikül (LV) ED, LVEF, LV vuruş hacmi (SV), LV kardiyak çıkış verileri (CO), LV kardiyak indeks (CI) ölçümleri ile değerlendirildi. Ölçümler gözlemci içi olarak tekrarlandı. Maksimum epikardiyal yağ kalınlığı (EP) 2 ve 4 odacık imajlarda ölçüldü. Kolmogorov-Smirnov normallik testinden sonra, eşleştirilmiş student t testi ile veriler karşılaştırıldı. Pearson korelasyon katsayısı kullanılarak EL yağ kalınlığı ile ventrikül ölçümleri karşılaştırıldı.

Bulgular: RVED (r = 0,39), RVEF (r = 0,35) ve LVED (r = 0,31) verileri EP artışına orta dereceli ve ters yönlü korelasyon gösterdi. EP artışı ile sağ ve sol ventrikülün diğer fonksiyonel verilerinde düşük korelasyon saptandı (r <0,3). Gözlemci içi ölçümlerde değişkenlik % 2,9-6,8 bulundu.

Sonuç: Epikardiyal yağ kalınlığındaki artışın sağ ve sol kalp fonksiyonları üzerinde düşük ve orta düzeyde etkisi saptandı.

Anahtar Kelimeler: Kalp, Manyetik Rezonans Görüntüleme, Ventrikül Fonksiyonu, Perikard, Yağ dokusu

Clinical findings of fat-containing lesions around the heart are often non-specific. These lesions are usually found incidentally in thoracic imaging studies performed for different reasons. Computed tomography (CT) and magnetic resonance imaging (MRI) are the preferred methods for more exact characterization of lesions containing fat and most commonly detected incidentally on echocardiography (1). Epicardial fat is a visceral fat accumulation located between the heart and the pericardium. Fat deposits in the mediastinum outside the parietal pericardium paracardial fat are also named intrathoracic fat. Echocardiography, CT, and cardiac MRI (CMR) have been used to evaluate epicardial fat. Pericardial fat is defined as the sum of epicardial and paracardial fat deposits (2).

Epicardial lipomatosis (EL) is an increase in the adipose tissue between the pericardium and myocardium. Schejbal et al. measured at several points the right ventricular free wall at 200 autopsies, and epicardial fat thickness was found on average (4.12 ± 1.4 mm) (3). Few studies in the literature were reported about the change of EL and heart functions. These studies are mostly studies with echocardiography(2). Flutcher et al. evaluated ejection fraction (EF) thickness by MRI using the average maximum epicardial fat thickness at several points of the RV free wall (4). EL studies with CMR, which is considered the gold standard in cardiac functional evaluation, are limited to case reports. In this study, EL and cardiac functional changes were evaluated with CMR.

This study aimed to define EL imaging findings in patients and research the effects of increased adipose tissue thickness on cardiac functions with CMR functional data.

METHOD

Study Population

A total of 33 patients (15 males and 18 females; mean age, 52 ± 10 years) determined with EL in the CMR examinations between 2014–2020 in the picture archiving and communication system of our hospital were re-evaluated retrospectively. In the end-diastolic phase of the CMR, 2 and 4 chamber images were used to measure the full layer epicardial fat thickness. Epicardial fat thickness was measured from the thickest place in 2 and 4 chamber images and noted. Patients who applied to our clinic for CMR examination with epicardial fat thickness that was diffusely thicker than 5 mm were included in the study with the diagnosis of EL. Perivascular adipose tissue located around the vessel in the atrioventricular canals was not included in the measurement. Patients without a history of coronary artery disease, hypertrophic cardiomyopathy, chronic pulmonary hypertension, diabetes, dyslipidemia, and other metabolic diseases were selected. None of them was taking cardiac drugs. Patients with severe arrhythmia, congestive heart failure, and thoracic surgery were excluded from this study, as well as patients with a history of steroid use. Fat tissue measurements other than the pericardium were not included in the study.

