

Epipericardial fat necrosis: a systematic literature review

Natalia Ostruszka¹, Patrycja S. Matusik², Jarosław Jarczewski², Tomasz Pulanecki¹, Julia Radzikowska¹, Michał Świątek², Agata Bal-Siemaszko¹, Maciej Krupiński³, Tadeusz Popiela²

¹Student's Scientific Group of Radiology, Jagiellonian University Medical College, Krakow, Poland

²Jagiellonian University Medical College, Krakow, Poland

³Faculty of Medicine, Andrzej Frycz Modrzewski Krakow University, Krakow, Poland

Medical Studies

DOI: <https://doi.org/10.5114/ms/210738>

Key words: computed tomography, radiology, epipericardial fat necrosis.

Abstract

Epipericardial fat necrosis (EFN) is a rare, benign condition characterised by localised inflammation and necrosis of fat surrounding the heart. We performed a systematic review of EFN cases published up to June 2024, identifying 61 patients from 46 articles. The mean age was 46.4 years, with a male predominance (60.7%). Nearly all presented with chest pain (98.4%), and pleural symptoms were common (65.6%). EFN was usually left-sided (80.3%), appearing as an encapsulated mass (60.7%) with dense stranding (57.4%). Computed tomography (CT) density was variable, while pleural effusion occurred in 37.7%. Reported management included analgesics or nonsteroidal anti-inflammatory drugs, corticosteroids, and surgical intervention. Among the 36 patients with available follow-up imaging, regression was reported in all cases. Despite its variable presentation, EFN is a self-limiting condition, and CT remains the most reliable imaging modality for diagnosis.

Introduction

Fat necrosis is a condition in which fat tissue in the body undergoes damage and cell death, often due to trauma, inflammation, or insufficient blood supply. It derives from aseptic saponification of fat [1]. It can present as firm, irregular lumps that sometimes resemble cancerous masses. Fat necrosis is particularly common in breast tissue, where it may result from trauma, surgery, or radiation therapy [2]. It also frequently occurs in peripancreatic fat, associated with pancreatitis, when digestive enzymes leak into fat tissue, causing inflammation and calcification [3]. Other sites include the fat appendages along the colon, where it appears as epiploic appendagitis, and subcutaneous fat, where injuries or injections can lead to firm nodules [4].

Epipericardial fat necrosis (EFN), also called mediastinal fat necrosis, is a rare and benign condition characterised by localised inflammation and necrosis of the adipose tissue surrounding the heart, specifically in the epipericardial fat, which lies adjacent to the parietal pericardium [5]. This condition remains largely self-limiting and is not associated with significant long-term complications, although it can mimic other serious thoracic conditions, causing diagnostic challenges.

The exact aetiology of EFN remains unknown, but several theories have been proposed [6, 7]. One potential cause is acute torsion, in which movement or twisting of the fat tissue could disrupt blood supply and trigger necrosis. Another theory involves increased intrathoracic pressure or shearing forces generated dur-

ing cardiac cycles, potentially leading to local tissue strain and ischaemia. These forces may induce injury in the surrounding fat tissue, leading to inflammation and eventual necrosis of the affected adipocytes [8]. Despite these hypotheses, the condition does not appear to be linked to any specific predisposing factors, nor are there other currently identified risk factors.

Patients with EFN typically present with chest pain that can be mistaken for cardiac or pleural conditions, which often prompts further imaging studies [9]. Radiological findings, particularly on computed tomography (CT) scans, usually reveal localised fat density alterations near the pericardium. Given its benign nature, EFN usually resolves on its own without the need for invasive treatment [6–8]. However, in cases where symptoms are significant or when there is diagnostic uncertainty, further monitoring and follow-up may be necessary.

The aim of our study was to perform a systematic review of published cases regarding EFN. We also emphasise the potential importance of genetic factors in the aetiology of this disease, and we discuss the potential role of artificial intelligence in the detection and differentiation of EFN.

Methods

Information sources and searching strategy

This systematic review was performed using the PubMed, Embase, and ScienceDirect databases

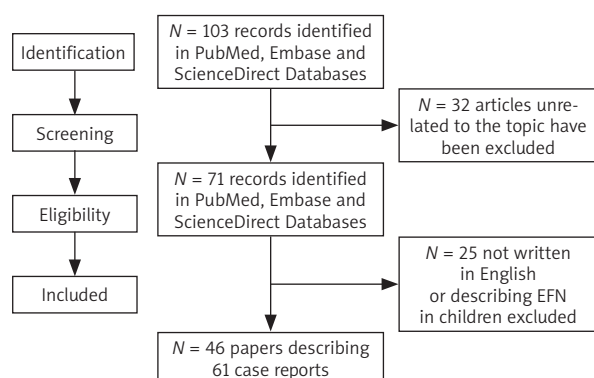


Figure 1. Flow diagram representing the methodology of our study

according to Prisma guidelines [9, 10]. Searching was performed on 11.06.2024 using the following keywords: “EFN” OR “epipericardial fat necrosis” OR “mediastinal fat necrosis” AND “computed tomography” OR “magnetic resonance imaging” OR “MRI” OR “CT” AND “case” OR “case report”.

Study selection

Only case reports available in full text and containing history, symptomatology, diagnostic course, and treatment of necrosis in epipericardial fat in humans were selected. We excluded articles that were written in a language other than English. Moreover, we excluded cases describing EFN in children [6, 11, 12]. The search identified 71 potentially eligible articles, of which 25 were excluded. Finally, 46 articles describing 61 patients were included in the review. A detailed flow diagram is presented in Figure 1.

Data items and collection

The following information was extracted from each analysed article: patient’s clinical characteristics, description of chest CT and chest magnetic resonance imaging (MRI, if available), treatments used, and follow-up information (Tables 1–3).

Results

Patient characteristics and presented symptoms

In our analysis we included 61 patients from 46 papers (Tables 1–3) [5, 9, 13–55]. The median year of publication of analysed cases was 2021 (2016–2023). The median age of describing patients was 48 (31–58) years, while the mean age was 46.4 years. The majority of patients were men (61%).

All but one of the patients presented symptoms. In most cases they subsided in the first 5 days; however, in 12 (19.7%) cases the symptoms lasted more than 5 days.

Acute pain was described in all but 1 patient. Utsumi *et al.* described a patient in whom EFN was found

accidentally during follow-up chest CT after thymectomy [41]. The patient did not show any symptoms and was observed for the next 8 years, when thoracoscopy and histopathology confirmed EFN diagnosis of the nodule. The pain radiated in 10 (16.4%) patients to the left shoulder or back. The patient reported by Haq *et al.* presented with severe pain (8/10 on VAS) lasting 4 days, worsening with inspiration and when changing position, and improving after administering ibuprofen [25].

While almost all authors reported acute pain as the main symptom, the character of the pain being pleural was mentioned in 40 (65.6%) cases. Fujita *et al.* described a 50-year-old male who presented with chest pain present for 3 days, elevated white blood cell count, C-reactive protein, and brain natriuretic peptide; his symptoms improved on the 5th day without any treatment mentioned [37].

The pain changed when the patient shifted position in 21 (34.4%) cases and was worse during inspiration in 23 (37.7%) patients. A 21-year-old woman, reported by Vande Berg *et al.* 2022 [24], presented to the emergency room with acute pain, radiation to the shoulder, and arising pain related with inspiration and supine position. She underwent surgery for definite diagnosis, and histology of the lesion confirmed epipericardial fat necrosis. Friedman *et al.* described a 68-year-old female with acute chest pain lasting 4 days, exaggerated by inspiration and postural changes; however, her EFN diagnosis was confirmed with chest CT [45]. Dyspnoea was reported in 7 patients (11.5%). A 39-year-old woman presenting with pleuritic chest pain and dyspnoea was reported by Cafezeiro *et al.* [43]. Chest CT revealed epipericardial fat necrosis, and she was administered low-dose oral corticosteroid therapy for 30 days, after which her symptoms resolved.

