What non-coronary incidental findings can a radiologist detect in an ECG-gated computed tomography scan?

Jakie zmiany pozawieńcowe może wykryć radiolog w badaniu metodą tomografii komputerowej serca z bramkowaniem EKG?

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Słowa kluczowe: zmiana dodatkowa, badanie TK serca, zmiana dodatkowa, pozawieńcowa.

Abstract

Introduction: Cardiac ECG-CT is the standard method of assessing atherosclerotic lesions of the coronary arteries. Radiologist should always evaluate all structures included in the study. Changes found during this "additional" assessment may have great importance in further diagnostic and therapeutic procedures.
Aim of the research: To analyse the significance of all extracoronary findings detected in 230 multi-slice cardiac tomography examinations.
Material and methods: The study retrospectively evaluated the results of 230 examinations of patients referred for ECG-CT. The study group consisted of 122 (53.0%) men and 108 (47.0%) women, aged 5–91 years, mean 57.6.
Results and conclusions: In the study, all incidental findings (IFs) detected in 230 CT examinations were analysed, and their total number was 1816 (7.9 /examination). IFs were found in 227 (98.7%) results. At least one IF was described for all women and for 119 of 122 men. The detected IFs were divided according to their significance into changes that were clinically significant for the patient's health or life (category 1) and not significant (category 2). Category 1 consisted of 1459 abnormalities (80.3%), and category 2 consisted of 357 (19.7%) IFs. In the study group, at least one clinically significant IF was reported in 105/108 women (97.2%) and in 113/122 men (92.6%). Moreover, 3 subcategories were distinguished in the group of I: category 1a – changes significant without the need for further diagnostic procedures (613 abnormalities – 33.8%); category 1b – significant changes in which further planned diagnostic or therapeutic procedures are indicated – 815 (44.9%); and category 1c – significant changes requiring urgent procedures – 31 (1.7%).

Streszczenie

Wprowadzenie: Badanie EKG-TK serca jest standardową metodą oceny zmian miażdżycowych tętnic wieńcowych. Radiolog zawsze powinien przeprowadzić ocenę wszystkich struktur objętych badaniem metodą tomografii komputerowej (TK). Zmiany stwierdzane podczas tej „dodatkowej" oceny mogą mieć duże znaczenie w dalszym postępowaniu diagnostycznym i terapeutycznym.
Cel pracy: Analiza wszystkich dodatkowych zmian pozawieńcowych wykrytych w wielorzędowej tomografii serca u 230 chorych pod kątem istotności.
Materiał i metody: W pracy poddano retrospektywnej ocenie wyniki 230 badań pacjentów skierowanych na badanie EKG-TK serca. Badana grupa liczyła 122 (53,0%) mężczyzn i 108 (47,0%) kobiet w wieku 5–91 lat, średnia 57,6 roku.
Wyniki i wnioski: W przedstawionym artykule dokonano analizy wszystkich zmian dodatkowych wykrytych w 230 badaniach TK, a ich łączna liczba wyniosła 1816 (7,9/badanie). Zmiany dodatkowe stwierdzono w 227 (98,7%) wynikach. Przynajmniej jedną zmianę dodatkową opisano u wszystkich kobiet oraz 119 u 122 mężczyzn. Wykryte zmiany dodatkowe podzielono pod kątem istotności na zmiany istotne klinicznie dla zdrowia lub życia pacjenta – kategoria 1, i nieistotne – kategoria 2. Kategoria 1 liczyła 1459 nieprawidłowości (80,3%). Zmian kategorii 2 opisano w liczbie 357 (19,7%). W badanej grupie przynajmniej jedną pozawieńcową zmianę istotną klinicznie opisano u 105 spośród 108 kobiet (97,2%) i u 113 spośród 122 mężczyzn (92,6%). Ponadto wydzielono 3 podkategorie w grupie zmian istotnych – kategoria 1a – zmiany istotne bez konieczności dalszego postępowania diagnostycznego (613 nieprawidłowości – 33,8%); kategoria 1b – zmiany istotne, w których wskazane jest dalsze postępowanie diagnostyczne lub terapeutyczne w trybie planowym – 815 (44,9%) nieprawidłowości; kategoria 1c – zmiany istotne, w których konieczne jest postępowanie w trybie pilnym – 31 (1,7%).