Imaging analysis

CMR examinations were evaluated by a radiologist who has cardiac imaging board-certificate. In the Syngo. via for MRI workstation, right ventricular ejection fraction (RVEF), left ventricular (LV) EF, LV stroke volume (SV), LV cardiac output, and LV cardiac index were calculated automatically over functional sequences. RV end-diastolic diameter (ED) and LVED were measured end-diastolic maximum lumen diameter between the inner walls according to the largest end-diastolic size in 4-chamber imaging. Data were collected, including age, gender, CMR imaging features, and both ventricular morphological data. All lumen diameters and measurement mean of the maximum epicardial fat thickness (EP) at 3 different levels of measurements were measured at maximal diameter in the end-diastolic phase. EP measurements were calculated from the epicardial space adjacent to the free wall of both ventricles. Ventricular functions adjacent to the measurement were evaluated with RV and LVEP values. Patients with EL were evaluated with RVEF, RVED, LVEF, LVED, LVCO, LVSV, and LVCI.

Cardiac magnetic resonance protocols

CMR studies were performed on a 1.5 Tesla scanner (Aera®, Siemens Healthineers, Erlangen, Germany). Patients were scanned with the electrocardiogram (ECG)-triggering using a 16-channel surface phased array body coils. After standard localizer scan images, breath-hold cine images were acquired in the 2- and 4-chamber views for the ventriculus. bSSFP cine imaging (TR/TE, 2.7–3.1/1.4–1.5; flip angle, 65°; temporal resolution, 25–39 milliseconds; in-plane resolution, 1.9 × 1.9 to 2.6 × 2.7 mm; mean value, 2.2 ± 0.2 × 2.2 ± 0.2 mm; and breath-hold duration, 10–12 heartbeats per section were acquired. Each slice has thickness of 8 mm with an interslice gap of 2 mm.) was performed in long axis 2- and 4-chamber view for biplanar assessment of LV and functions. Contours were drawn automatically and if needed manually. Biplanar anatomical and functional parameters were calculated automatically by post-processing Syngo. via for MRI.

An intravenous injection of contrast agent (Magnevist; Schering, Berlin, Germany) of 0.2 mmol/kg was administered into an antecubital vein for late gadolinium enhancement (LGE) imaging in a flow rate of 2 mL/sec. Minimum 10 min after contrast administration, IR SSFP inversion time (TI) scouting sequence was performed at a mid-ventricular short-axis location to determine optimal TI. TI was adapted to optimally null the signal of the remote myocardium calculated automatically. Two-dimensional (2D) LGE images were acquired in short-axis views covering the entire LV myocardium by using three different LGE sequences, such as segmented, single-slice, and single-breath-hold 2D fast low angle shot-based phase-sensitive inversion recovery sequence. There was only one radiologist in our clinic who had a cardiac imaging board certificate. Therefore, measurements were repeated interobserver.

Statistical analysis

All statistical analyses were done with the help of Statistical Package for the Social Sciences version 20.0 (IBM Corp., Armonk, NY, USA). Kolmogorov-Smirnov normality test was performed before the paired student t-test since the number of patients was ($n < 50$). A paired student t-test was used to compare epicardial fat thickness measurements in long-short-axis views and determine the significant differences between variables of parametric data in patients. P-value of <0.05 was considered statistically significant. Pearson correlation was used for correlation between RVEP, LVEP, and RVEF, RVED, LVED, LVEF, LVCO, LVCI, and LVSV. If the found r value is (−1), it is interpreted as a fully negative linear relationship, (+1) is a fully positive linear relationship, and r = 0 means no linear relationship between two variables. The closer the absolute value of the correlation coefficient is to the value of 1, the stronger is the linear association. Interobserver variability was assessed using the method of Bland – Altman.

RESULTS

A total of 33 patients (15 males and 18 females; mean age, 42 ± 10 years) were diagnosed with EL in the CMR examination. No deterioration in ventricular contractile functions in Cine SSFP sequences was detected by visual evaluation. Contrast enhancement consistent with myocardial ischemia or fibrosis was not observed on LGE images due to the absence of coronary artery disease history and young age of our study group paeticipants.

