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Clinical and anatomical features of cardiac fat deposits

A.V. Solovieva[1]*, T.P. Sergeeva[2]

[1] Ryazan State Medical University, Ryazan, Russian Federation

[2] Ryazan Clinical Hospital № 11, Ryazan, Russian Federation

Authors

Alexandra V. Solovieva, M.D., PhD, associate professor of the Department of Intermediate Therapy with the course of endocrinology, clinical pharmacology, and occupational diseases, Ryazan State Medical University, Ryazan, Russian Federation

Tatiana R. Sergeeva, M.D., physician of the Department of Pathology, Ryazan Clinical Hospital № 11

Objective. *To analyze clinical and anatomical features of cardiac visceral fat deposits: epicardial fat and interatrial septum lipomatosis during the pathological examination.*

Materials and methods. *We analyzed the results of autopsy in 27 patients (15 females and 12 males) aged from 53 to 88 years. We estimated the thickness of epicardial fat (EF) and interatrial septum (IAS), prevalence and severity of atherosclerotic lesions of aorta and coronary arteries.*

Results. *Brain stroke was the cause of death in 44 % cases, and 11 % of death cases were due to myocardial infarction. Left coronary artery (LCA) had 40 % stenosis on average (30;50 %), right coronary artery had 44 % stenosis on average (40;60 %), and calcified atherosclerotic plaques were detected in 18 patients (66.6 %). Average EF thickness was 14 millimeters (10; 15) and ranged from 5 to 20 millimeters. Average thickness of AS was 10 millimeters (7;15) and ranged from 4 to 20 millimeters.*

Histological study demonstrated that epicardial fat represented a single layer of adipose tissue surrounding right coronary artery and sinus venosus, and that lipocytes of the EF inner layer grew between the bundles of myocardial muscle fibers.

Adipose tissue permeates the peripheral part of IAS myocardium, which creates a picture of altered bands of muscle and adipose tissue during microscopic examination.

Adipose tissue infiltrates the zone of the greatest thickness of IAS in a range from 30 % to 70 %. We detected a correlation between interatrial and interventricular septum thickness (r=0.47; p=0.012), whereas females demonstrated a correlation between left ventricular mass (r=0.67; p=0.023) and AS thickness.

* Corresponding author. Tel.: +7-920-634-09-62. E-mail: savva2005@bk.ru

Males had a positive correlation between thickness of IAS and blood level of triglycerides (r=0.77; p=0.001). A positive correlation between epicardial fat thickness and left ventricular thickness was also detected (r = 0.59; p = 0.042).

Conclusion. *The thickness of IAS lipomatosis and the thickness of epicardial fat tissue correlates with triglyceride blood level, left ventricular myocardial hypertrophy, and calcification of coronary arteries in autopsy.*

Keywords: *epicardial fat, lipomatosis of interatrial septum*

Conflicts of interest: nothing to declare.

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Introduction

Local fat deposits attract close attention of clinical practitioners nowadays, for example, some of them suggest to use epicardial fat (EF) as a new marker of cardiovascular diseases [1]. EF plays role in the development of left ventricular myocardial hypertrophy, coronary atherosclerosis, diastolic function disturbances and fibrosis of cardiomyocytes [2, 3, 4]. Lipomatosis hypertrophy of interatrial septum and its role in the development of cardiovascular diseases is studied less by Russian authors.

Interatrial septum lipomatosis or lipomatosis hypertrophy of interatrial septum (LHIAS) is asymptomatic in most cases and is usually seen in elderly and obese patients. The association between LHIAS, supraventricular rhythm disturbances [5, 6, 7, 8] and sudden cardiac death causes the greatest clinical interest [9]. LHIAS prevalence range from 2% to 8% during transthoracic and transesophageal echocardiography respectively, however, true prevalence is unknown [10].

Hypertrophied interatrial septum due to lipomatosis has a «dumbbell» shape during a visualization with two-dimensional echocardiography or computer tomography (CT). Figures 1 and 2 represent the anatomy of IAS normally and during LHIAS.

The question of determining the thickness of interatrial septum (IAS) thickness, when it can be considered to be hypertrophied, is controversial. One study showed that IAS thickness of adipose tissue normally is about 0–9.6 mm anterior and 0–9.9 mm posterior to foramen ovale during the CT [11]. The study of J.D.Gay was dedicated to LHIAS and included patients with IAS thickness less than 1.0 sm [9]. We chose the thickness of 10 mm and more as a marker of lipomatosis hypertrophy, even though some foreign authors chose 20 mm and more.

We did not find any clinico-anatomical studies of local cardiac fat deposits in available domestic literature, when foreign articles mostly describe clinical cases of this disorder.

Objective

To analyze clinical and anatomical features of cardiac visceral fat deposits: epicardial fat and interatrial septum lipomatosis during the pathological examination.

Materials and methods

We analyzed the results of autopsy in 27 patients (15 females and 12 males) aged from 53 to 88 years (median age is 74 (64; 79) years).

