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The evaluation of epicardial adipose tissue radiodensity according to age

Yaş dağılımına göre epikardiyal yağ doku radyodansitesinin değerlendirilmesi

Arslan Öcal [1], Ersin Sarıçam [2], Ali Doğan Dursun [3], Mehmet Fazıl Tolga Soyal [4], Hakkı Serkan Şahin [4], Gülçin Türkmen Sarıyıldız [5]

[1] Gulhane Education and Research Hospital, Department of Cardiology, Ankara, Turkey
[2] Medicana International Hospital, Atilim University, Cardiology Clinic, Ankara, Turkey
[3] Atilim University, Department of Physiology, Ankara, Turkey
[4] Medicana International Hospital, Atilim University, Cardiovascular Surgery Clinic, Ankara, Turkey
[5] Medicana International Hospital, General Surgery Clinic, Ankara, Turkey

ORCID ID of the author(s)
AÖ: 0000-0002-9971-1974
ES: 0000-0002-8736-1786
ADD: 0000-0001-9056-0025
MFTS: 0000-0001-6276-3140
HSŞ: 0000-0002-2460-0444

Corresponding author/Sorumlu yazar:
Ersin Sarıçam
Address/Adres: Medicana International Ankara Hastanesi, Atılım Üniversitesi, Söğütözü İlçesi 2165 Sokak No: 6, Söğütözü, Ankara, Türkiye
E-mail: saricamersin@yahoo.com

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Abstract

Aim: The grading of fatty degeneration by cardiac computerized tomography (CCT) is an important bioradiological marker to discriminate biological characteristics. Epicardial adipose tissue (EAT) degeneration has been accused of causing heart disease. However, the relationship between age and EAT radiodensity is not well known. In this study we examined epicardial adipose tissue radiodensity with CCT.

Methods: A total of 147 subjects who underwent contrast-enhanced evaluation of coronary arteries with CCT between Jun 2018-July 2019 due to intermediate probability of coronary artery disease (CAD) were included in this retrospective cohort study. The radiodensities of three epicardial regions (right atrioventricular groove, posterior interventricular groove, and anterior epicardial area) and individual subxiphoid fat radiodensity ratios were obtained. Group comparisons were made according to 10-year-periods (between 10- 80 years of age).

Results: We found that epicardial adipose tissue/ subxiphoid fat radiodensity ratio decreased with increasing age. After the 3rd decade, we detected a negative correlation between EAT/subxiphoid fat radiodensity ratio (r=-0.11). The radiodensity ratios of patients between 20-30 and 30-40 years of age in the LCX, RCA and anterior epicardial regions were 1.71 (0.14) and 1.06 (0.40) (P<0.001), 1.71 (0.20) and 1.04 (0.30) (P<0.001), and 1.70 (0.07) and 1.17 (0.42), respectively (P<0.001).

Conclusion: EAT radiodensity ratio changes are associated with aging. Increased age is negatively correlated with EAT radiodensity ratio, which is considered fat degeneration. We realized that those changes occurred sharply after the third decade.

Keywords: Epicardial adipose tissue, Fatty degeneration, Radiodensity ratio

Öz

Amaç: Yağ doku dejenerasyonu değerlendirmenin sınıflanması kardiyak tomografi (KT) kullanarak biyolojik karakteristiklerin ayırmak için önemli bir biyoradyolojik göstergedir. Epikardiyal yağ doku dejenerasyonu kalp hastalıklarına neden olmakla suçlanmaktadır. Fakat yaş ile epikardiyal yağ doku dejenerasyonu arasında ilişki çok iyi bilinmemektedir. Bu çalışmada biz KT kullanarak epikardiyal yağ doku radyodansitesi inceledik.

Yöntemler: 2018 Haziran ve Temmuz 2019 yılları arasında 147 hastanın orta derece olasılık koroner arter hastalığı için orta derece olasılık nedeniyle koroner arterleri KT ile değerlendirilmesi yapıldıç Bu restrospektif kohort çalışmadır. Üç epikardiyal bölge (sağ atriyoventriküler groove, posterior interventriküler groove ve anterior epikardiyal) radyodansitesi ve bireysel subxiphoid yağ radyodansitesi elde edildi. Grup karşılaştırılmaları 10 yıllık periyodlara göre yapıldı (10 ile 80 yaş arası).