Epicardial fat thickness measurements

The 4-chamber and short-axis views in the right ventricle was found at three-point measurement results of the maximum thickness in the epicardial adipose tissue (EP) as the mean RVEP of 11.36 mm (±4.3 mm). The mean right heart values was the RVED mean of 56.23 mm (±15.1 mm) and RVEF mean of 40.23 % (±13.2%) [Table 1].

Table 1: Right Ventricular Maximum Epicardial Fat Thickness (RVEP), Right Ventricular Ejection Fraction (RVEF), Right Ventricular End-Diastolic Diameter(RVED)

	RVEP	RVEF	RVED
RVEP	1	,035	-,393*
RVEF	,035	1	-,500**
RVED	-,393*	-,500**	1

In this Pearson Correlation table is observed that the change between RV, measurement mean of the maximum epicardial fat thickness (EP) at 3 different levels, and RVEF, RVED show moderate correlation (r=0,39).

In the left ventricle, an average LVEP of 7.36 mm (±3.6 mm) adipose tissue thickness was measured in the maximum epicardial fat thickness measurements made from three points in 4 cavities and short-axis images. The mean left heart values was LVED mean of 47.33 mm (±16.4 mm), LVEF mean of 47.14% (±13.5%), LVSV 81 ml (±35.3 ml), LVCO 5.5 (±2,3), and LVCI 2.8 (± 2.6) [Table 2].

Table 2: Left Ventricular Maximum Epicardial Fat Thickness(LVEP), Left Ventricular End-Diastolic Diameter (LVED), Left Ventricular Ejection Fraction (LVEF), Left Ventricular Stroke Volume(LVSV), Left Ventricular Cardiac Output(LVCO), Left Ventricular Cardiac Index(LVCI)

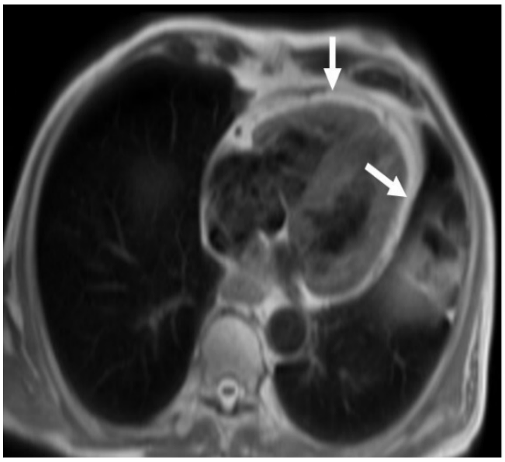
	LVEP	LVED	LVEF	LVSV	LVCO	LVCI
LVEP	1	-,318	,026	-,006	,104	,018
LVED	-,318	1	-,286	-,192	-,392*	-,344*
LVEF	,887	,107		,832	,805	,812
LVSV	,976	,286	,832		,000	,005
LVCO	,564	,024	,805	,000		,001
LVCI	,018	-,344*	-,043	,474**	,565**	1

Pearson Correlation table is observed that the change between LV, the measurement mean of the maximum epicardial fat thickness (EP) at 3 different levels and LVEF, LVED, LVSV, LVCO, and LVCI show a low correlation. LVED and LVEP show moderate correlation (r=0,31).

CMR Findings

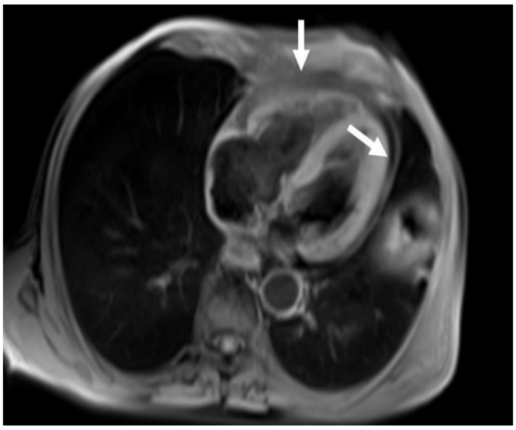
Homogeneous fat suppression was observed in fat-suppressed sequences in all patients with EL. Contrast enhancement was not observed in the adipose tissue of fat-suppressed T 1-weighted sequences in patients with EL (Fig. 1 and 2).