Imaging features

CT scan was performed in all but one of the cases. EFN was most often found on the left side of the pericardium (49 cases, 80.3%). Mean age for left-sided position was 45.18 years and for right-sided EFN position was 47.25 years. Pleuritic pain was reported in 7 of 12 patients with right-sided lesions (58.3%) and in 33 of 49 patients with left-sided lesions (67.3%). Radiating pain was found in 8.0% of the cases for right- and 18.0% of the cases for left-sided EFN. All reported cases of dyspnoea occurred in patients with left-sided lesions (7/49, 14.3%). All reported cases of dyspnoea occurred in patients with left-sided lesions (7/49, 14.3%). Celikkanat *et al.* described a 22-year-old male with sudden pleuritic chest pain that did not relieve after non-steroidal anti-inflammatory drug. Blood tests revealed mildly elevated D-dimer, and a chest CT was performed to rule out pulmonary embolism [13]. The encapsulated lesion of fat necrosis in this patient was located in the right side of cardiophrenic adjacent

Table 1. Studies describing EFN detected during CT imaging

Study	Patient characteristics	Symptoms	CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Abraham <i>et al.</i> 2021 [23]	32-year-old female	Acute episodes of non-radiating, pleuritic left-sided chest pain with no associated systemic symptoms during the 3rd trimester of her pregnancy. The pain worsened with deep breathing and intensified throughout the day but was partially relieved with codeine	CT identified EFN as an encapsulated fatty lesion adjacent to the pericardium	N/d	N/d
Vande Berg <i>et al.</i> 2022 [24]	21-year-old female	Left-sided stabbing chest pain with radiation to the left shoulder	Low-density (~80 Hounsfield units) nodular structure with a surrounding soft tissue attenuation rim on the left diaphragmatic dome with a diameter of 2 cm and adjacent lung atelectasis. A clear connection to the mediastinum was demonstrated	N/d	Surgery showed no diaphragmatic defect but revealed a twisted epipericardial fat pad with necrosis, left the hospital 3 days later in good general condition
Haq <i>et al.</i> 2019 [25]	55-year-old female	4-day history of non-exertional chest pain. It started as acute left-sided pleuritic chest pain that radiated into the neck with associated numbness of the left arm. The patient rated the pain up to 8/10 in severity	CT pulmonary angiogram showed encapsulation of the epipericardial fat with internal and adjacent fat stranding consistent with a diagnosis of epipericardial fat necrosis	N/d Only chest radiograph follow-up 3 weeks after the onset of her initial symptoms showed a reduction of the left basal atelectasis with a smaller effusion. A repeat radiograph 3 months later was normal. At 6-month follow-up, the patient had remained symptom free without recurrence of her chest pain	Ibuprofen and acetaminophen
Couto <i>et al.</i> 2020 [26]	50-year-old male	Sudden intense pain located in the lower left anterior part of the chest, worsened by deep inspiration and with 10 hours of duration	Thoracic CT showed an ovoid encapsulated mediastinal (epipericardial) fatty lesion in the left cardiophrenic angle with a soft tissue rim and intrinsic and surrounding soft tissue stranding, without pleural effusion	N/d	Analgesic therapy

Table 1. Cont.

Study	Patient characteristics	Symptoms	CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Jouan <i>et al.</i> 2013 [27]	A 70-year-old female	Left shoulder pain that resolved spontaneously. After a few days, sudden acute left anterior chest pain occurred. The pain was intense at rest, increased by deep breathing, and was incompletely alleviated by acetaminophen	1. Chest CT scan showed a small pleural effusion and a left anterior paracardial airspace pulmonary consolidation. A CT scan could not rule out a lingular infarct corresponding to a distal PE. Second CT scan performed at day 7 revealed a juxtacardiac mass consisting of a round, left paracardiac, well-limited, 4-cm, mediastinal lesion adjacent to the lingula, encapsulated with a partially fatty content associated with a left pleural effusion and an enlarged left mediastinal lymph node under aortic arch	N/d	Acetaminophen and tramadol
de Giassi <i>et al.</i> 2014 [28]	1. 23-year-old female 2. 40-year-old male 3. 80-year-old male 4. 59-year-old female 5. 44-year-old male 6. 46-year-old male 7. 52-year-old female 8. 41-year-old male 9. 49-year-old male 10. 24-year-old male 11. 45-year-old male	1. Pleuritic pain – right sided 2. Pleuritic pain – right sided-back 3. Pleuritic pain – left sided - shoulder 4. Pleuritic pain – left sided 5. Pleuritic pain – left sided 6. Pleuritic pain – left sided, dyspnoea 7. Pleuritic pain – left sided - precordial 8. Pleuritic pain – left sided 9. Pleuritic pain – left sided 10. Pleuritic pain – left sided 11. Pleuritic pain – right sided	1. Right 2. Right 3. Left 4. Left 5. Left 6. Left 7. right 8. Left 9. Left 10. Left 11. Right The CT findings associated with EFN were focal pericardial thickening (4 of 11 patients), small pleural effusion (9 of 11 patients), and mild atelectasis of the lung bases (7 of 11 patients)	3. Axial chest CT follow-up scan performed 7 weeks later demonstrated complete resolution of the findings. 5. Axial view of the chest CT control performed 4 weeks later. The lesion has almost completely resolved, with mild residual focal stranding in the epipericardial fat	N/d
Matos <i>et al.</i> 2023 [29]	39-year-old female	2-week history of pleuritic chest pain	CT performed in the ED described a nodular mass with heterogeneous density measuring 41 × 25 mm, without contrast enhancement. Next CT, which showed an area of fat densification adjacent to the anterior wall of the heart, measuring 42 × 18 mm, consistent with EFN, associated with a slight left pleural effusion	A chest CT was performed for re-evaluation, and it showed a regression of the area of fat densification/necrosis	Ibuprofen 600 mg three times a day

Table 1. Cont.

Study	Patient characteristics	Symptoms	CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Haseeb <i>et al.</i> 2024 [30]	55-year-old male	Sudden onset of excruciating left-sided pleuritic chest pain and shortness of breath for the past 2 days	CT pulmonary angiogram revealed findings suggestive of EFN oval-shaped mass, with a central hypodense area, surrounded by a rim of hyperdense, inflammatory tissue	N/d	Ibuprofen
Kenyon <i>et al.</i> 2023 [31]		Acute pleuritic chest pain	Encapsulated, mixed fat, soft tissue density in the left pericardiac region deemed to represent EFN	Follow-up magnetic resonance (MR) cardiac imaging at 1, 4, and 12 months demonstrated the self-resolving characteristics of this condition	N/d
Ikeo <i>et al.</i> 2022 [32]	80-year-old male	Sudden chest pain and sputum. febrile and hypoxaemic	CT revealed a mass in the right middle lobe with necrotic epipericardial fat	N/d	Acetaminophen
Accorsi <i>et al.</i> 2023 [33]	29-year-old male	6-day non-traumatic pleuritic chest pain. The pain was stabbing, intense, and severe in the dorsal decubitus position	CT of the chest on axial view showing a rounded lesion (arrow) with fat attenuation and variable degrees of densification of the adipose planes	N/d	Mid-term anti-inflammatory strategy
Otake <i>et al.</i> 2023 [34]	Female in her mid-20s	1-week history of left shoulder and epigastric pain; the pain worsened with deep inspiration	CT: soft-tissue attenuation lesion that contains a fatty centre located in the epipericardial fat at the left cardiophrenic angle	Follow-up chest CT scan 3 months after presentation reveals disappearance of the soft-tissue lesion	Loxoprofen
Bensard <i>et al.</i> 1990 [35]	67-year-old black female	3-day history of acute left-sided pleuritic chest pain, radiating into the left axilla	3 × 3 cm mass in the anterior left side of the chest, abutting the left cardiac margin. The mass was nonhomogeneous, with a density consistent with fat	N/d	Patient was taken to the operating room for an exploratory thoracotomy
Fukumatsu <i>et al.</i> [36]	A 25-year-old male	Mild left anterior chest pain for one week, worsening over time, accompanied by dyspnoea	CT: fatty lesion (11 × 6 × 8 mm) surrounded by a thick rim was observed on the left side of the pericardial fat. Slight fat stranding was observed inside and adjacent to the lesion	A follow-up chest radiograph after 1 week revealed no pleural effusion, and the chest pain was almost resolved (1 of 10 on the numerical rating scale). The patient's symptoms disappeared completely after 4 months	Analgesics

Table 1. Cont.

