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Lipomatous hypertrophy of the interatrial septum in ECG-gated multislice computed tomography of the heart

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A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

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Summary

Background: Lipomatous hypertrophy of the interatrial septum (LHIS) is a benign disorder characterized by fat accumulation in the interatrial septum (IAS).

The purpose of the study was to analyze the incidental detection of LHIS in patients with various clinical conditions, referred to ECG-gated multislice computed tomography (ECG-MSCT) examinations of the heart.

Material/Methods: The ECG-MSCT examinations of 5786 patients (2839 women; 2947 men), were analyzed. The examinations were performed using 8-row (1015 patients) and 64-row (4771 patients) MSCT, in pre- and postcontrast scanning.

We analyzed the shape of the IAS, density and maximal thickness of IAS, the thickness of the epicardial adipose tissue, and the degree of contact of IAS with the ascending aorta and superior vena cava. We also determined body mass index (BMI) in patients with LHIS.

Results: LHIS was detected in 56 (0.96%) patients, with an average age of 61.5±9.8 years. The mean BMI in the analyzed group was 30.1±4.86. During the end-diastolic phase the thickness of IAS was significantly higher ($p<0.0001$), and on average equaled 18.3mm. The mean optical density of the IAS was conspicuously higher ($p<0.0001$) in post-contrast phase than in pre-contrast phase. The thickness of the epicardial adipose tissue in the region of the left atrioventricular groove was on average 15 mm. In all cases the dumbbell shape of IAS was observed.

Conclusions: The incidental frequency of LHIS occurrence in patients diagnosed with the ECG-MSCT examinations is about 1%. In most subjects it is linked with a higher BMI and increased thickness of the epicardial adipose tissue.

key words: **ECG-gating multislice computed tomography • lipomatous hypertrophy of the interatrial septum • heart**

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Background

Lipomatous hypertrophy of the interatrial septum (LHIS) was first described in autopsy reports in 1964 [1]. It is a rare pathology that leads to mild adipose infiltration of the interatrial septum (IAS). The frequency of occurrence for this condition is estimated at 1–8%; and depending on the diagnostic method employed, from 1% in autopsy examination to 2–8% in echocardiography [2,3].

The thickness of the interatrial septum increases with the patient's age; hence, hypertrophy is detected when this value exceeds 10 mm [4,5]. The etiology of lipomatous hypertrophy is unknown; however, it is generally thought to be a hamartoma type of change [6].

Clinical research results indicate that lipomatous hypertrophy may develop without any symptoms and is only an incidental finding during imaging studies or autopsy. Despite its benign character, conspicuous clinical cases of LHIS are primarily connected with the incidence of supraventricular cardiac arrhythmias, and even cases of sudden death [7,8].

Imaging diagnostics of lipomatous hypertrophy is primarily based on transthoracic echocardiography (TTE), magnetic resonance imaging (MRI) and computed tomography (CT).

LHIS is diagnosed most frequently with TTE, but difficulties with distinguishing this pathology from the proliferative process may appear when using this modality. An appropriate and early diagnosis of hypertrophy may enable avoidance of biopsy or surgery.

The aim of the study was to analyze incidental detection of LHIS and to evaluate its morphology in a group of patients with various clinical conditions, referred for heart examinations with ECG-gated multislice computed tomography (ECG-MSCT).

Material and Methods

The ECG-MSCT examinations of 5786 patients (2839 women, 2947 men), of average age 55.53±12.85 (range, 1 to 90 years) years were retrospectively analyzed for the occurrence of lipomatous hypertrophy of the interatrial septum. Examinations of 1015 patients were performed using an 8-slice scanner (LightSpeed Ultra, GE Medical Systems), while in 4771 patients a 64-slice scanner was used (LightSpeed VCT GE Medical Systems). This study was approved by the Bioethics Committee of the Medical University of Lublin, Poland (number KE-0254/153/2009) and patient consent was waived.