1-a



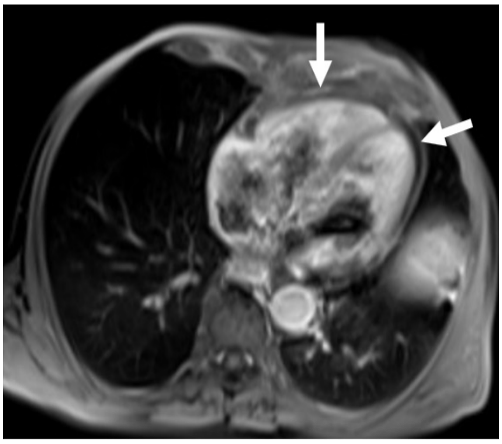
In a 48-year-old male patient with a presumptive diagnosis of resistant pericardial effusion, four-chamber SSFP

1-b



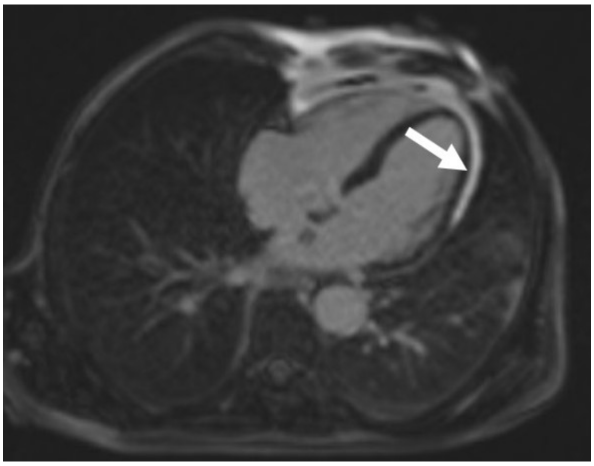
Fat sat T

1-c



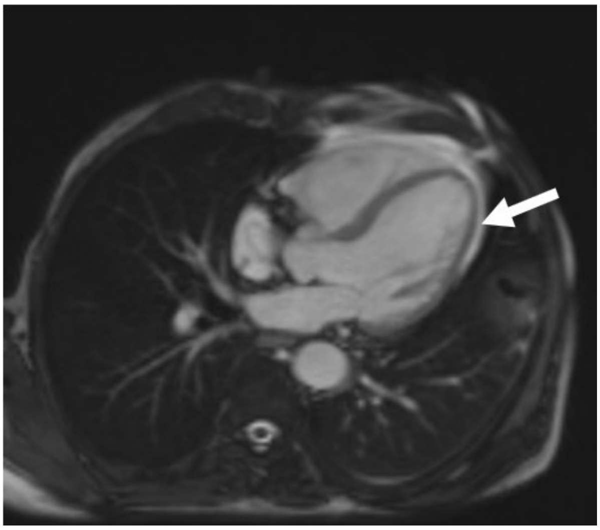
Fat-sat without contrast T

1-d



PSIR four-chamber

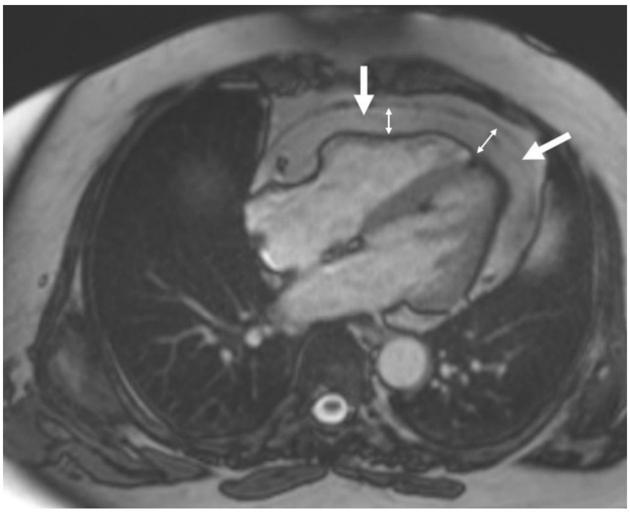
1-e



And cine SSFP four-chamber (e) images shows the increase in epicardial adipose tissue (arrows) due to epicardial lipomatosis.