Study	Patient characteristics	Symptoms	CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Fujita <i>et al.</i> 2024 [37]	50-year-old male	Left anterior chest pain since 8 hours, worsened with changes in posture and respiration	CT was performed on the 11th day from onset showing an ovoid fat attenuation lesion measuring 25 × 12 mm with a soft tissue attenuation rim in the pericardial fat tissue near the left ventricular apex. Mild thickening and contrast enhancement of the adjacent pericardium was also noted	No follow-up was performed	N/d
Gorospe <i>et al.</i> 2022 [38]	A 57-year-old female	Left-sided pleuritic chest pain 1 week before CT examination performed for lung cancer screening purposes	Combination of a nodular/ovoid fatty lesion with surrounding stranding of the epipericardial fat pad in the cardiophrenic space on the left side	A thoracic CT performed 3 months after the diagnosis of EFN shows a normal epipericardial fat pad	Self-limited
Zayour <i>et al.</i> 2022 [39]	A 19-year-old male patient; COVID-19 (mild disease course), vaccinated double dose against SARS-CoV-2	Acute onset chest pain and dyspnoea	Fat stranding along with the left epipericardial fat pad – suggestion of fat necrosis	Subsequent improvement of symptoms observed during his follow-up appointment after one week of discharge	Colchicine and non-steroidal anti-inflammatory drugs
You <i>et al.</i> 2022 [40]	A 60-year-old male with a history of hypertension and recent COVID-19 pneumonia	Acute, excruciating pleuritic chest pain	Significant epipericardial fat stranding along the right cardiophrenic angle with reactive anterior mediastinal lymph nodes	Not reported	Ibuprofen 600 mg twice daily for one week
Utsumi <i>et al.</i> 2021 [41]	A 62-year-old man; 10 months after a thymectomy for thymoma by sternotomy (WHO classification B1+B3, Masaoka Stage II thymoma)	Nothing	22-mm nodule with fat density was detected at the anterior cardiophrenic angle 10 months after the thymectomy. The nodule did not change in size, but the capsule started to calcify at 7 years after thymectomy	Excised	No data
Navani <i>et al.</i> 2021 [42]	A 28-year-old woman at 16 weeks of gestation	2-day history of severe, worsening left-sided pleuritic chest pain	A region of focal inflammatory fat stranding in the pericardium adjacent to the left ventricular apex	Cardiac magnetic resonance 6 weeks later imaging demonstrated reduced prominence of the pericardial fat adjacent to the left ventricular anterior apical wall with no signs of pericardial fat oedema	Analgesia and self-limited

Table 1. Cont.

Study	Patient characteristics	Symptoms	CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Mortensen <i>et al.</i> 2020 [7]	A 22-year-old healthy male	Left-sided chest pain intensifying over the last 2 days; worsening severely when laying down and with inspiration	A focal inflammatory stranding in a pericardial fat layer lateral to the apex of the left ventricle	MRI 3 weeks after the initial presentation showed slightly coarse pattern of the fat tissue	Ibuprofen as needed
Cafezeiro <i>et al.</i> 2020 [43]	A 39-year-old woman with a history of heart transplant	Severe pleuritic chest pain in the inframammary region of the left hemithorax in addition to dyspnoea on moderate effort. Tachycardia (110 beats/min)	A dense area in the anterior epipericardial fat, on the left, associated with discrete thickening and adjacent pericardial effusion	Regression of radiological changes in CT after 2 weeks	Oral corticosteroid therapy (prednisone 10 mg) for 30 days
Shah <i>et al.</i> 2016 [44]	A 59-year-old male with a medical history of type 1 muscular dystrophy	Acute onset of chest which began in the morning (the same day)	Fat stranding in the pericardial space concerning for epipericardial fat necrosis, and a small left sided pleural effusion	A repeat CT scan of the chest 4 weeks later showed resolution of the epipericardial fat necrosis	NSAIDs. “His hospital course was complicated by aspiration pneumonia with development of a loculated pleural effusion requiring a video assisted thoracoscopy”
Nguyen <i>et al.</i> 2018 [55]	A 25-year-old man	An 1-week intermittent left-sided, parasternal chest pain, which was non-radiating but worsened with sudden movements	A well-encapsulated 1.3 cm fat containing lesion with adjacent fat stranding in the epipericardial fat	None	NSAIDs. Self-limited
Friedman <i>et al.</i> 2018 [45]	A 68-year-old female	An acute chest pain lasting for 4 days, chiefly in the left mid-axillary line and lower ribs. The pain first appeared while resting, and was exaggerated by inspiration and postural changes without any relation to physical exercise	A well-circumscribed ovoid lesion in the mediastinal fat, abutting the pericardium in the left cardiophrenic angle	Not reported	Not reported
Lezcano Gort <i>et al.</i> 2018 [46]	A 79-year-old woman	Two-day history of left pleuritic chest pain	An ovoid, encapsulated, fat-containing mass in the anterior left mediastinum, with thickening of the adjacent pericardium	At 3-month follow-up the patient was free from any symptoms, with resolution of the CT findings	Analgesics, beta-blockers, and a short course of intravenous diuretics

Table 1. Cont.

Study	Patient characteristics	Symptoms	CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Díaz <i>et al.</i> 2016 [47]	1. A 24-year-old man with a history of nontraumatic pneumothorax, which was treated surgically 2. A 46-year-old woman 3. A 32-year-old man 4. A 50-year-old woman	1. A 3-day history of persistent left-side chest pain, which worsened with deep breathing and torso movements 2. A 1-week history of left-sided costal pain that intensified while she was lying down in the ipsilateral decubitus position 3. A 1-day history of right rib cage pain, which increased with deep breathing 4. A 4-day history of right rib pain, which was exacerbated by deep inspiration	1. A focal area of increased density in the adipose tissue of 26 × 11 mm in the cardio-phrenic space, located at the level of the anterior arch of the left sixth rib 2. A 1-cm bilobed fat density lesion, with areas of higher density in its thickness and in the adjacent adipose tissue in the left epicardiophrenic region, with features of fat necrosis. CT was performed 7 days after the symptoms 3. A 22 × 7-mm focus of increased density of the epipericardial fat, adjacent to a lower right rib, compatible with fat necrosis 4. A nodular formation with fat density in the right epicardiophrenic region measuring 15 mm, associated with increased diffuse density of neighbouring fat, compatible with fat necrosis	Not reported	Not reported
Celikkanat <i>et al.</i> 2016 [13]	A 22-year-old male	A sudden pleuritic chest pain	A mass in fat attenuation localised in the anterior mediastinum, in the right side of cardiophrenic space adjacent to the right side of pericardium and pleura. The lesion was encapsulated, 3 × 2 cm in size, and contained dense strandings, which suggests inflammatory processes. A minimal pleural effusion was also detected in the right lung	CT month later: the mass in the fat attenuation that contained dense strandings was substantially decreased in size and pleural effusion was completely regressed	NSAIDs. Self-limited
Koutouzi <i>et al.</i> 2015 [14]	A 52-year-old woman with hypothyroidism	A 3-day history of left-sided chest pain, which was enhanced by deep inspiration	In the anterior left mediastinum there was a 2.5-cm wide encapsulated, striated epipericardial fat accumulation, with a mild thickening of the adjacent pericardium	None; in the 6-month follow-up the patient was free from any symptoms, with normal exercise stress test and echocardiogram	None

Table 1. Cont.