The examinations were performed in layers: 2.5 mm in native scan and 0.625 mm (64-row CT) or 1.25 mm (8-row CT) after intravenous administration of the contrast medium – bolus 70–100 ml of Ultravist (iopromide) 370 mgI/mL at a rate of 4–5 mL/s, followed by 30 ml saline at 4ml/s. In all cases retrospective ECG-gating was employed. If necessary, for reduction of heart rate, patients received oral metoprolol 25–50 mg administered 30–60 minutes before the examination. Reconstruction windows were set manually, depending on the heart size, FOV 20–27 cm and a few centimeters above the tracheal bifurcation and below the lower heart outline.

After scanning, the output data were sent to a diagnostic console (Advantage Workstation 4.2 or 4.3), GE Medical Systems). All MSCT images were analyzed by 2 experienced radiologists.

According to Rosenquist et al. [5], LHIS was recognized when the septum width exceeded 10 mm in the cardiac diastolic phase.

The morphology of the interatrial septum, visible in precontrast phase, was analyzed, as well as the density of the interatrial septum in the phase prior to and after contrast administration.

The maximum width of the septum was measured within the region of the fossa ovalis during end-diastole and end-systole phases on reconstructed images obtained along the long axis of the heart (Figure 1A,B). The contractility index of the interatrial septum was determined, defined as the difference between the maximum and minimum septum width in the diastolic and systolic phases, respectively. The mean optical density of the IAS was also determined in pre- and postcontrast phase.

The thickness of the epicardial adipose tissue, defined as adipose tissue between the visceral layer of the pericardium and the surface of the heart, was also analyzed [9]. Measurements were performed on reconstructed images obtained along the long axis of the heart during the 75% phase of the RR cycle, in the area of the left atrioventricular groove (Figure 2).

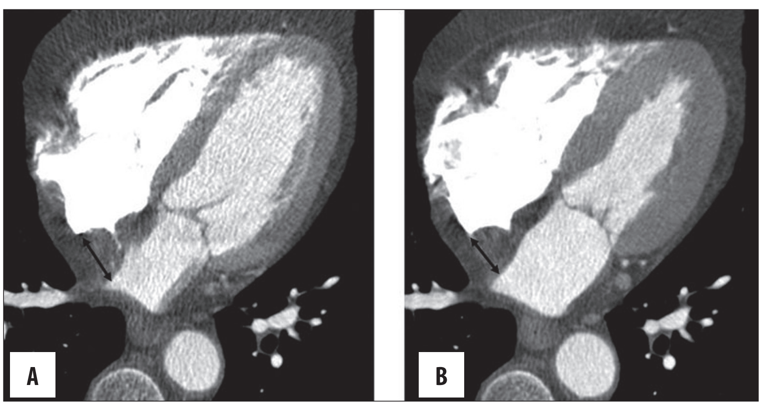

Figure 1. LHIS in 60-year-old man with ischaemic heart disease during: (**A**) diastole, (**B**) systole.

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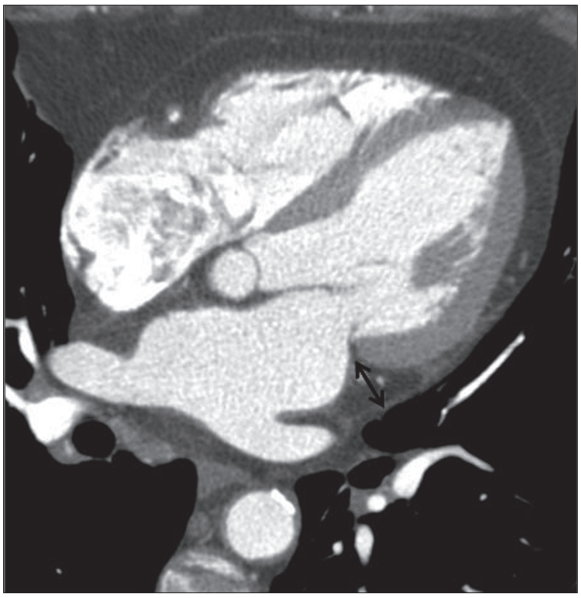

Figure 2. Epicardial adipose tissue thickness in the left atrioventricular groove in 69 year-old-patient with LHIS (black arrow).

(range, 21.7 to 40.7). Overweight was diagnosed in 17 subjects (BMI 25–30), and obesity in 31 (BMI >30).