Figure 2:.

2-a

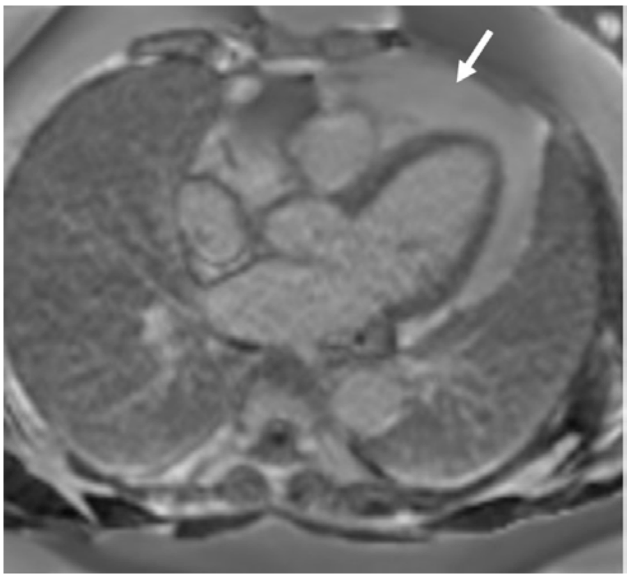


In a 54-year-old female patient, increased epicardial adipose tissue (arrows) is observed in four-chamber SSFP and EP measurement was made from the distance between the pericardium and the epicardium (double-headed arrow)