Study	Patient characteristics	Symptoms	CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Mohamed Hoesein <i>et al.</i> 2016 [15]	A healthy 39-year-old female	An acute chest pain worsening on breathing	A fatty lesion with focal infiltration of the epipericardial fat near the left heart border	None	Analgesics
Berchuck <i>et al.</i> 2015 [16]	An 80-year-old man with history of coronary artery disease requiring PCI, heart failure with preserved EF, hypertension, chronic tobacco use, COPD, provoked DVT 2 years earlier treated with 6 months of oral anticoagulation, untreated latent TB, and Barrett's oesophagus	A left-sided chest pain and hypoxia. The pain had been present intermittently for 6 months, was located both anteriorly and posteriorly, described as stabbing, and worse with inspiration. In the preceding 6 months, he presented to multiple hospitals with the same complaint and was treated for pneumonia once, COPD exacerbation multiple times, and underwent thoracentesis for a left-sided pleural effusion. These interventions resulted in transient improvement, but the chest pain continued to recur	A small left-sided pleural effusion and new diffuse inflammatory changes within the epipericardial fat of the left mediastinum with prominent stranding and swirling soft tissue density extending to the pericardial surface with mild inflammatory changes of the pericardium	At 3-month follow-up the patient reported resolution of chest pain after 2 months without recurrence of symptoms. Repeat CT showed no pleural effusion and near complete resolution of epipericardial fat stranding	Ibuprofen was started prior to discharge
Gutiérrez <i>et al.</i> 2014 [17]	A 57-year-old man	An acute chest pain without clear signs of angina	Cardiac CT: images of the fat at the left cardiophrenic angle revealed a poorly defined increase in the density, with a central zone of the same density as that of the mediastinal fat. Within the lesion, there was a modest increase in density in the form of fine filaments	Not reported	Not reported
Bhatt <i>et al.</i> 2013 [18]	1. A 51-year-old man 2. A 30-year-old man	1. Dyspnea and left pleuritic chest pain that radiated patient's back 2. 4-day history of right pleuritic chest pain radiating to the back, afebrile, ↑ CRP	1. Chest CT showed a $3.2 \times 1.3 \times 3.2$ cm (transverse, AP, and craniocaudal, resp.) ovoid fat attenuation lesion delimited by a thin, soft tissue attenuation rim in the juxtapericardial anterior mediastinal fat. The lesion exhibited intrinsic soft tissue stranding and surrounding soft tissue attenuation that abutted the adjacent pericardium 2. CT: $3.1 \times 1.9 \times 3.7$ cm ovoid fat-attenuation lesion with soft-tissue stranding in right major fissure, encapsulated, small ipsilateral effusion	1. None (follow-up CT was recommended but was not performed) 2. Follow-up CT: effusion resolved, lesion unchanged	1. NSAIDs Analgesics 2. Initial IV antibiotics (no improvement), surgical resection at day 19.

Table 1. Cont.

Study	Patient characteristics	Symptoms	CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Mazzamuto <i>et al.</i> 2012 [19]	A 64-year-old man	An acute left chest pain of 3 days duration. The pain increased during palpation of the 6th and 7th anterior intercostal spaces	Contrast-enhanced CT scan of the chest on admission shows on transverse section at the level of the heart a rounded lesion adjacent to the left antero-lateral part of the pericardium. The lesion shows a central area of low attenuation (-80 HU) and is surrounded by a capsule of higher density. The nearby pericardium is slightly thickened	Control CT after 2 weeks showed the disappearance of the lesion	Anti-inflammatory drugs
Runge <i>et al.</i> 2011 [9]	A 70-year-old man with a history of borderline hypertension and mild obesity	A 2-day history of left-sided pleuritic chest pain, left shoulder pain, and mild dyspnoea. On the night of admission, he awakened with severe pleuritic pain in the left mid-axillary area. The pain was not positional and did not radiate, and was not reproducible by palpation. He had mild dyspnoea, which he attributed to splinting to control the severity of his pain	Chest CT identified a 6.4 × 2.5 cm low-density soft-tissue shadow in the left lung base. A second, smaller paracardiac density (2.9 × 2 cm in diameter) was also noted	Three months following discharge, the patient experienced recurrent left pleuritic chest pain. Imaging studies showed that the area of increased attenuation in the paracardiac fat had decreased in size, to 2.2 cm by 1.4 cm. The left-basilar density had resolved. Six months later, the paracardiac lesion had decreased in size to 1.4 cm in diameter. The patient was monitored with serial CT imaging studies for 12 months after his acute episode, and his symptoms did not recur	Not reported
Ataya <i>et al.</i> 2011 [5]	A 48-year-old man	A history of 10 days of acute anterior pleuritic chest pain. His pain was provoked by movement or being supine and was alleviated by sitting upright	A heterogeneous soft tissue mass with regions of fat attenuation in the left cardiophrenic space, contiguous with the pericardium and abutting the left anterior chest wall	A follow-up CT examination performed 1 month later showed interval decreased size of the lesion with near complete resolution	Not reported
Pineda <i>et al.</i> 2005 [20]	A 54-year-old woman	A sudden onset of pleuritic chest pain. The pain disappeared in 2 days. Three weeks later, she returned with another episode of chest pain	Chest CT showed a lesion adjacent to the pericardium with a low attenuation coefficient (-48 H) surrounded by a capsule of higher density that enhanced after administration of IV contrast material. Slight thickening of the adjacent pericardium was evident	Two months later, chest CT showed a marked decrease in the size of the epipericardial fat lesion and the adjacent pericardial thickening	Analgesics

Table 2. Studies describing EFN detected during MR imaging

Study	Patient characteristics	Symptoms	MRI features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Rafiee <i>et al.</i> 2022 [21]	A 37-year-old man	A sudden-onset pleuritic pain in his right anterior lower chest radiating to the upper abdomen, 1-day long	T2-W – well encapsulated, oval shape high signal intensity lesion with thin peripheral hypointense rim in the right pericardial fat. Linear enhancement of the adjacent inflamed pleura and pericardium was noted. T1 in-phase and out-of-phase images showing significant signal loss in the lesion on the out-of-phase sequence – fat lesion	Radiologic follow-up was not performed	Self-limited

to the pericardium and pleura. In most of the reported cases it presented itself with an encapsulated mass (37 cases, 60.7%) with dense strandings (35 cases, 57.4%). In 21 cases (34.4% of all, 42% of those who presented with at least one of those traits) the necrosis was characterised by both features. Fukamatsu *et al.* described a 25-year-old male who presented with severe pleuritic chest pain worsening over a week and dyspnoea [36]. Contrast chest CT revealed an ovoid, fatty lesion with a thick rim, with contrast enhancement and dense, fat stranding inside the lesion.

Density of the necrosis was described as hypo-, iso-, and hyperdense in 20, 9, and 22 cases, respectively; 10 cases were without any information on density. In 7 (11.5%) patients CT showed post-contrast enhancement of the mass.

Pleural effusion was detected in 23 (37.7%) cases. Pericardial effusion was found in only 1 patient while pericardial thickening was present in 13 (21.3%). A chest CT of the aforementioned patient described by Cafezeiro *et al.* revealed a dense area with discrete thickening and adjacent pericardial effusion [43]. Calcification of the mass was found in 1 patient reported by Utsumi *et al.* [41]. The lesion in a 62-year-old male started developing calcification at 7 years after thymectomy, and at 8 years thoroscopic resection of the nodule was performed. It was then confirmed to be epipericardial fat necrosis.

Magnetic resonance imaging (MRI) was performed in 10 patients (16.4%). Pleural effusion, pericardial effusion, and pericardial thickening were found in this imaging in 2, 0, and 1 patient/s, respectively. Late gadolinium enhancement was shown in two patients. Baig *et al.* described a 58-year-old woman presenting with severe, intermittent, left-sided pleuritic chest pain (10/10 on the VAS) lasting 2 weeks, with no other significant findings

[50]. Cardiac MRI of this patient revealed an epipericardial lesion of soft tissue oedema and with gadolinium enhancement typical for an active disease process.

Management

Treatment with nonsteroidal anti-inflammatory drugs, corticosteroids, or surgery was reported in 29 (47.5%) patients. Of these, 20 (32.8% of the total cohort) received conservative treatment, whereas 9 (14.8%) underwent surgical intervention. Among 36 patients with available follow-up imaging, regression of EFN was reported in all cases, with complete resolution in 64% and partial regression in 36%.