Introduction

In recent years, ECG-CT of the heart has become the standard method of assessing atherosclerotic changes in the coronary arteries in patients with suspected or confirmed coronary disease, as well as in monitoring patients after coronary stenting and bypass surgery. The indications for ECG-CT of the heart are constantly expanding and now include, among others, examinations before planned ablation procedures [1–3], assessment of congenital and acquired heart defects, and diagnosis of complications of chronic cardiac pacing. Regardless of the main indication for the examination, the radiologist should always evaluate all structures included in the computed tomography (CT) scan, especially the heart, pericardium, lung, and pleura muscles, as well as the adjacent mediastinal organs, the chest wall, and the diaphragm area. The changes found during this "additional" evaluation, although requiring extended reconstructions and prolonging the examination analysis time, may be of great importance in further diagnostic and therapeutic procedures.

The literature on the diagnosis of coronary heart disease using computed tomography is numerous and proves the well-established and constantly expanding role of this method in everyday clinical practice [4–12]. Far fewer data can be found in the literature on the diagnosis of extracoronary lesions that can be diagnosed during CT coronary angiography.

Aim of the research

The aim of the study was to analyse all incidental findings in terms of significance detected in multislice ECG-gated tomography in a group of 230 patients referred for the study for various clinical reasons.

Material and methods

The paper presents a retrospective evaluation of the results of 230 consecutive examinations of patients referred for ECG-CT of the heart to the Department of Radiology and Nuclear Medicine, Independent Clinical Hospital No. 4, Lublin. All tests were performed on a 64-row GE apparatus. The study group consisted of 122 tests performed in men (53.0%) and 108 in women (47.0%). The age of the patients ranged from 5 to 91 years. The mean age was 57.6 years, and the median was 60 years. All patients had an additional reconstruction window covering the full width of the chest in both native and post-contrast scanning. All patients underwent a contrast test.

The main reasons for referrals for a cardiac CT scan were divided by radiologists into 9 basic categories: suspicion of coronary artery disease, follow-up after coronary bypass or stenting procedures, congenital heart defects, acquired heart defects, cardiomyopathy, heart thrombus or tumours, pericardial disease, large vessel disease, and others (i.e. other reasons that were not assigned to any of the above-mentioned groups).

After the initial registration and the appointment of the examination date, patients reported for a cardiac CT examination approximately 1 h before the scheduled start of the scanning. The creatinine level and the level of thyroid hormones were checked. After the interview, the heart rate and blood pressure were measured, and the patient was measured and weighed. If the heart rate was above 65 beats/min a β-blocker was administered. Usually an oral preparation was used – Metocard in a dose of 25 mg or 50 mg.

The examinations were performed using a General Electric LightSpeed VCT 64-row tomograph with Cardio software. The collimation was 64 × 0.6 mm, and the tube voltage was 120 kV. The contrast agent was administered with an automatic syringe, most often into the antecubital vein, in an adult dose of 70–120 ml. In children, the dose was individually adjusted depending on age and body weight, on average 1.5–2 ml/kg with a flow of 1–3 ml/s. In adults, a flow of 4.5 to 5 ml/s was used. The usual method was a controlled bolus, and very rarely the test bolus method.

Definition and evaluation criteria for incidental findings (IF): In this study, any deviation from the norm found in the ECG-CT examination of the heart not related to the main reason for referral was considered as an incidental finding. For example, if a patient was referred for suspected coronary artery disease, the IFs included both the detected aortic bilobal variant, left ventricular hypertrophy, and the described lung nodule and thoracic vertebral haemangioma.

The criterion of clinical significance of incidental findings: Each of the detected IF was analysed as to whether it was a change significant for the life or further health of the patient, or whether the abnormality did not have direct clinical significance. All non-coronary lesions detected and described in the patient studies of the analysed group of 230 examinations were divided into 2 main categories: clinically significant and clinically insignificant changes (category 1 and 2). In the category of significant changes, 3 additional subcategories (1a–1c) were additionally separated (Figure 1).

- category 1a – changes significant without the need for further diagnostic procedures;
- category 1b – significant changes, where further action is indicated – diagnostic or therapeutic;
- category 1c – major changes requiring urgent procedures.