In the end-systolic and end-diastolic phases, the largest transverse measurement of IAS was taken. The typical dumbbell shape sparing the fossa ovalis region was visible in all patients on axial, sagittal and coronal views (Figure 4).

During the end-diastolic phase the thickness was significantly higher ($p<0.0001$) and on average was 18.3 mm. The contractility index of IAS was on average 3.87 mm (±2.85) (Table 1).

The mean optical density of the IAS was also determined in pre- and postcontrast phase. The mean optical density of the interatrial septum was conspicuously higher ($p<0.0001$) after administering a contrast agent (–17, HU) compared to the analysis in the native scanning.

The thickness of the epicardial adipose tissue, measured in the region of the left atrioventricular groove, was on average 15 mm (range, 10.5 to 27 mm). In 51 of 54 patients with LHIS (92.5%) this value was above 12.4 mm.

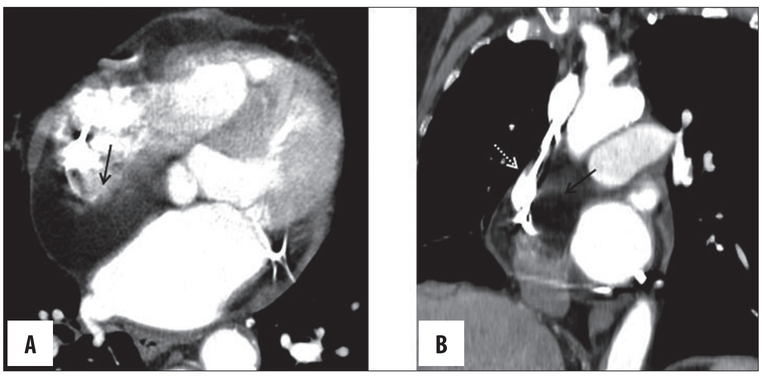

Figure 3. CT scan of 79 year-old patient referred to MSCT examination with the suspicion of the heart tumour- it is visible the large fatty infiltration within the IAS (black arrow), compressing vena cava superior (white arrow) a) axial image b) MPR reconstruction.

The degree of contact of the interatrial septum with the ascending aorta and superior vena cava was also determined, thus classifying patients according to Meaney et al. to 1 of the following groups: contact at 45–90°, 90–180°, 180–270° and over 270° [10].

The BMI for the patients with diagnosed LHIS was calculated.

Results

In the analyzed group of 5786 patients, LHIS was diagnosed in 56 subjects (29 men and 27 women; 0.98% and 0.95% respectively), which constituted 0.96% of the investigated group. The average age of the patients with LHIS was 61.5±9.8 years (range; 35 to 80) and was significantly higher ($p<0.0007$) in relation to the whole analyzed group.

With respect to the fact that in 2 cases the typical criteria for diagnosing LHIS (typical shape of IAS) were not met (Figure 3A,B), 54 patients were further analyzed.

Forty-eight of 54 patients with LHIS (88.9%) had a BMI of >25. The mean BMI in the investigated group was 30.1±4.86

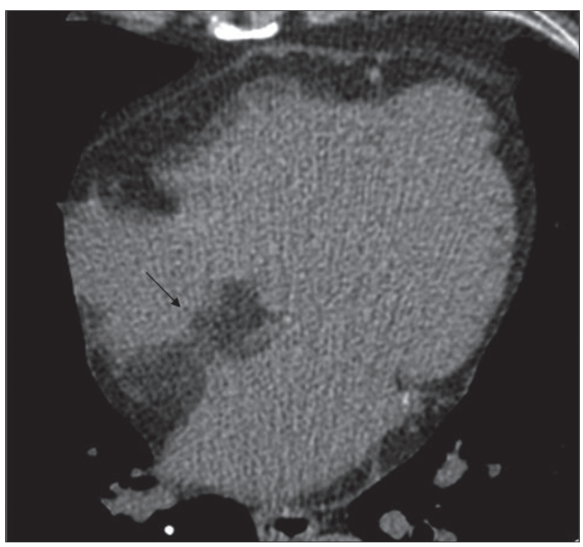

Figure 4. Dumbbell shape of IAS with lipomatous hypertrophy in 69-year-old woman with ischaemic heart disease (black arrow).