Discussion

Symptoms

EFN manifests itself as acute, severe, and localised chest or arm pain, dyspnoea, diaphoresis, tachypnoea, and tachycardia [3, 8]. The pain can radiate to the neck, shoulder, back, axilla, or arm. In most cases the pain subsides within a week [9]. Studies have found that pain is mostly left-sided, which coincides with the CT results and the necrosis being mostly on the left side. The mentioned symptoms imitate cardiopulmonary causes such as acute coronary syndrome, pneumothorax, acute pericarditis, or pulmonary embolism [33, 37]. This can be a source of higher diagnosis rates at emergency departments than in physicians' clinics. One study found that the diagnosis rate for EFN is 2.58% of patients admitted to the emergency department with complaints of acute chest pain and established with CT, and 0.26% of all patients undergoing chest CT for any reason [28]. However, the incidence of EFN in the overall population might be higher be-

Table 3. Studies describing EFN detected during both MRI and CT imaging

Study	Patient characteristics	Symptoms	MRI & CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
van den Heuvel <i>et al.</i> 2021 [22]	A 58-year-old man	2 days of sharp, substernal chest pain, which worsened during inspiration	MRI (after 5 days): T1 – low signal, T2 – high signal. Late gadolinium enhancement imaging – hypo-enhanced areas surrounded by areas of hyperenhancement CT: inhomogeneous epipericardial mass (mediastinal/right side)	Follow-up CT 3 months after admission showed a marked regression of the epipericardial mass	Self-limited
Simon <i>et al.</i> 2019 [48]	A 35-year-old woman	A history of 2-days non-radiating, left-sided pleuritic chest pain with no associated dyspnoea, cough, sputum, or sweating	A fatty lesion in the left cardiophrenic angle surrounded by inflammatory tissue and associated with small pleural effusion	CT scan performed 2 weeks following the diagnosis revealed almost complete regression of the anterior mediastinal mass and resorption of the pleural effusion	Aspirin (because of suspected pericarditis)
Neto <i>et al.</i> 2019 [49]	A 42-year-old man	Severe non-radiating left-sided pleuritic chest pain for the previous 4 days, only partially relieved by analgesics	CT: An increased radiolucency and nodularity of anterior/left-sided pericardial fat with nodular appearance consistent MRI: Hypersignal on T1- and T2-weighted images with loss of signal in fat saturation sequences and no first-pass or late gadolinium enhancement. The mass was delimited from the remaining pericardiac fat by a regular halo that presented hypersignal in T2, late enhancement and did not saturate on fat saturation sequences	CT after 6 months: slight densification of the anterior mediastinum's fat in lesser degree than in the previous exam	Colchicine and non-steroidal anti-inflammatory drugs
Baig <i>et al.</i> 2012 [50]	A 58-year-old woman with a history of dyslipidaemia and gastroesophageal reflux disease	An intermittent, severe (10 out of 10), non-radiating, left-sided pleuritic chest pain of 2 weeks' duration. It was not associated with nausea, dyspnoea, or diaphoresis	CT: A soft tissue lesion interposed between the chest wall and the pericardium, 2.5 cm high × 1.2 cm anterior-posterior × 2.5 cm transverse. The lesion was characterised by a streaky infiltration of epipericardial fat with mild expansion but without invasion of the deeper cardiac structures or the chest wall. MRI: An epipericardial lesion anterior to the right ventricle and pulmonary outflow tract that was high signal on T2-weighted images, typical of soft tissue oedema, and with mild enhancement after gadolinium, typical of an active disease process	Follow-up chest CT and cardiac MR after 10 weeks showed interval resolution of the infiltrative changes, expansion, oedema, and enhancement of the lesion	Analgesics

Table 3. Cont.

Study	Patient characteristics	Symptoms	MRI & CT features and location (left or right side)	Time of control with normal epipericardial fat appearance	Treatment
Pineda <i>et al.</i> 2005 [20] (second case)	A 50-year-old man	An acute left chest pain of 3 days' duration. The symptoms increased with cough, postural changes, and deep inspiration	CT: left paracardiac mass, which had low attenuation values equivalent to subcutaneous fat and contained dense strands MRI: An MRI examination confirmed the fatty contents of the lesion with hypointense strands. Sagittal and coronal images failed to show any connection with the abdominal cavity	Not reported	The possibility of a liposarcoma was raised, and 1 week later, the patient underwent a thoracotomy that revealed the lesion was part of the epipericardial fat. Pathology found fatty necrosis and no identifiable tumour
Barreto <i>et al.</i> 2023 [51]	23-year-old male	Severe acute left pleuritic chest pain, worsening with deep inspiration and Valsalva manoeuvre	CT: pulmonary angiogram depicted at the left cardiophrenic angle a focal 3 cm ovoid-shaped fat lesion with stranding and thin, soft tissue margins, consistent with necrosis of the epipericardial fat MR: demonstrated a 3 cm fatty lesion with increased T2 signal in the left cardiophrenic angle consistent with focal oedema	A chest CT follow-up was performed 2 months after and confirmed the resolution of the inflammatory changes	Ibuprofen 600 mg twice daily and pantoprazole 40 mg once daily, with symptomatic improvement after 4 weeks
Shah Alam <i>et al.</i> 2023 [52]	31-year-old female	Left-sided chest pain associated with left sided elbow joint pain intensifying over the last 2 days. Aggravated while exerting, lifting heavy weights and while lying down. Relieved while sitting	CT chest and MRI Thorax contrast showed small ill define STIR hyper intensity with thin peripheral enhancement in the anterior mediastinum in the left side posterior to the 5th costal cartilage and anterior to the pericardium suggestive of changes in the fat – focal panniculitis. Confirming the diagnosis as epipericardial fat necrosis	2–3 weeks later CT showed resolution of the lesion	Colchicine and Non-steroidal anti-inflammatory drugs for 2–3 weeks
Inoue <i>et al.</i> 2000 [53]	55-year-old male	Sudden sharp, pleuritic pain in the left anterior lower chest. Two days later he was admitted to another hospital following a traffic accident in which he sustained a bruise on the anterior chest	CT scan of the thorax demonstrated a nonhomogeneous mass in the anterior left side of the chest, abutting the left cardiac margin, and a left-sided pleural effusion. CT scans, and magnetic resonance imaging (MRI) were interpreted as showing a nonhomogeneous left pericardial mass having a density consistent with fat	N/d	Surgery for suspected neoplasm
Yoshino <i>et al.</i> 2024 [54]	75-year-old male	Fever and chest pain	CT: mass lesion of 53 × 48 mm in size with mixed fat and soft density in the major fissure area between the middle and lower lobes of the right lung, and the possibility of mediastinal origin was considered. MRI: Radiologic reading showed a mass with mixed fat and soft tissue signal in the major fissure area between the middle and lower lobes of the right lung, and the lesion appeared to be continuous with the pericardial fatty tissue	N/d	Surgical resection of the suspected right extrapulmonary tumour