Results

General characteristics of the performed and analysed ECG-CT examinations of the heart

Study mode

Most of the tests were performed on an outpatient basis – 176 (76.5%) or a referral mode from a clinic, most

often a cardiology clinic. The rest are patients studied from the departments and clinics of the hospital.

Reasons for referring patients for a CT scan of the heart

Reasons for a referral for ECG-gated computed tomography were very diverse and were divided into 9 categories based on the primary reason for the referral (Table 1). The frequency of particular reasons for referring to a cardiac CT scan differed significantly, ranging from 1.3% to 62.6%.

Coronary heart disease was the most common reason for referral to a CT scan in the group (72.6%, including suspected disease 62.6% and control after revascularization procedures 10.0%). The next most frequent reasons for referrals were large vessel disease and "other" referrals, often including the assessment of the pulmonary vein openings prior to the planned ablation procedure. Rare causes of referral (1.3–3.0%) included congenital anomalies, acquired heart defects, cardiomyopathies, pericardial diseases, and tumours or thrombi in the lumen of the heart cavities.

Age and sex of the studied population

The age of 230 patients ranged from 5 to 91 years, the mean age of the group was 57.6 ±5.7 years, the median was 60 years, 13 (5.7%) studies were performed in people up to 20 years of age, and 75.7% of the respondents were over 50 years of age.

In the entire analysed population of patients examined in the ECG-CT, men predominated (n = 122). The age of men ranged from 5 to 88 years, and the mean was 55.1 ±7.6 (median: 59). 108 examinations (47%) were performed in women. The age of women ranged from 16 to 91 years, and the mean was 60.5 ±7.4 (median: 61). The average age of women was about 5 years higher than that of men.

Extra-coronary incidental findings detected on CT of the heart

General analysis of incidental findings

In the presented study, all IFs detected and described in 230 CT examinations were analysed, and their total number was 1816 (7.9 per study). Incidental findings were found in 227 (98.7%) results. At least one IF was described in all women from the study group and in 119/122 men.

Extra-coronary incidental findings and the reason for referral to ECG-CT of the heart

The greatest number of incidental findings was reported in the group of patients referred for examination with suspected coronary heart disease (1034 – 56.9%), control after surgical treatment of coronary artery disease (201 – 11.1%), and in the group of diagnoses defined as "other" (279 – 15.4%). The next group of patients referred for examination due to large vessel disease was the next most frequent group of IFs (137 – 7.5%). In patients referred for the study for other reasons, incidental findings amounted to less than 3% (Table 2).

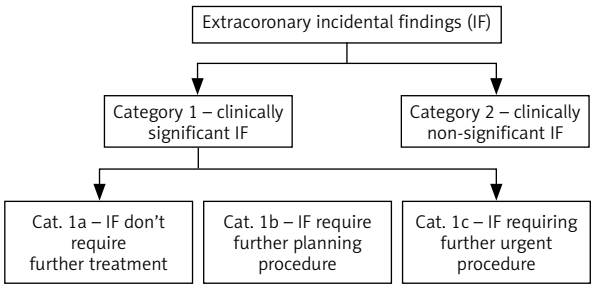

Figure 1. Division of extracoronary incidental findings into insignificant and clinically significant

Table 1. Main reasons for referral for CT scan

Main reason for referral for examination	*N*	%
Suspicion of coronary artery disease	144	62.6
Follow-up after revascularization procedures	23	10
Congenital heart defects	5	2.2
Acquired heart defects	6	2.6
Cardiomyopathy	5	2.2
Pericardial disease	3	1.3
Heart thrombus or tumours	7	3
Large vessel disease	12	5,2
Others	25	10.9
Total	230	100

In the group of 167 people referred for ECG-CT due to coronary heart disease (suspicion and follow-up after revascularization procedures), at least one IF was described. These changes were described in 162/167 people referred to the study (97.0%) in 1235 (68%) lesions out of 1816 of all IFs.

The indicator of the number of detected IFs per person ranged from 2.3 changes per test to 10.3, and the average was 7.9. The highest rate of changes was found in the group of pericardial diseases (10.3), acquired defects (10.2), in the group of changes in the so-called "other" (9.6) and large vessels (9.1). The lowest rate concerned persons referred with suspected congenital heart disease (2.3) lesions/examination.