During the pathological examination we estimated EF, which was localized perpendicular to the aortic ring along the AS posterior edge and the interventricular septum (IVS). The thickness of IAS was measured at the upper posterior edge of foramen ovale. Furthermore, we estimated the prevalence and severity of atherosclerotic lesions of coronary arteries.

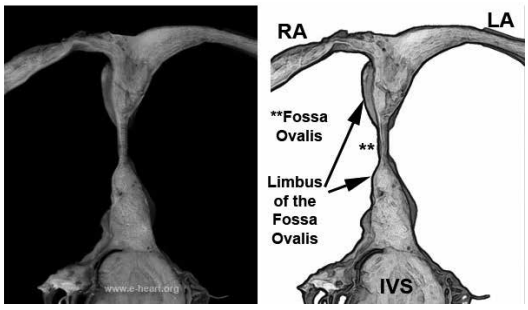

Figure 1. The anatomy of interatrial septum normally (taken from http://www.e-heart.org)

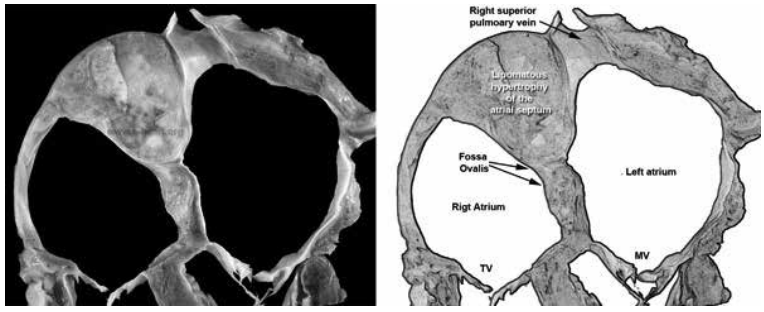

Figure 2. The anatomy of interatrial septum during LHIAS (taken from http://www.e-heart.org)

During the estimation of IAS thickness, we measured diameter of the tissue surrounding foramen ovale (FO) at the upper posterior area. IAS was dissected with transverse diametrical section through FO parallel to fibrous ring. Adipose tissue which surrounds foramen ovale is represented at the section (Figure 3).

The thickness of epicardial adipose tissue was measured at the section from the posterior heart wall along the right edge of IAS and IVS at the coronary sulcus area at the level of inferior coronary sinus wall (Figure 4).

The picture represents the dissected strip of the right ventricular posterior wall along the interventricular septum, the arrows at the cross section point at the level of epicardial fat thickness determination at the coronary sulcus area and along the inferior edge of coronary artery and sinus venosus.

Figure 5 represents the dissection of the heart by A. I. Abrikosov method, and the arrows point at the sections, in which the epicardial fat thickness and the thickness of the tissue surrounding foramen ovale, which represents the lipomatosis hypertrophy of AS, is measured.

Histological examination of all studied heart zones was conducted by standard histological processing of the tissue, followed by hematoxylin and eosin staining.

Statistical analysis was performed using Statistica 10.0 software (StatSoft, Inc., USA). Quantitative parameters are present as median values (Me) and quartiles (25%, 75%). Qualitative parameters are present as frequencies or fractions (in %). Analysis of correlation between two variables was done using Spearman's rank correlation test (r). The level of significance (p) was taken as 0.05.

Results and discussion

Table 1 represents causes of death in patients, where cardiovascular diseases are prevalent.

Table 1. **Causes of death**

Cause of death	Number of patients
Acute cerebrovascular accident	12
Myocardial infarction	3
Cardiosclerosis	2
Lung cancer	2
Chronic glomerulonephritis	1
Chronic bronchitis	1
Chronic obstructive pulmonary disease	1
Pulmonary embolism	1
Endometrial cancer	1
Pleural mesothelioma	1
Breast cancer	1
Encephalopathy	1
TOTAL	27

Figure 3. Dissected AS with radial section from the center of foramen ovale to upper posterior edge

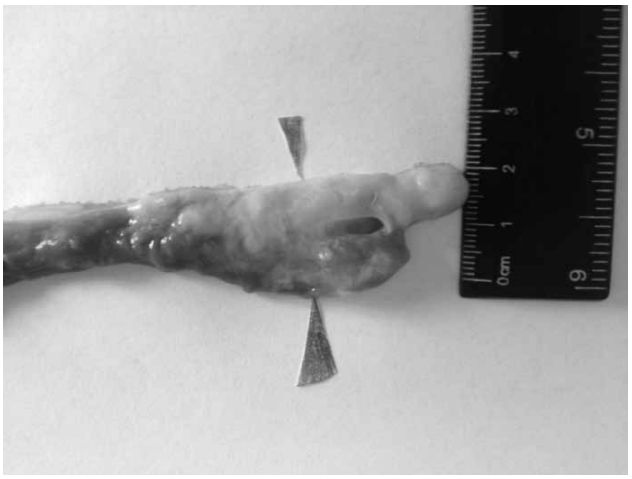

Figure 4. Epicardial fat thickness determination

Figure 5. Measurement of IAS thickness (upper arrows) and EF (distal arrows) during autopsy

In addition to the diseases, which caused death, one third of patients had type 2 diabetes, 9 patients had postinfarction cardiosclerosis (33.3 %), 14 patients had arterial hypertension (52 %), 6 patients had heart rhythm disturbances, interatrial fibrillation in particular (22.2 %).