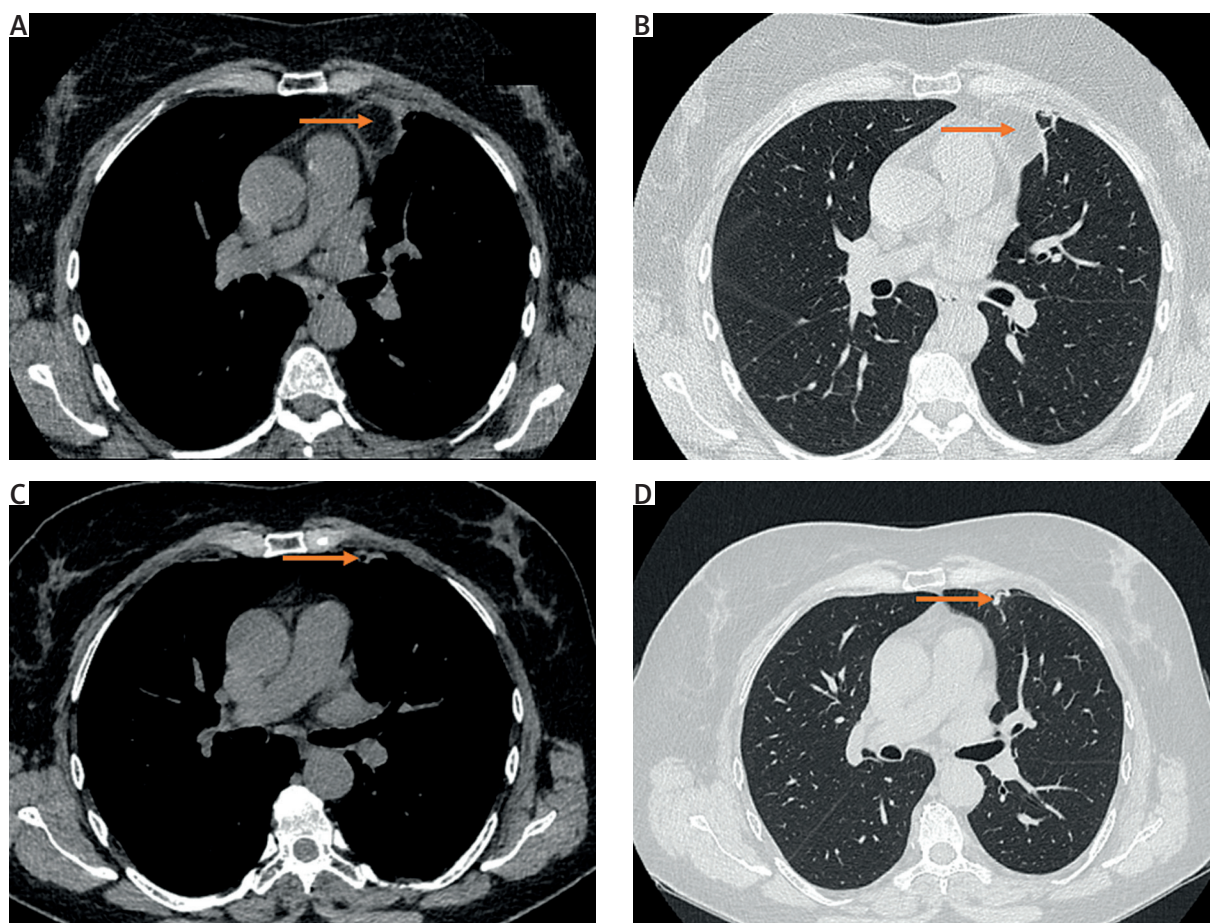


Figure 2. A case of a patient with epipericardial fat necrosis is shown in panels **A** and **B**, captured using computed tomography imaging. The control study for this same patient, conducted 4 years later, is presented in panels **C** and **D**

cause the milder symptoms could be overlooked by physicians or disregarded by patients.

Most studies state no prevalence in age or sex; however, in this systematic review most patients (61%) were male [5, 49, 55]. This may suggest a changing trend towards male gender, with emerging new case reports in the literature. Obesity was considered to be a risk factor, but no such relationship was demonstrated in studies. Electrocardiogram and laboratory findings are usually normal, which can help in differential diagnosis, distinguishing from, among others, myocardial ischaemia. However, non-specific ST-changes can occasionally be found. Some studies reported elevated D-dimer, CRP, or white blood cell count, probably due to inflammatory processes taking place in the tissue [7]. Non-specific symptoms means that imaging modalities such as CT or MRI scans play an important role in differential diagnosis.

Imaging

Chest CT should be the preferred modality to establish a more definitive diagnosis. The differential

diagnosis may include liposarcoma, lipoma, thymolipoma, cysts, and diaphragmatic hernias. EFN usually reveals itself on CT scan as a round or ovoid, well-circumscribed, encapsulated mass and, in most cases, located anteriorly on the left side of the pericardium [51, 55]. In some cases, calcification of the lesion can be found. Inflammatory features such as dense strandings, thickening of pericardium, or pleural effusion were also present in more than half of the published cases [20, 37]. The finding of encapsulated fatty mass with dense strandings and thickening of the pericardium, together with the aforementioned symptom of chest pain, should be a triad strongly suggesting a diagnosis of EFN. Figure 2 shows CT imaging features of patients with EFN.

MRI is less frequently used but no less useful. The first MRI of an EFN case was published in 2005 by Pineda *et al.* [20]. Characteristic features for EFN, such as ovoid shape, pleural effusion, and pericardial thickening, can be observed. In the acute phase, increased signal intensity may be observed on fluid-sensitive T2-weighted sequences. Two cases also reported

late gadolinium enhancement. Chest radiography can be initially normal with only small pleural effusion at the diaphragmatic angle on the side of the necrosis. If EFN is advanced, a shade of circumscribed density could be seen [30, 33]. If echocardiography is performed, it may show an ovoid, solid mass located in the pericardium. The histopathology of the mass shows pooling of fat in compartments, lipide-laden macrophages, and subintimal fibrosis of arterioles.

Treatment

From 1957 to 2005 the treatment method of choice was exploratory thoracotomy and excision of the lesion. Twenty cases of surgically treated EFN are known to have been reported in those years. There have been suggestions that surgery should remain a first-line treatment option to rule out neoplastic changes. In 2005 Pineda *et al.* reported a case of a patient who was treated conservatively with non-steroidal anti-inflammatory drugs (NSAIDs), in whom the pain subsided after a few days without the need of performing surgery [20, 56]. Since then, the approach to treatment has changed in favour of non-invasive options. According to current knowledge, the gold standard for diagnosis should be a CT scan, and treatment should be conservative because NSAIDs are usually sufficient to manage the symptoms. If after a CT scan there is still uncertainty, an MRI can be performed; only then, the next step may be an exploratory thoracotomy to exclude malignancy. Follow-up imaging may be considered when the diagnosis remains uncertain or when symptoms or imaging abnormalities persist. The timing and modality should be individualised [5, 7, 55].

Potential risk factors

Obesity, particularly visceral fat accumulation, is frequently mentioned as a potential risk factor. Excessive fat tissue may increase the susceptibility to various forms of injury, including those that could trigger inflammation and necrosis [57]. The increased metabolic activity in obese individuals might also play a role in EFN development. Physical trauma to the chest region could directly damage the epipericardial fat, initiating an inflammatory response and potentially leading to necrosis [7]. This could be due to blunt force trauma, surgical procedures, or even intense physical exertion. Conditions or activities that significantly increase intra-thoracic pressure (e.g. severe coughing, straining during bowel movements, intense physical exercise) might compromise blood flow to the epipericardial fat, causing ischaemia and subsequent necrosis. The repetitive mechanical stresses of cardiac contractions might create shearing forces within the epipericardial fat, leading to micro-injuries and inflammation. Individuals with certain cardiac conditions (e.g. arrhythmias, valvular disease) or those experiencing intense physical activity might

be at greater risk [58, 59]. The underlying inflammatory processes involved in EFN might be triggered by various factors, including infection, autoimmune disorders, or other systemic inflammatory conditions. Identifying the specific inflammatory pathways and their initiating triggers is essential for a better understanding of EFN pathogenesis.

Interestingly, genetic and metabolic factors that influence fat tissue development and inflammatory processes may be engaged in the aetiology of EFN [56]. Firstly, genes associated with obesity and fat distribution may play a crucial role. Although obesity is associated with visceral fat accumulation and systemic inflammation, it has not been established as a risk factor for EFN. Certain genetic mutations can lead to excessive fat deposition in the body, including epicardium (such as *FTO* and *MC4R*) [60]. Secondly, genes that regulate inflammation are crucial because inflammation is a key element in fat necrosis. Genes like *IL6* and *TNF- α* , which encode pro-inflammatory cytokines, can increase the risk of inflammatory conditions, potentially predisposing individuals to EFN [61]. Thirdly, genes involved in lipid metabolism also play a role. Mutations in genes associated with fat processing, such as *APOA5* and *PPARG*, can influence how fat is stored and metabolised, which may be linked to the risk of epipericardial fat necrosis. Additionally, genes related to insulin resistance can impact EFN risk. Insulin resistance is often associated with excess fat tissue and inflammation. Genes such as *IRS1* and *IGF1* may predispose individuals to insulin resistance, indirectly increasing the risk of developing EFN, because insulin resistance is tied to chronic inflammation in fat tissue [62]. Finally, epigenetic factors are significant. Epigenetics, which involves regulating gene expression through chemical modifications of DNA without changing its sequence, can also play a role. Lifestyle factors, diet, and environmental exposure can alter the expression of genes related to fat metabolism and inflammation, potentially contributing to EFN [63]. However, the exact genes involved and their specific mechanisms of action remain largely unknown. Further genetic research using larger cohorts is needed to identify potential genetic markers associated with EFN risk.

Artificial intelligence in diagnosis

Interestingly, artificial intelligence shows great potential in the automatic segmentation and assessment of epicardial fat on CT imaging, enabling more efficient evaluation of cardiovascular risk and improving both diagnostic and prognostic workflows [64]. Machine learning and deep learning algorithms, such as convolutional neural networks, provide fast, reproducible, and accurate measurements that previously relied on labour-intensive manual segmentation [65]. Importantly, radiomics techniques also hold promise in the dif-

ferential diagnosis of epipericardial fat necrosis, by extracting quantitative and textural features that could help distinguish it from other mediastinal pathologies [64–66]. This remains an emerging field and a promising area for future research and clinical validation.