The influence of patients' age on the frequency of detected extracoronary incidental findings

Throughout the study material, a systematic increase in the number of IFs per study index was

Table 2. Characteristics of extra-coronary IF, including the reason for referral to ECG-CT examination

Reason for referral	Number of people with additional changes		Number of incidental findings	
	N	%	*N*	%
Suspicion of coronary artery disease	136	60	1034	56.9
Follow-up after revascularization procedures	26	11.4	201	11.1
Congenital heart defects	3	1.3	7	0.4
Acquired heart defects	5	2.2	51	2.8
Cardiomyopathy	4	1.8	33	1.8
Pericardial disease	3	1.3	31	1.7
Heart thrombus or tumours	5	2.2	38	2.1
Large vessel disease	15	6.6	137	7.5
Others	29	12.8	279	15.4
Absence	1	0.4	5	0.3
Total	227		1816	

observed in the subsequent age groups, from 6.8 to 9.0 per study. The frequency of changes in the youngest age group (0–20 years) was similar to the age group 21–30 years and slightly lower than in the following age groups. Values in age groups over 30 years of age were similar (7.8–9.0), and the frequency of detected changes in people over 70 years old was only slightly higher than in younger age groups (Table 3).

Clinical significance of extracoronary incidental findings detected on ECG-CT

To assess the clinical significance of incidental findings, 2 main categories were distinguished in accordance with the methodology: significant (category 1) and insignificant (category 2) changes. In the category of significant changes, 3 subcategories were distinguished: category 1a – significant changes that do not require further diagnostic and/or therapeutic procedures, category 1b – significant changes requiring further planned management, and category 1c – significant changes requiring immediate further treatment.

Table 3. The patients' age and the frequency of extra-coronary IFs in the analysed material

Age	Number of tests	Number of incidental findings	Number of IF per patient
0–20	13	89	6.8
21–30	5	34	6.8
31–40	12	93	7.8
41–50	26	211	8.1
51–60	61	472	7.7
61–70	66	523	7.9
71–80	35	295	8.4
Over 81	11	99	9
Total	230	1816	7.9

A total of 1816 incidental findings were found in the study group. Significant changes accounted for as much as 80.3% of all detected IFs. 357 (19.6%) irregularities were classified as insignificant, 613 (33.8%) as significant changes without further treatment, 815 (44.9%) as significant changes requiring further planned treatment, and 31 (1.7%) as significant changes requiring further urgent proceedures (Table 4). At least one clinically significant post-coronary lesion was reported in 105/108 women (97.2%) and in 113/122 men (92.6%).

Significance category and localization of extracoronary incidental findings

The next stage of the analysis was the assessment of the locations of the individual categories of significance of changes.

Category 1 – significant changes

Category 1a – significant changes that do not require further diagnostic and therapeutic procedures

613 abnormalities were classified as significant changes, the detection of which was significant for the further health or life of the patient but did not require additional clinical and/or diagnostic procedures (1a). They accounted for 33.8% of all additional changes.

As many as 269 (43.9%) of the detected changes, concerned the heart. The most commonly described cases were enlargement of the heart in its entirety or in individual cavities (146), and thickening of the valve leaflets was very common (70). The cases of

Table 4. Number and percentage structure of IFs of varying clinical significance detected on CT

C ategory of IF	The type of incidental findings	Group	
		N	%
II	Non-significant IFs	357	19.6
Ia	Significant IFs that do not require further diagnostic and/or therapeutic procedures	613	33.8
Ib	Significant IFs requiring further planned management	815	44.9
Ic	Significant IFs requiring immediate further treatment	31	1.7
	Total	1816	100.0

scarring lesions, myocardial fatty hypertrophy, and areas of perfusion disorders were almost 10 times less numerous (18). In a few cases, changes related to the implantation of an artificial valve were found.

A large group of changes that were significant but did not require intervention (183 changes, 29.9%) comprised changes in the skeletal system. The most frequently reported were degenerative changes affecting the spine (168). Other lesions included vertebral haemangiomas and thoracic deformities.