During the pathological examination aortic atherosclerotic plaques occupied 35 (30; 40) % of the area, at the same time, the prevalence of atherosclerotic coronary arteries lesions reached about 90–100 % (50 (35; 60) % for right coronary artery (RCA) and 35 (30; 60) %) for left coronary artery (LCA)). LCA and RCA had 40 (30; 50) % and 44 (40;60) % coronary stenosis, respectively, and calcification of atherosclerotic plaques was found in 18 patients (66.6 %).

Total heart weight was 470.5 (371; 604) g, net heart weight was 374 (258; 471) g, LV mass was 130 (94; 185) g, right ventricular (RV) mass — 69 (54; 90) g, IAS thickness — 17 (14; 19) mm and RV thickness — 3 (3; 5) mm.

The thickness of EF ranged from 5 to 20 mm, and its average value was 14 (10;15) mm. The average IAS thickness was 10 (7;15) mm (ranged from 4 to 20 mm). Lipomatosis of IAS was revealed in 16 patients, in which IAS thickness was ⩾ 10 mm. There were no significant gender differences in the thickness of cardiac fat deposits.

Histological study of posterior heart wall sections at the coronary sulcus area demonstrated that EF represented a single layer of adipose tissue between myocardium and epicardium surrounding RCA and sinus venosus. Epicardium represents a thin layer of fibrous fibers, covered by mesothelium and located at the outer layer of EF tissue. The inner layer of EF is adjacent to myocardium and forms rough boundary line due to lipocytes growth between the bundles of myocardial muscle fibers. The absence of fascia between myocardium and EF allows biologically active substances, such as proinflammatory cytokines, to penetrate into the coronary blood flow from adipose tissue, what causes changes in the walls of coronary arteries, leading to atherosclerosis development [12], and plaque instability in patients with CAD.

During the description of IAS cross sections histological examination results, it is important to mention the following observations. IAS had variable thickness on both sides of the sections due to a layer of fibrous connective tissue. Subendocardial fibrosis represented even wider layer of fibrous tissue at the left atrial area, where cardiomyocyte complexes with irregular shape (mainly fan-shaped and x-shaped) were found among the fibrous fibers, which were spread from FO to periphery. In some cases, small lymphocytic and histiocytic infiltration was observed mostly under the layer of subendocardial fibrosis. Muscular fibers of active myocardium were located at the IAS between subendocardial layers of fibrous tissue and spread from the peripheral zone of the greatest thickness to foramen ovale. Cardiomyocytes had different extent of hypertrophic and dystrophic changes. Adipose tissue permeates the peripheral part of IAS myocardium, which creates a picture of altered bands of muscle and adipose tissue during microscopic examination.

Wider layers of adipose tissue are mostly localized at the inner layer of IAS. There is no lipomatosis of Myocardium at the FO region. Adipose tissue infiltrates the zone of the greatest thickness of IAS in a range from 30 % to 70 %. Consequently, the main reason of the increase of IAS thickness is lipomatosis, and other causes include hypertrophy and swelling of cardiomyocytes.

Since LHIAS is caused more by adipocyte proliferation, than by its hypertrophy, some authors discuss the new name of this pathology, but it is still fair to call it «lipomatosis hypertrophy of interatrial septum». During the correlation analysis, the correlation between interatrial and interventricular septum thickness was detected (r=0.47; p=0.012), whereas females also demonstrated a correlation between left ventricular mass (r=0.67; p=0.023) and IAS thickness.

Males had a positive correlation between thickness of IAS and blood level of triglycerides (r=0.77; p=0.001). We also detected a positive correlation between EF thickness and LV thickness in females (r=0.61; p=0.015) and calcinosis of LCA in males (r=0.59; p=0.042), what confirms the data on the role of epicardial obesity in atherosclerotic lesions of the coronary arteries [3, 12, 13, 14, 15]. According to other investigations, by the results of autopsy, epicardial fat mass correlated with heart mass, and atherosclerotic plaques of the coronary arteries had tendency to be more prominent on the arterial wall, which had contact with EF deposits [16].

Conclusion

According to the correlation of cardiac fat deposits, which were determined using the thickness of IAS lipomatosis and the thickness of epicardial fat tissue, triglyceride blood levels, left ventricular myocardial hypertrophy, and calcification of coronary arteries in autopsy, cardiac fat deposits of visceral adipose tissue can be used as markers of cardiovascular risk in patients.

Conflict of interest: None declared.

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