Bulgular: Epikardiyal yağ doku / subxiphoid yağ radyodansitesi oranları artan yaş ile azalmaktadır. Üçüncü 10 yıl sonrası epikardiyal yağ doku / subxiphoid yağ radyodansitesi oranları keskin bir şekilde azaldığını gözlemledik. Pearson correlation oranı negative ve r=-0,11). Yirmi ve 30 yaş arası ile 30-40 yaş arası LCX bölgesi sırasıyla 1,71 (0,14) vs. 1,06 (0,40); P<0,001). RCA bölgesinde ayni yaşlarda sırasıyla 1,71 (0,20) vs. 1,04 (0,30) P<0,001.Anterior epikardiyal bölge aynı yaşlarda sırasıyla 1,70 (0,07) vs. 1,17 (0,42) P<0,001.

Sonuç: Epikardiyal yağ doku radyodansitesi oranı değişikliği yaş ile bağlantılıdır. Artan yaş daha az epikardiyal yağ doku radyodansitesi oranı ile ilişkilidir. Bu ilişki yağ dejenerasyonu kabul edilir (negatif korelasyon). Biz bu değişikliklerin 3. 10 yıl sonrası keskin bir şekilde olduğunu gözlemledik.

Anahtar kelimeler: Epikardiyal yağ dokusu, Radyodansite oranı, Yağ dejenerasyonu

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Introduction

Cardiac computerized tomography (CCT) is a helpful technique for radio-density evaluation in terms of discernment of the characteristics between similar tissue types [1,2]. The grading of fatty degeneration is an important bio-radiological marker.

Epicardial adipose tissue (EAT) is positioned between the myocardial surface, the visceral layer of the pericardium and the surrounding coronary artery region. However, EAT degeneration was accused of causing heart disease. The relationship between EAT and atrial fibrillation, atherosclerosis, hypertension was shown in numerous studies [3-5]. In evaluation of EAT degeneration, radiodensity measurements are not standardized due to amorphous shape of epicardial adipose tissue. Besides, the relationship between age and EAT radiodensity is not well known. Our aim in this study was to quantify the relationship between standardized individual EAT radiodensities and age.

Materials and methods

A total of 147 subjects who underwent CCT between June 2018-July 2019 due to intermediate probability of coronary artery disease (CAD) were retrospectively evaluated. Informed consent forms were obtained from all patients. Approval for the study protocol was obtained from Medicana International Ankara Hospital Human Research Ethic Committee (2019/5), and the study was conducted in accordance with the Declaration of Helsinki principles. Patients who received antihypertensive treatment were considered to have hypertension. Those with prior coronary artery stent or coronary by-pass operations, atrial fibrillation, implanted pacemaker, cardioverter-defibrillator, and coronary narrowing above 40% were excluded.

Cardiac computed tomography (CCT) study schedule and interpretation

CCT procedures were performed with a dual source scanner (Philips Brillance 64, number 9938, Holland). Scans for CAC measurements were obtained using a standard scan protocol with 1.0-mm slice collimation. The CAC score was quantified using the Calcium Score module of Syngo software and expressed in Agatston units. Tube voltage was set to 120 or 140 kV depending on body mass. Tube current changed from 400 to 445 mA. Scan duration was 4-10 seconds. Intravenous metoprolol was used in cases where pulse>70 beats/min. The general heart rate during the scan was 60-65 beats/min. Delay time among contrast injection and scan launch was based on the time – density curve obtained after a 10-ml test bolus infusion. The average 80-100 ml of contrast dye was given at a rate of 5 ml/s, which was followed by a 40-ml saline solution flush. The scanning was made during a single inspiratory breath hold, starting at the level of bronchial carina, and finishing 10 mm beyond the heart apex.

Scans were processed and analyzed off-line on a dedicated workstation (Extended Brilliance, Workspace version 7.1.1.28 Philips medical Solutions). Analysis and measurement of the images were performed at the most motionless mid- to end-diastolic phase gated at 60–80% of the RR interval. In the presence of motion artifacts, additional reconstructions were used to evaluate the coronary arteries. The signal-to-noise ratio was calculated by dividing the difference in mean attenuation (HU) between the coronary lumen and peri-coronary tissues by the standard deviation of the mean attenuation in the aortic root.

Coronary artery lesion calculation

The recognized coronary artery lesion was evaluated for stenosis severity along multiple longitudinal, transverse, and oblique axes with the use of multi-planar reconstructions, thin-slab maximum intensity projections, and curved reconstruction techniques. The coronary lesion's severity was quantified by the maximum percentage of luminal diameter stenosis observed in any plane. In ambiguous cases, the percentage of luminal narrowing was recognized by a 2-observer consensus. CAD was identified with the presence of at least one coronary lesion with ≥40-50% luminal diameter stenosis. Coronary lesion assessment was made by interventional cardiologists experienced in acquisition and interpretation of angiography and unaware of the results of EAT measurements.