The third group consisted of 76 lesions found in the lungs and bronchi (12.4%). emphysema (31), interstitial changes (29), compression of the bronchial tree and trachea by adjacent pathologies (4), and pulmonary infarction in the course of pulmonary embolism (3). About 5% were lesions in the thoracic vessels other than aorta (33.5.4%), with the predominant dilatation of the pulmonary trunk and pulmonary arteries (in 23 studies). The rarer ones included the presence of collateral venous vessels, surviving the left superior vena cava, widening of the inferior or superior vena cava, as well as thickening and fibrosis of the wall at the exit of the pulmonary veins after ablation.

The next group of 20 (3.3%) lesions concerned the aorta and its branches. The most numerous were the presence of thrombi or atherosclerotic lesions in the aortic lumen, right aortic arch, postoperative changes related to the presence of a conduit in the aortic lumen, and a significantly rotated aortic bulb. This group also included isolated cases of haemodynamically insignificant stenosis of the subclavian, celiac trunk, and renal arteries included in the study.

Changes in the pericardium (3.7%) were described in 23 cases. There are also such changes as partial absence of the pericardium, thickening of the plaques, slight calcification of the pericardium, and changes after radiotherapy. A small group of 4 (0.6%) lesions concerned the abdominal organs shown in the tests. These were adrenal hyperplasia and an infarction in the spleen, features of the convexity of the upper pole of the kidney into the hernia of the diaphragm dome, and post-inflammatory contours of the kidney.

The changes in the mediastinum and pleura were few – 1–2 abnormalities each. These included thickening or calcification of pleural plaques and postoperative changes.

Category 1b – significant changes that require further procedures

In total, 815 irregularities (44.9% of all additional changes) were included in the significant additional changes that required further planned treatment. The changes in the heart included as many as 417 (51.2%) abnormalities. The most numerous group of lesions comprised hypertrophy of the heart muscle (81), the second abnormality was the dysfunction of the heart muscle (80), and the presence of foci of fat remodelling of the heart muscle, mainly of the right ventricle, was found with a similar frequency (38).

Pathologies related to the morphology and function of the valve apparatus were described in 43 studies. In the group of abnormalities and congenital abnormalities, the following were found: in 47 cases, a patent foramen ovale (PFO), in 13 cases – a small muscle defect or a part of the membranous interventricular septum, and in 2 cases – a defect of the atrial septum. The aneurysm protrusion of the atrial septum in the fossa oval was described in 18 studies (including 1 patient with ASD II). In 1 case, an aneurysm protuberance of the entire interatrial septum was described. Aneurysms of the ventricle or the membranous part of the interventricular septum were described in 5 cases. In 19 patients, a trace intra-atrial shunt was described at the location of the Bachmann bundle. Radiological symptoms of cardiomyopathy were described in 3 cases. Rare changes included changes after heart surgery (1) and a distorted and compressed silhouette of the heart (1).

A total of 121 (14.8%) lesions were included in the group of pathological changes requiring planned diagnostic or therapeutic measures concerning the lungs and bronchi. The most common were nodules in the lungs. Small (several millimetres) nodules in the pulmonary parenchyma were described in 63 studies (including 20 calcified). Most often, they were clusters of small nodules in both peaks accompanied by fibrosis after a specific process. Subpleural nodules were described in 16 studies. Increased interstitial pattern was

found in 31 studies, and mosaic perfusion after pulmonary embolism in 1 case. Other lesions included foci of lung tissue consolidation (10 studies), focal ventilation disorders of the ventilation type (6), inflammatory bronchiolar lesions with an image of a budding tree (2), bronchiectasis (2), and tracheal diverticulum (1).

The group of lesions in the mediastinum included 111 abnormalities (13.6%). The most numerous were enlarged lymph nodes (39) and borderline lymph nodes (11). A hiatal hernia was found in 33 cases. Persistent thymic tissue was visualized in 5 studies. Thyroid enlargement as well as parenchymal nodules were reported in 11 studies, and a postoperative retrosternal fluid reservoir in 1 case.

Lesions of the aorta or the arch branch accounted for 12.3% (100 lesions); most often it was lumen dilation (62), in 3 cases it was aortic aneurysm, and in 1 case – narrowing of its lumen. In 1 case, an abnormal position of the aorta was found. In addition to the numerous typical, often calcified atherosclerotic plaques, in 4 cases the atherosclerotic plaques in the aorta had uneven outlines and ulceration. The remaining changes concerned the arteries departing from the aorta, most often their narrowing (30).