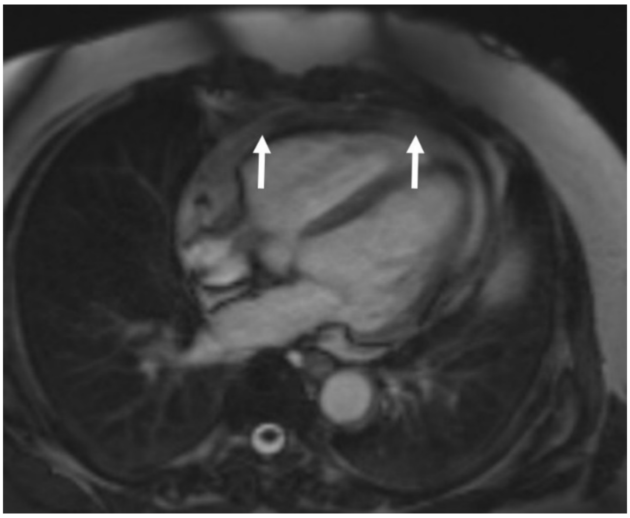
2-b

PSIR four-chamber (b, c),

2-c

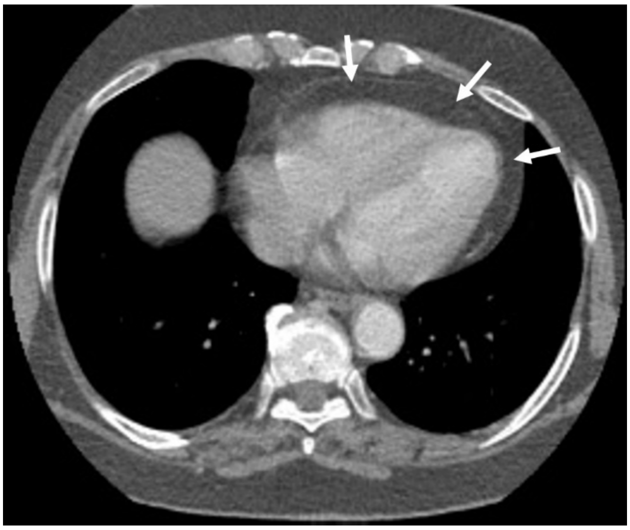


2-d



and cine SSFP four-chamber (d) images

2-e

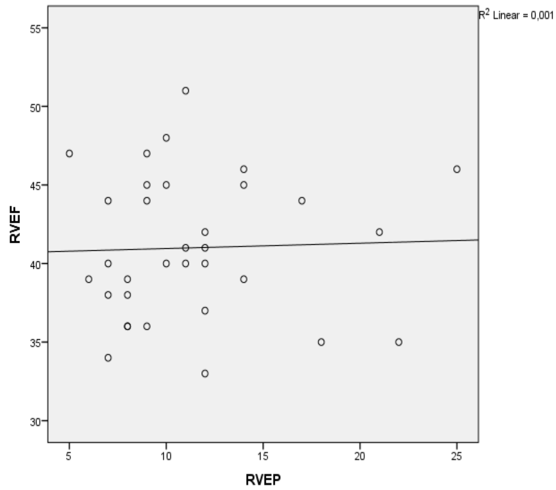


In 12 patients (8 women), adipose tissue compatible with interatrial septal lipomatosis (max. 12, mean 7 mm) was detected in the interatrial septum. Incidentally, subcutaneous lipoma (mean 25.12 mm ± 15.8 mm) was observed in 5 patients (3 women). Any adipose tissue pathology was not observed in the mediastinal regions that was included in images. Pericardial thickness was found with mean 2.2 mm (±1.51 mm).

Statistical Findings

The RVED (r = 0.39), RVEF (r = 0.35), and LVED (r = 0.31) data showed a moderate inverse correlation to the EP increase [Table 1]. Statistically, RVEP and right heart functional values were found to be moderately correlated (Fig. 3).

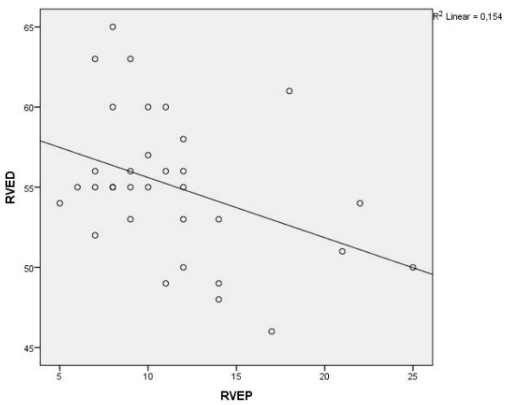
Figure 3. In this scatter plot graphic was observed that the change between RV measurement mean of the maximum epicardial fat thickness (EP) at 3 different levels and RVEF showed nominal distribution.



The highest correlation was found between RVEP and RVED as [r= −0.39]. A low and moderate correlation was found between LV functional data and LVEP. A moderate inverse correlation was observed between LVEP and LVED (r = −0.31). No high correlation was observed between LVEP and left ventricular functions [Table 2].

As a result, RVED decreases negative moderate correlation (r = −0.39) with the increase in RVEP (Fig.4).

Figure 4. In this scatter plot graphic was observed that the change between RVEP and RVED.



No significant change was found in the functional data of the right and left dventricle with increase EL (r < 0.4). The effect of increased EP on the right and left heart functions was found to be restricted. No significant relationship was found between age, gender, and EP. Intra-observer variability was between 2.9 and 6.8%.

DISCUSSION

In this study, effects of the maximal (EP) on the right and left ventricular functions in patients with EL were investigated. Very few studies in literature were reported about cardiac functions in patients with EL. This study aimed to evaluate the effects of increased EP on the right and LV functions. Our results showed a moderate correlation between the increased EP and RVED and LVED. Other RV and LV functional data correlated low with the change in EP. In patients with EL, EP is important on RV and LV functions.

Results of the study are clinically important. EL may cause a false view of the pericardial fluid increase in echocardiography (5,6). Studies on the effect of increased EP on cardiac functions are limited to case reports in literature (1,5,6,7,8). The most similar study to our study in the literature has been reported in a limited patient group with heart failure. Flüchter et al. defined the main purpose of their study as evaluating the fat volume measurement technique in CMR. Increased EL thickness and its effect on ventricular functions were not investigated because congestive heart failure cases were selected in this study (4). The relationship between the right and left heart functions and EL thickness has not been evaluated in the English literature available to us. With this study, an important deficiency in the literature will be overcome, and our study will guide us in the follow-up of patients with EL.