Conclusions

The exact aetiology of EFN remains unknown, and the potential contributions of genetic and environmental factors have not been established. EFN manifests in most cases as acute, severe, and localised chest or arm pain, dyspnoea, diaphoresis, tachypnoea, and tachycardia. Chest CT should be the preferred modality to establish a more definitive diagnosis. Current evidence indicates that conservative management with NSAIDs is sufficient in most patients, as the condition is typically self-limiting. Follow-up imaging is advisable to confirm regression or resolution of the lesion and to exclude alternative diagnoses. Early recognition of EFN and adherence to a conservative approach can prevent unnecessary invasive procedures and optimise patient outcomes.

Funding

This research was financed by the Jagiellonian University Medical College.

Ethical approval

Not applicable.

Conflict of interest

The authors declare no conflict of interest.

References

- Janssen TJ, Wigley CH, Adegbe D, Zoller F, Mosahebi A. The treatment of symptomatic fat necrosis: a review and introduction of a new treatment algorithm. *J Plast Reconstr Aesthet Surg*. 2023; 77: 87-93.
- Vasei N, Shishegar A, Ghalkhani F, Darvishi M. Correction to: Fat necrosis in the breast: a systematic review of clinical. *Lipids Health Dis*. 2019; 18(1): 158.
- Bansal A, Gupta P, Singh H, Samanta J, Mandavdhare H, Sharma V, Sinha SK, Dutta U, Kochhar R. Gastrointestinal complications in acute and chronic pancreatitis. *JGH Open*. 2019; 3(6): 450-455.
- Giannis D, Matenoglou E, Sidiropoulou MS, Papalampros A, Schmitz R, Felekouras E, Moris D. Epiploic appendicitis: pathogenesis, clinical findings and imaging clues of a misdiagnosed mimicker. *Ann Transl Med*. 2019; 7(24): 814.
- Ataya D, Chowdhry AA, Mohammed TL. Epipericardial fat pad necrosis: computed tomography findings and literature review. *J Thorac Imaging*. 2011; 26(4): W140-142.
- Kim SJ, Han BH, Cho Y, Ryu DS, Yoon GY, Paik W, Kim YR. Epipericardial fat necrosis in a pediatric patient diagnosed using contrast-enhanced MRI findings: a case report and literature review. *J Korean Soc Radiol*. 2022; 83(5): 1160-1167.
- Mortensen SG, Buchmann P, Lappegard KT. Epipericardial fat necrosis: a case report and a review of the literature. *Clin Med Insights Case Rep*. 2020; 13: 1179547620940769.
- Alomari L, Khushaim A. Diagnosis of epipericardial fat necrosis on multimodality imaging in a pediatric patient: a case report and review of the literature. *J Radiol Case Rep*. 2020; 14: 16-24.
- Runge T, Greganti MA. Epipericardial fat necrosis – a rare cause of pleuritic chest pain: case report and review of the literature. *Arch Med Sci*. 2011; 7(2): 337-341.
- Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hróbjartsson A, Lalu MM, Li T, Loder EW, Mayo-Wilson E, McDonald S, McGuinness LA, Stewart LA, Thomas J, Tricco AC, Welch VA, Whiting P, Moher D. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *PLoS Med*. 2021; 18(3): e1003583.
- Artunduaga M, Fuqua BL, Pierry C, Soto Giordani GA, Roman-Colon AM. Imaging diagnosis of epipericardial fat necrosis in children. *Pediatr Radiol*. 2020; 50(2): 285-288.
- Bolourchi M, Renjen P, Kovanlikaya A, Baad M, Traister M, Flynn PA, Kern JH. Epipericardial fat pad necrosis-a rare cause of chest pain in an adolescent. *Pediatr Emerg Care*. 2021; 37(6): e345-e347.
- Celikkanat S, Hamcan S, Bozlar U, Tasar M. Epipericardial fat necrosis clinically mimicking pulmonary embolism: computed tomographic angiography findings. *Am J Emerg Med*. 2016; 34(10): 2056e2055-2056e2056.
- Koutouzi G, Maniotis C, Falkenberg M, Zachrisson K. Epipericardial fat necrosis. *Acta Cardiol*. 2015; 70(6): 736.
- Mohamed Hoessein FA, Swaans M, van Es HW. A 39-year-old otherwise healthy female with acute chest pain. Epipericardial fat necrosis. *Heart*. 2016; 102(7): 540-547.
- Berchuck JE, Patel S. Epipericardial fat necrosis: an unusual and under diagnosed cause of chest pain. *J General Intern Med*. 2015; 30: S391-S392.
- Gutierrez M, Hidalgo A, Carreras F. Epipericardial fat necrosis. *Rev Esp Cardiol*. 2014; 67(12): 1053.
- BhattMY, Martinez-JimenezS, Rosado-de-ChristensonML, Watson KR, Walker CM, Kunin JR. Imaging manifestations of mediastinal fat necrosis. *Case Rep Radiol*. 2013; 2013: 323579.
- Mazzamuto G, Ghaye B. Epipericardial fat necrosis. *J Belgian Soc Radiol*. 2012; 95(3): 154-155.
- Pineda V, Caceres J, Andreu J, Vilar J, Domingo ML. Epipericardial fat necrosis: radiologic diagnosis and follow-up. *AJR Am J Roentgenol*. 2005; 185(5): 1234-1236.
- Rafiee MJ, Khaki M, Haririsanati L, Fard FB, Chetrit M, Friedrich MG. MRI findings of epipericardial fat necrosis: as a rare cause of acute chest pain in a healthy man. *Radiol Case Rep*. 2022; 17(7): 2488-2491.
- van den Heuvel FMA, Dimitriu-Leen AC, Habets J, Nijveldt R. Case report: epipericardial fat necrosis-a rare cause of chest pain. *Eur Heart J Case Rep*. 2022; 6(1): ytab529.
- Abraham R, Govind A, Simon R, Adeyemo A. Antenatal diagnosis of epipericardial fat necrosis in a primigravida determines delivery method. *BJOG Int J Obstet Gynaecol*. 2021; 128: Suppl 2: 155-179.
- Vande Berg BA, Tanghe L, Dubbeldam A. Pedunculated epipericardial fat torsion: a subtle clinical and radiological mimicker. *J Belg Soc Radiol*. 2022; 106(1): 35.