EAT Measurements

EAT is known as the adipose tissue located within the pericardial sac. EAT radiodensities were obtained using the volume module. EAT radiodensity (regions of interest (ROIs), Hounsfield unit, HU) was measured in the three different epicardial regions in 0.05 cm^2 adipose tissue area (right atrioventricular groove (RCA), posterior interventricular groove (LCX), and anterior epicardial region) (Figure 1). Due to amorphous shape of the epicardial adipose tissue, these measurements were standardized with subxiphoid fat tissue and three epicardial fat radiodensity/subxiphoid fat radiodensity ratio values were obtained as constant ratio. To identify pixels corresponding to adipose tissue within the ROIs, a threshold attenuation range from −190 to −30 HU was used, and a change from negative to positive was considered fat degeneration. Constant ratio was classified within a period of ten years. Mean EAT radiodensity was analyzed on a HU scale. All the EAT measurements were performed by one investigator (H.U); 30 randomly selected cases were re-assessed by H.U. and E.S to obtain the intra- and inter-rater variabilities.

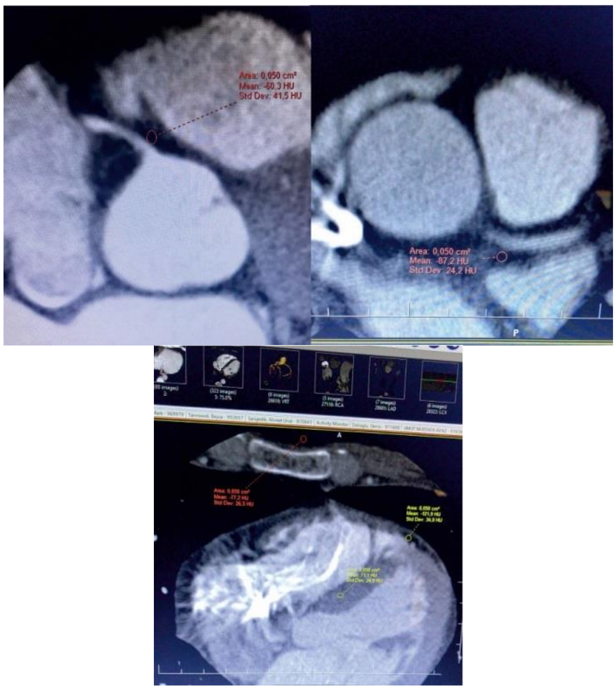

Figure 1: Three different epicardial regions in 0.05 cm^2 adipose tissue area (right atrioventricular groove, posterior interventricular groove, and anterior epicardial region)

Statistical analysis

The data was analyzed with SPSS statistical analysis software (SPSS 17.0 Inc, Chicago, IL, USA). The normality of the data was checked with Shapiro-Wilk Test. The difference between the independent groups (decades for age) was determined by one-way analysis of variance (ANOVA) and Tukey's multiple comparison in normally distributed variables, and by Kruskal Wallis test in non-normally distributed variables. The difference between the dependent groups (epicardial region) was determined by repeated ANOVA and Tukey's multiple comparison tests in case of normal distribution, and by Friedman test in non-normal distribution. Pearson correlation test was used for correlation analysis. The significance level was 0.05; when multiple comparisons were implemented for nonparametric tests, an adjusted α (α = 0.05/ number of test) was used.

Results

Three epicardial regions' (right atrioventricular groove, posterior interventricular groove, and anterior epicardial) radiodensity and individual subxiphoid fat radiodensity ratios were obtained. Each group ratio is shown in Table 1. The radiodensity ratios of patients between 10-20 and 20-30 years of age in the LCX, RCA and anterior epicardial regions were 1.73 (1.54) and 1.71 (0.14) (P=0.98), 1.99 (2.63) and 1.71 (0.20) (P=0.62), and 1.71 (1.78) and 1.70 (0.07), respectively (P=0.12).

We found that epicardial adipose tissue/ subxiphoid fat radiodensity ratio decreased with increasing age. This decrease was sharp after the 3rd decade - there was a negative correlation between EAT/subxiphoid fat radiodensity ratio (r=-0.11) (Figure 2). The radiodensity ratios of patients between 20-30 and 30-40 years of age in the LCX, RCA and anterior epicardial regions were 1.71 (0.14) and 1.06 (0.40) (P<0.001), 1.71 (0.20) and 1.04 (0.30) (P<0.001), and 1.70 (0.07) and 1.17 (0.42), respectively (P<0.001).