EL is usually asymptomatic and detected incidentally. A specific treatment protocol for EL has not been reported, and symptomatic treatments are used (5,6,7,9). Our results will assist in clinical follow-up and treatment planning. The maximum epicardial fat thickness was 26 mm; however, no significant finding was found in RV and LV functions. Incidentally detected spontaneous EL alone is not an indication for operation. In the case of EL that occurs secondary to corticosteroid treatment, results of surgical treatment have been reported in literature (1).

Our study design had few limitations. First, there were no histologically confirmed patients of EL. This review was retrospective that it could be performed with a small number of patients with incomplete clinical information. EL is a rare pathology that is not fully classified. Thus, involvement is not homogeneous. Long-term follow-up is required to determine the prognosis in patients with EL; however, long-term follow-up was not possible in the study. In addition, no age grouping was made since our cases were few. Moreover, the study was a single-center study, and all CMR examinations are interpreted by a single radiologist. In our case, EP measurement was not calculated as epicardial volume, but by the thickness measurement average of adipose tissue at 3 levels. Finally, adipose tissue cannot be measured volumetrically.

CONCLUSIONS

As a result, a moderate correlation was found between RVEP and RVED. The increase in EP effect on RV and LV functions was limited. Thus, prospective studies with larger patient series are needed to determine the factors that play a role in prognosis in patients with EL. Contribution of the author SA: Study design, data acquisition, data collection, analysis, and interpretation. The author participated in the drafting, editing, and approval of the final version of the manuscript.

Conflict of interest

None of them were declared.

REFERENCES

1. Pruente R, Restrepo CS, Ocazionez D, Suby-Long T, Vargas D. Fatty lesions in and around the heart: a pictorial review. *Br J Radiol*. 2015;88(1051):20150157. doi:10.1259/bjr.20150157

2. Bertaso AG, Bertol D, Duncan BB, Foppa M. Epicardial fat: definition, measurements and systematic review of main outcomes. *Arq Bras Cardiol*. 2013;101(1):e18-e28. doi:10.5935/abc.20130138

3. Schejbal V. [Epicardial fatty tissue of the right ventricle-morphology, morphometry and functional significance]. Pneumologie. 1989;43(9):490-9.

4. Flüchter S, Haghi D, Dinter D et al. Volumetric assessment of epicardial adipose tissue with cardiovascular magnetic resonance imaging. Obesity (Silver Spring). 2007;15(4):870-8.

5. Miller CA, Schmitt M. Epicardial lipomatous hypertrophy mimicking pericardial effusion: characterization with cardiovascular magnetic resonance. *Circ Cardiovasc Imaging*. 2011;4(1):77-78. doi:10.1161/CIRCIMAGING.110.957498

6. Kaur N, Singh J, Haq S, Garg S, Bhatnagar S. Pleural and Mediastinal Lipomatosis with Subpleural Fat as a Mimicker of Pleural Effusion-A Rare Case Report. *J Clin Diagn Res*. 2017;11(7):TD03-TD04. doi:10.7860/JCDR/2017/26182.10156

7. Bajwa F, Koenig G, Hegab S, Parikh S, Ananthasubramaniam K. A Case Series of Epicardial Lipomatosis Masquerading as Extracardiac Pathology on Echocardiography: Role of Multimodality Imaging in Clarifying Misdiagnosis. *CASE (Phila)*. 2020;4(5):389-392. Published 2020 Jul 7. doi:10.1016/j.case.2020.05.023

8. Sanal HT, Kocaoğlu M, Yildirim D, Ors F. Multiple cardiac lipomas and pericardial lipomatosis: multidedector-row computer tomography findings. *Int J Cardiovasc Imaging*. 2007;23(5):655-658. doi:10.1007/s10554-005-9051-x

9. Smail H, Baciu A, Dacher JN, Litzler PY. Surgical resection of circumferential epicardial adipose tissue hypertrophy: Case report and systematic review of the literature. *J Thorac Cardiovasc Surg*. 2016;151(2):e27-e30. doi:10.1016/j.jtcvs.2015.08.083