The group of category 1b changes related to the abdominal organs was quite numerous and varied, including 35 abnormalities (4.3%). Fatty liver was described the most frequently (8) – its enlargement was found in 4 studies. The enlargement of the spleen was described 7 times. Thickening of the stomach or oesophagus wall was reported in 7 patients. In 2 cases nodules in the adrenal glands were found. Few changes concerned the pancreas: pancreatic tail cyst and segmental dilatation of the Wirsung duct (2), liver haemangioma (3), biliary dilatation (1), and abnormal kidney blood supply from the pseudo-canal during aortic dissection (1).

A small group of category 1b changes concerned the skeletal system (17, 2.1%). Severe osteoporotic lesions were described in 9 cases, osteosclerotic lesions for further diagnosis in 4 cases, in 2 cases no union and dehiscence of the sternum after sternotomy, in 1 case a thoracic malformation requiring further treatment, and in 1 case a discopathy was diagnosed with significant pressure on the meningeal sac.

In the group of pleural lesions (7; 0.8%), moderate amounts of fluid in the pleural cavity were most often found in 5 patients. Changes in other chest vessels were sparse and included 2 abnormalities (0.2%). They included suspected superior vena cava defect and stenosis of the distal section of the brachiocephalic vein. The group of changes referred to as "other" included 5 irregularities (0.6%): the presence of an air bubble stimulator and a small haematoma after implantation surgery (1), ambiguous changes after mastectomy, extensive calcification in the posterior part of the meningeal sac, and enlarged axillary and subclavian lymph nodes.

Category 1c – significant changes requiring further urgent procedure

Category 1c, i.e. significant changes, the detection of which was significant for the health or life of the patient and required further clinical and/or diagnostic procedures urgently, included 31 additional changes (1.7% of all lesions) and concerned 22 people (9.6% of the 230 studies in the group).

They most often affected the lungs and bronchi (7 detected lesions; 22.6%). These were lumps in the lung parenchyma with spherical contours (4), pulmonary oedema (1), and inflammatory changes (1). Within the thoracic bone structures, compression fractures of the vertebral bodies were found 6 times (19.4%, category 1c).

Aortic lesions requiring urgent intervention were found in 5 out of 230 cases (frequency 2.2% of all lesions; 16.1% lesions in category 1c). In 2 cases there was an intramural aortic haematoma, and in 1 case, dissection in the arteries departing from the arch, aortic dissection, and the presence of an unstable aortic thrombus. In 5 cases (16.1% of changes in category 1c), the changes concerned other vessels in the chest, and in all cases it was acute pulmonary embolism.

Abnormalities concerning the abdominal organs were described in 4 cases (14.9% of category 1c lesions): gastric mucosa thickening (1) and inflammatory oesophageal wall thickening along its entire length (1); in the liver, an unclear focus was found in the parenchyma for diagnosis (1) and a meta focus to the liver (1); and cardiac abnormalities were described in 2 studies (6.5%) – either tumours or clots in the lumen of the heart cavities.

Only one lesion (1, 3.2%) was included in the pericardial lesions – thickened and inflamed pericardial plaques with signs of inflammation in the subacute phase. The few abnormalities in the mediastinum included the presence of a nodular structure in the lower thymus (1) and the hilar and mediastinal enlarged lymph nodes bundles, most likely in the course of sarcoidosis (1). One lesion was classified as "other", which was the density of weaving in the right breast with suspected neoplastic hyperplasia (1, 3.2% of category 1c lesions).

Category 2 – minor changes

A total of 357 additional changes were classified as insignificant. They accounted for 19.7% of all 1816 additional changes in this group. The most numerous group, including 145 out of 357 abnormalities (40.6%), were lung and bronchial lesions. Fibrosis in the lung parenchyma were the most frequently reported (113 cases). The others included tuberculous lesions, cysts in the pulmonary parenchyma, an additional fissure in the lung, and an additional airy vein.