Table 1: The radiodensity ratio according to each decade

A decade (years)	Right atrioventricular groove mean (SD)	Posterior interventricular groove mean (SD)	Anterior epicard mean (SD)
11-20 (n=3)	1.99(2.63)	1.73(1.54)	1.71(1.78)
21-30 (n=2)	1.71(0.20)	1.71(0.14)	1.70(0.07)
31-40 (n=20)	1.04(0.30)	1.06(0.40)	1.17(0.42)
41-50 (n=61)	1.02(0.43)	1.02(0.42)	1.16(0.36)
51-60 (n=42)	0.96(0.36)	1.01(0.34)	1.11(0.28)
61-70 (n=12)	0.92(0.40)	0.98(0.45)	1.03(0.38)
71-80 (n=7)	0.89(0.36)	0.93(0.46)	0.99(0.35)
P-value	<0.001	<0.001	<0.001

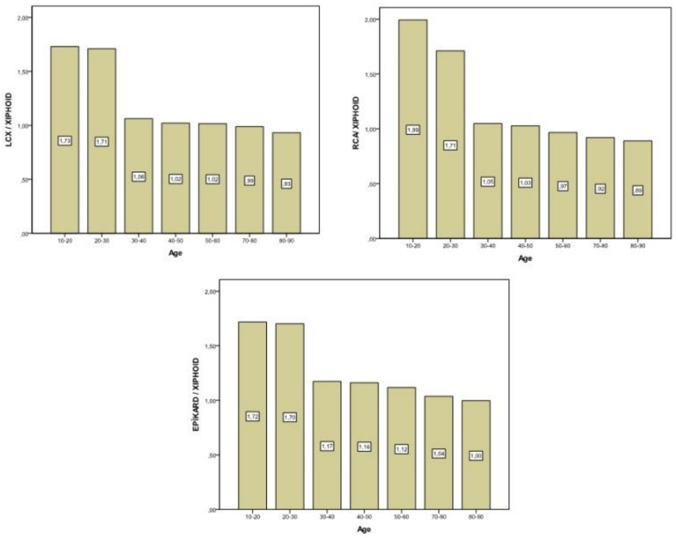

Figure 2: Epicardial adipose tissue / subxiphoid fat radiodensity ratios

Discussion

The measurement of the radiodensity of human tissues is a commonly used method that helps in discriminating among both similar and diverse tissue types and organs in routine clinical study, as evaluated by CCT [6,7]. For instance, the reduction of coronary artery atherosclerotic plaques can be examined to determine their composition and therefore, their vulnerability and the possibility of cardiovascular events [8,9]. Myocardial edema in large acute myocardial infarctions may be recognized by decreased Hounsfield units (HU) value [10]. Fat degeneration results in decreased negativity HU in radiologic terms. A greater ratio (less negativity) of EAT radiodensity suggests a transition from hypodense 'fatty' components to hyperdense 'non-fatty' components within the EAT. The 'non-fatty' appearance arises from non-adipose (inflammatory) cells, contrast-enhanced microvasculature, and interlobular septa [11].

Due to amorphous shape of epicardial adipose tissue, radiodensity measurements are not standardized. Besides, the relationship between age and EAT radiodensity is not well known. In this study, we first examined the relationship between standardized individual EAT radiodensity detected by CCT in the heart with regards to decades. Among the study population, EAT radiodensity changed to more positive with increased age. Our data demonstrate that EAT degeneration accelerates after the 3rd decade. We suggest that decreased EAT radiodensity ratio is associated with fat degeneration. Although other studies did not find any relationship between aging and epicardial fat measurements, they have only included older subjects or obese patients with high epicardial adiposity, and cases with cardiac diseases [12,13]. In our study, patients with coronary artery stents or prior coronary by-pass operations were excluded.

Aging is related to metabolic degeneration characterized by changes in fat distribution, and insulin resistance. These metabolic modifications are associated with a variety of age-related diseases that subsequently result in increased mortality [14]. Therefore, age is a degeneration marker. It has been known that the prevalence of atherosclerosis and atrial fibrillation is associated with increased age. Moreover, age has been used in decision making for thromboprophylaxis in non-valvular atrial fibrillation (CHA2DS2-VASc score) [15]. Our data support that EAT radiodensity ratio, whose decrease is considered fat degeneration, is negatively correlated with age. We have reason to suggest that EAT radiodensity ratio could be a degeneration marker.

Limitations

The current study is non-invasive, and further invasive surgical studies to confirm our results are needed.

Conclusion

EAT radiodensity ratio changes are associated with aging. Increased age is negatively correlated with EAT radiodensity ratio, which is considered fat degeneration. We realized that those changes occurred sharply after the third decade. We believe that EAT radiodensity could be used as a degeneration marker.

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