Table 1. Morphological parameters of the interatrial septum and thickness of the epicardial adipose tissue.

		Mean	SD	Min	Max	p
Thickness of IAS (mm)	End-systole phase	14.8	4.04	8	34	<0.0001
	End-diastole phase	18.3	5.04	11	41	
	Contractility index	3.9	2.85	1	12	–
Thickness of epicardial adipose tissue (mm)		15	2.57	10.5	27	–
Optical density (HU)	Native	–83.1	22.9	–6.25	–129	<0.0001
	Post-contrast	–17.4	2.6	–1	–115	

Table 2. Circumferential contact of fatty mass within IA with ascending aorta and superior vena cava.

	Circumferential contact (°)	Number of patients
Ascending aorta	45–90	44
	90–180	10
Superior vena cava	45–90	4
	90–180	34
	180–270	16

The degree of contact of the adipose mass in IAS with the ascending aorta and vena cava superior is shown in Table 2.

Discussion

Lipomatous hypertrophy of the interatrial septum is a benign disorder in which the interatrial septum is infiltrated by adipose cells. In the literature it is sometimes referred to as "massive fat deposits" [11] or as adipose hamartoma [12]. The first description of LHIS was presented on postmortem examination in 1964 [1].

In our own material LHIS was found in 56 patients, which constituted 0.96% of the group examined on ECG-gated MSCT. These data are closest to the outcome of autopsy examination – Gay et al. [11] and Reyes et al. [3] confirmed occurrence of LHIS in autopsy material in 1% of subjects. Pochis et al. [2], in turn, showed the occurrence of LHIS in 8% of patients diagnosed with TTE. Lower frequency of incidence was found claimed by Heyer et al. [13]. In the course of multislice computed tomography of the chest, conducted in the group of 1292 patients, lipomatous hypertrophy of the interatrial septum was found in 28 persons (2.2%). Kuester et al. [14] found LHIS in 23 of 802 patients (2.8%) diagnosed with PET-CT examinations. In the relevant literature [11,15] it is suggested that LHIS appears more often in females, but in our work such a correlation was not found – hypertrophy appeared with a similar frequency in groups of female and male patients (0.95% and 0.98%, respectively).

Many authors suggest a connection between the occurrence of lipomatous hypertrophy and high BMI coefficient and advanced age of patients [3,8,14–16]. A similar correlation was found in our work – 48 (88.9%) of patients with LHIS had an increased BMI coefficient, of which 17 subjects were overweight and 31 obese. The average age of the patients with lipomatous hypertrophy was also significantly higher ($p<0.0007$) in relation to all analyzed subjects – 61.5 years. In younger patients (under 35 years) LHIS was not detected.

Echocardiography, magnetic resonance, and computed tomography are the most commonly used techniques for imaging this pathology. In addition, Fan et al. [17] proved the usefulness of PET (Positron Emission Tomography) and Kuester et al. [14] established the usefulness of PET-CT in diagnosing LHIS.

In diagnostic imaging, the atrial septum with lipomatous hypertrophy takes a characteristic hourglass or dumbbell shape. All researchers recorded the same shape of the interatrial septum. Heyer et al. [13], in turn, evaluating the research with the use of multislice computed tomography, found that such morphology occurs in 92.6% of cases.

Beau et al. [16] noted that in patients receiving parenteral nutrition the adipose tissue layer becomes enlarged in the area of the atrial septum. According to Degott et al. the probability that the interatrial septum will become the site for fatty tissue deposition increases with the subject's age, degree of obesity and other factors affecting metabolism [18].

In our study, for the first time, the thickness of the epicardial adipose tissue in the region of the left atrioventricular groove was analyzed in patients with LHIS. Wang et al. [9], measuring the thickness of the epicardial adipose tissue in various regions of the heart, showed that only the thickness of the epicardial adipose tissue in this particular location is in significant statistical relation to the occurrence of the 3 conditions that are typical for metabolic syndrome (raised blood pressure, hyperlipidemia, hyperglycemia). The cut-off point for the thickness of the epicardial adipose tissue in the region of the left atrioventricular groove, which correlates with the occurrence of the metabolic syndrome, was found by Wang et al. [9] to be 12.4 mm. In our work, in 92.5% of patients with diagnosed LHIS, the thickness of the epicardial adipose tissue in the left atrioventricular groove exceeded this value, and was on average 15 mm.