The next most common (56 abnormalities, 15.6%) were changes in the chest vessels. In as many as 55 ca-

ses (15.4%) these were anatomical variants of the pulmonary veins, such as the common left pulmonary vein or the presence of an additional right pulmonary vein.

The aortic lesions included 2 anatomical varieties of arteries leading from the arch (0.6%).

The changes in the skeletal system accounted for 10.6%; these included symptoms of a history of Scheuermann's disease (30), single changes in vertebral morphology (8), and the condition after a past, healed rib fracture (1). Heart lesions accounted for 6% of changes in this group, and the most frequently described abnormalities were minor valve calcifications, mainly aortic, which did not impair their function, others included single, non-significant anatomical variants of the heart structures, altered heart axis, and slight calcifications in the heart muscle, some postoperative.

Non-significant changes in the epigastric region (6.2%) included the presence of cysts in the liver (12) and kidneys (6), higher position of the left diaphragm dome, the presence of an accessory spleen, and the presence of a nodule with calcification on the diaphragm outline (1).

The non-significant changes in the pleura and the pericardium were mainly small pleural thickenings (17 lesions; 4.8%), and in the mediastinum, calcification in the lymph nodes, described in 19 studies.

Discussion

To assess the clinical significance of additional lesions, 2 main categories were distinguished: significant (category 1) and non-significant (category 2) changes. In the category of significant changes, 3 narrower subcategories were distinguished: category 1a – significant changes that do not require further diagnostic and/or therapeutic procedures, category 1b – significant changes requiring further planned management, and category 1c – significant changes requiring immediate further treatment.

In the analysed material, 1459 changes were classified as significant (category 1), which accounted for 80.3% of the total 1816 described non-terminal additional changes. In category 1a there were 33.8% of changes, in category 1b – 44.9% of changes, and in category 1c – 1.7% of irregularities. Further treatment was indicated for 46.6% of the pathologies described. At least one clinically significant extracoronary lesion was reported in 105/108 women (97.2%) and in 113/122 men (92.6%).

It seems that a clearly worded test result of CT should be, for a referring doctor and for the patient, a hint to take further consultation. Because of the large number of described deviations from normal, in case of changes requiring further action, the urgency of further consultations and diagnostics should be clearly defined.

The system of division of additional changes in terms of their significance adopted in this study is the closest to the classification used in the studies by Aglan *et al.* [10], Koonce *et al.* [11], and Ibrahim *et al.* [12]; however, there is a basic methodological difference consisting of taking into account extracranial changes of the heart.

In the study by Aglan *et al.* [10], in which incidentally detected non-cardiac changes were divided into 4 groups, the first one contained changes significant for urgent diagnosis or treatment, the second – changes significant for further planned management (36%), in the third group there were insignificant changes (22.3%), and in the fourth – completely mild (24.7%). At the same time, the authors compared the results of 2 groups of examinations: CT scan – group A, versus whole chest tomography – group B. In my study, the percentage of people with additional changes was much higher (98.7% vs. 43.2%) as well as the number of lesions/person (7.9 vs. 0.36), which is mainly related to the difference in the analysed anatomical area, which in my material also applies to heart changes.

The second work in which the distribution scheme of additional changes is similar is the publication by Koonce *et al.* [11] based on an analysis of 1764 studies. Additional changes were also ranked into 4 groups. In the first group there were changes that required immediate treatment/diagnostics (4.9%), and in the second group the duration of further treatment was extended to 30 days (11.1%). The third group of changes included examinations of patients who should have further diagnostics performed within 1 month to 12 months (55.3%). The last group consisted of additional changes, the so-called small changes not requiring control (28.7%). The frequency of detecting additional changes in the material of this study was much higher than in the material of Koonce *et al.* (frequency 98.7%, 7.9/study vs. frequency 25%, 0.29/study).

In the publication of Ibrahim *et al.* [12], the authors also divided additional changes into 4 groups, describing them as urgent (12.8%), intermediate (12.0%), mild (24.0%), and incidental (13, 6%). Urgent lesions included all that required surgical intervention. In the case of indirect lesions, a medical consultation was sufficient, and in the case of benign lesions, a follow-up examination. The changes described by the authors as incidental did not require further treatment. There was a much higher percentage of people who had changes (98.7% vs. 62.4%) and a higher number of changes per test (7.9 vs. 0.62).

The presented work cannot be directly compared with the majority of other publications due to the completely different division of accessory lesions in terms of significance and taking into account only non-cardiac lesions.

Several studies have used a 3-tier division into significant (or urgent), intermediate/possibly significant,

Table 5. Summary of literature data on the 3-grade division of non-cardiac incidental findings in ECG-CT tests of the heart

Author	Number of tests	Number of changes	The number of non-significant changes	Number of intermediate changes	Number of significant changes
Kirsch *et al.*	100	145	107(73.8%)	22 (15.2%)	16 (11%)
McKenna *et al.*	132	224	149(66.5%)	50 (22.3%)	25 (11.2%)
Chaosuwannakit and Makarawate	192	56	21 (37.5%)	23 (41.1%)	12 (21.4%)
Cademartiri *et al.*	670	1234	332(26.9%)	821(66.5%)	81(6.5%)
Gravina *et al.*	742	131	87 (66.4%)	29 (22.1%)	15 (11.4%)
Elgin *et al.*	1000	91	37 (40.5%)	37 (40.5%)	17 (19%)
Lazura *et al.*	1044	729	459 (63%)	96 (13%)	174 (24%)
La Grutta *et al.*	4303	6886	2095 (30.4%)	4486(65.2%)	305 (4.4%)
MacHaalany *et al.*	966	448	321 (33.2%)	68 (70.1%)	12 (1.2%)

and mild changes [13–20]. The data are summarized in Table 5. The size of the studies varied greatly, from 100 to 4303; however, in the case of the latter study, they came from 4 centres. Similarly, the number of additional changes in these publications ranged from 56 to 6886. Most authors provided data on the percentage structure of additional changes, except for the work of MacHaalany *et al.* [21], who applied the results to studies with a given category of significance of changes.

It can be concluded that the structure of the studied groups in the literature shows a similar distribution of additional lesions, revealing the lowest percentage of significant changes, and significantly higher benign or intermediate changes. In two publications, benign, indirect and significant changes were additionally divided in terms of location into changes in the chest and abdominal cavity [15, 16], while 2 studies concern additional changes detected in cardiac MR [17, 19].

Some authors used a simpler method of dividing additional changes, distinguishing 2 groups: significant and insignificant changes [22–34]. Only non-cardiac changes were considered in all studies. The percentage of people with additional changes, as in the previously cited studies, ranged within wide limits from 24% to 80%, people with significant changes from 8% to 39%, and insignificant changes from 20% to 87%.

In several studies, the number of people with malignant lesions was identified as a special group [28–30, 33, 34]. Dewey *et al.* [25] compared the number of all and significant and non-significant changes in CT and MRI in the same patients, presenting almost twice as many additional changes detected by computed tomography – including changes of significant importance for the patient. Venkatesh *et al.* [23] presented the results of the same studies, but described by 2 independent doctors (R1 and R2), showing large differences in the number of lesions detected by them, including changes of significance for the patient. When reading the literature, it can be seen that the authors of most of the works present a low percentage of significant changes. The only exception is the study by Lee *et al.* [27], who found clinically significant changes in 52% of cases.

A significant proportion of the works only mention the frequency of tests with significant changes, giving this percentage within broad ranges from 2.4% to 56% [35–49].

Conclusions

All additional, extra-coronal changes in the group of 230 ECG-gated CT examinations were found to be 1816, which is an average of 7.9 lesions/examination. The mean number of additional lesions described in the study increases with the age of patients from 6.8/study aged 0–30 years to 9/study aged over 80 years.

The number of additional lesions described in cardiac tests depends on the reason for referral, ranging from 2.3 to 10.3 lesions/examination. The highest rate of changes was found in the group of pericardial diseases (10.3) and acquired defects (10.2), and the lowest was in people referred with suspected congenital heart disease (2.3 changes/examination).

As much as 80.3% of the described abnormalities were of significant clinical importance for the patient's health and life, and significant changes requiring urgent measures accounted for approximately 1.7%. Significant changes that required planned actions comprised approx. 44.9%. Changes that were significant, but did not require further treatment accounted for 33.8% of all changes. Clinically insignificant changes accounted for 19.6%.

Conflict of interest

The authors declare no conflict of interest.

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