In this study we also analyzed the maximum width of the septum with lipomatous hypertrophy in the end-systolic and end-diastolic phase, as well as the contractility index.

During end-systolic phase the width of the septum was significantly larger (p<0.0001), with an average increase of 3.9 mm (range; 1–12 mm).

Meaney et al. [10] for the first time analyzed the contact of the fatty mass in IAS with the ascending part of the aorta and the superior vena cava. In their group in 8 cases (67%), contact with the aorta was estimated at 45–90°, and in 2 (16.5%) at 90–180°. In 2 subjects the infiltration surrounded the superior vena cava entirely (16.5%), while in another 2 (16.5%) – there was 180–270° contact, and in 8 (67%) there was 90–180° contact. Similar findings were obtained in our study – in most patients (81.5%) the fatty mass was in contact with the ascending aorta in the range 45–90°, and with the superior vena cava it was in the range of 90–180° (63%).

The optical density of the interatrial septum with lipomatous hypertrophy was also determined both in the native scanning and after application of the contrast agent. Heyer et al. [13] found that no patient showed significant contrast enhancement of the fatty mass in IAS. In our study the mean density in the native scanning was –83.1 HU and after bolus injection it was significantly higher (p<0.0001) and equaled –17.4 HU.

The etiology of lipomatous hypertrophy remains unknown. One existing theory suggests that this condition develops as a consequence of the survival of mesenchymal cells within the interatrial septum, which, influenced by certain stimuli, may differentiate into adipocytes.

From the point of view of histopathology, lipomatous hypertrophy refers to nonencapsulated infiltration of fat cells dispersed between hypertrophic myocytes [15]. This infiltration may contain mature adipocytes, fetal fat cells and brown adipose tissue [19]. A characteristic feature is the occurrence of multi-vacuolated fat cells [15].

A correlation between the occurrence of lipomatous hypertrophy and cardiac arrhythmia has been reported; however, the mechanism of such dependency remains unexplained. As early as in 1969 Kluge [20] pointed to the relation between cardiac dysrhythmia and the incidence of lipomatous hypertrophy of the interatrial septum. Heyer et al. [13] recorded cardiac arrhythmia in 61.9% of subjects with diagnosed LHIS, of which the most frequent was atrial fibrillation. In rare cases, lipomatous hypertrophy may lead to the obstruction of the superior vena cava or the right atrium [21].

Differential diagnosis of lipomatous hypertrophy of the interatrial septum includes lipomas, which, unlike lipomatous hypertrophy, are distinctly encapsulated, and are mostly found in young patients [22]. Similarly to adipose infiltration of the interatrial septum, they remain clinically ”silent”. They become recognized incidentally during imaging studies or surgery.

In most cases, LHIS does not require any specific treatment. Surgical management should be limited to patients with symptoms of superior vena cava syndrome or right atrium obstruction [21].

Although the majority of the descriptions of LHIS have been made by transthoracic echocardiography, this method is not able to differentiate between fatty infiltration and connective or neoplastic tissue.

ECG-gated MSCT enables incidental recognition of this disorder and morphological evaluation of infiltrated IAS in consecutive patients with different clinical reasons for diagnostic imaging. It may be also a good objective and accurate method to confirm TTE diagnosis of LHIS.

Conclusions

The incidental frequency of LHIS occurrence in patients diagnosed with the ECG-MSCT examinations is about 1% for the patients examined for a variety of clinical reasons. In most subjects it is linked with a raised BMI coefficient and increased thickness of the epicardial adipose tissue in the region of the left atrioventricular groove. The dumbbell shape of the fatty mass in the region of the interatrial septum and densities matching those of adipose tissue should suggest diagnosing lipomatous hypertrophy without forcing the patient to undergo biopsy or unnecessary surgery.

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