25. Haq S, Wilson MP, Manca D. Epipericardial fat necrosis: an uncommon self-limiting cause of pleuritic chest pain. *CMAJ* 2019; 191(50): E1378-E1381.
26. Couto J, Pontes dos Santos L, Marques Mendes E, Brito A, López R, Santos C. Epicardial fat necrosis: a rare and benign cause of chest pain. *Rev Portug Cardiol*. 2020; 39(2): 113-114.
27. Jouan F, Sacre K, Debray MP, Crestani B, Chauveheid MP, Papo T. A 70-year-old woman with acute chest pain and a paracardiac mass. *Chest*. 2013; 143(3): 866-869.
28. de Giassi KS, Costa AN, Bachion GH, Apanavicius A, Filho JR, Kairalla RA, Lynch DA. Epipericardial fat necrosis: an underdiagnosed condition. *Br J Radiol*. 2014; 87(1038): 20140118.
29. Matos ML, Matias PCF, Grijo C, Gouveia RB, Patacho MFS, Almeida AJ. Epipericardial fat necrosis: a case report of an underdiagnosed disease. *Porto Biomed J*. 2023; 8(2): e205.
30. Haseeb M, Shafiq A, Sheikh MA, Khan MF. Epipericardial fat necrosis and Covid-19. *Eur J Case Rep Intern Med*. 2024; 11(3): 004346.
31. Kenyon SK, Wijesekera VA, Wesley AJ. Case report on the radiographic features of epipericardial fat necrosis in a patient presenting with acute chest pain. *J Med Imaging Radiat Oncol*. 2023; 67(5): 509-513.
32. Ikeo S, Yasuda N, Sakai Y, Hayashi Y, Sokai A, Iwata T, Nishimura T. Epipericardial fat necrosis in a patient with sudden chest pain. *Respirol Case Rep*. 2022; 10(12): e01068.
33. Accorsi TAD, Paixao MR, Piorino EMS, Amicis K, Kohler KF, Souza Jr JL. Epipericardial fat necrosis as a differential diagnosis of acute chest pain: a case report and algorithm proposal for diagnostic approach. *Einstein*. 2023; 21: eRC0183.
34. Otaka Y, Harada Y, Kawamura R, Shimizu T. Epipericardial fat necrosis. *Eur J Case Rep Intern Med*. 2023; 10(3): 003823.
35. Bensard DD, Cyr JAS, Johnston MR. Acute pleuritic chest pain and lung mass in an elderly woman. *Chest*. 1990; 97(6): 1473-1474.
36. Fukamatsu F, Nakamura D, Ippongi K, Yamada K, Takekoshi D, Imai S. Epipericardial fat necrosis: a case report. *Radiol Case Rep*. 2024; 19(8): 2984-2987.
37. Fujita M, Kitagawa K, Domae K, Yamaguchi S, Kokawa T, Takafuji M, Ichikawa Y, Sakuma H. Epipericardial fat necrosis diagnosed by cardiac CT in a patient with apical hypertrophic cardiomyopathy. *Radiol Case Rep*. 2024; 19(5): 1708-1711.
38. Gorospe L, Ayala-Carbonero AM, Montelongo-Martin A, Mirambeaux-Villalona RM, de Leaniz JG. Epipericardial fat necrosis incidentally detected at lung cancer screening with low-dose thoracic CT. *J Cardiovasc Imaging*. 2022; 30(3): 226-228.
39. Zayour M, Karaki M, Al Ashkar R, Chammas E. Epicardial fat necrosis after COVID-19 infection: a case report. *Cureus*. 2022; 14(5): e25154.
40. You J, Hou L, Chatterjee S, Bhansali RD. Epipericardial fat necrosis: a rare, potential complication of COVID-19 pneumonia. *J Am Coll Cardiol*. 2022; 79(9): 2370.
41. Utsumi T, Saito T, Honda O, Ishida M, Maru N, Matsui H, Taniguchi Y, Hino H, Murakawa T. Right epipericardial fat necrosis after thymectomy. *Ann Thorac Surg*. 2022; 113(4): e259-e261.
42. Navani RV, Ashkar C, Gibbs H. Epipericardial fat necrosis: chest pain in a young pregnant woman. *Med J Aust*. 2021; 214(8): 355-356e351.
43. Cafezeiro CRF, Lopes MP, Silva CT, Avila MS, Seguro L, Mangini S, Campos IW, Gaiotto FA, Marcondes-Braga FG, Bacal F. Epipericardial fat necrosis as cause of chest pain in patient after heart transplantation. *Am J Transplant*. 2020; 20(5): 1451-1453.
44. Shah AH, Bogale V, Hurst D, dePrisco G. Epipericardial fat necrosis as a cause of acute chest pain. *Proc (Bayl Univ Med Cent)*. 2016; 29(4): 432-433.
45. Friedman YE, Gayer G, Livne Margolin M, Kneller A, Mouallem M. Epipericardial fat necrosis. *Isr Med Assoc J*. 2018; 20(5): 327-328.
46. Lezcano Gort LE, Herrera Denis I, Romero Castro MJ, Kouunka Z, Chipayo Gonzales D, Gómez Barrado JJ. Epipericardial fat necrosis: an atypical cause of acute chest pain. *Acta Cardiol*. 2018; 73(2): 190-191.
47. Diaz J, Alegria J, Perez D, Medina C. Epipericardial fat necrosis: sonographic findings and their correlation with computed tomography. *J Ultrasound Med*. 2016; 35: 2279-2283.
48. Simon C, Lorek C, Boularan C, Fontaine-Delaruelle C. A 35-year-old woman with acute pleuritic chest pain and an unusual mediastinal opacity. *Chest*. 2019; 155(1): e17-e20.
49. Neto A, Seabra D, Moreno N, Magalhaes S, Pires L, Pinto P. Epipericardial fat necrosis as a differential diagnosis of chest pain-a case report. *Echocardiography*. 2020; 37(1): 132-134.
50. Baig A, Campbell B, Russell M, Singh J, Borra S. Epicardial fat necrosis: an uncommon etiology of chest pain. *Cardiol J*. 2012; 19(4): 424-428.
51. Barreto I, Oliveira FG, Barreira SC, Inacio JR. Epipericardial fat necrosis in chest CT and MRI: a case report of an unusual cause of chest pain associated with the initial diagnosis of undifferentiated connective tissue disease. *BMC Cardiovasc Disord*. 2023; 23(1): 314.
52. Shah Alam T, Thomas J, Shenoy N, Philips G.. Epicardial fat necrosis in a young female: a case report. *Int J Rheum Dis*. 2023; 26(9): 1877-1879.
53. Inoue S, Fujino S, Tezuka N, Sawai S, Kontani K, Hanaoka J, Ichinose M, Encapsulated pericardial fat necrosis treated by video-assisted thoracic surgery: report of a case. *Surg Today*. 2000; 30(8): 739-743.
54. Yoshino R, Nakatsubo M, Ujiie N, Ito A, Yoshida N, Aoki N, Kitada M. Ectopic epipericardial fat necrosis: a case report. *Surg Case Rep*. 2024; 10(1): 54.
55. Nguyen DN, Tran CD, Rudkin SM, Mueller JS, Hartman MS. Epipericardial fat necrosis: uncommon cause of acute pleuritic chest pain. *Radiol Case Rep*. 2018; 13(6): 1276-1278.
56. Patel VB, Mori J, McLean BA, Basu R, Das SK, Ramprasath T, Parajuli N, Penninger JM, Grant MB, Lopaschuk GD, Oudit GY. ACE2 deficiency worsens epicardial adipose tissue inflammation and cardiac dysfunction in response to diet-induced obesity. *Diabetes*. 2016; 65(1): 85-95.
57. Ellulu MS, Patimah I, Khaza'ai H, Rahmat A, Abed Y. Obesity and inflammation: the linking mechanism and the complications. *Arch Med Sci*. 2017; 13(4): 851-863.
58. Al Chekakie MO, Akar JG. Epicardial fat and atrial fibrillation: a review. *J Atr Fibrill*. 2012; 4(6): 68-77.
59. Wong CX, Ganesan AN, Selvanayagam JB. Epicardial fat and atrial fibrillation: current evidence, potential mechanisms, clinical implications, and future directions. *Eur Heart J*. 2017; 38(17): 1294-1302.

60. Khan S, Verma AK, Khan V, Bhatt D, Rafat S, Alsahli MA, Rahmani AH, Meena B, Naqvi IH, Dev K. Role of FTO and MC4R polymorphisms in escalating obesity and their indirect association with risk of T2D in Indian population. *Diabetes Ther.* 2020; 11(9): 2145-2157.
61. Sahasrabuddhe AV, Pitale SU, Sivanesan SD, Deshpande PK, Deshpande SP, Daiwile A. Pathogenic gene expression of epicardial adipose tissue in patients with coronary artery disease. *Indian J Med Res.* 2020; 151(6): 554-561.
62. Jo D, Choi SY, Ahn SY, Song J. IGF1 enhances memory function in obese mice and stabilizes the neural structure under insulin resistance via AKT-GSK3 β -BDNF signaling. *Biomed Pharmacother.* 2025; 183: 117846.
63. Jung BC, Kang S. Epigenetic regulation of inflammatory factors in adipose tissue. *Biochim Biophys Acta Mol Cell Biol Lipids.* 2021; 1866(11): 159019.
64. Hoori A, Hu T, Lee J, Al-Kindi S, Rajagopalan S, Wilson DL. Deep learning segmentation and quantification method for assessing epicardial adipose tissue in CT calcium score scans. *Sci Rep.* 2022; 12: 2276.
65. Zhang L, Sun J, Jiang B, Wang L, Zhang Y, Xie X. Development of artificial intelligence in epicardial and pericoronary adipose tissue imaging: a systematic review. *Eur J Hybrid Imaging.* 2021; 5: 14.
66. Zhang L, Xu Z, Jiang B, Zhang Y, Wang L, de Bock GH, Vliegenthart R, Xie X. Machine-learning-based radiomics identifies atrial fibrillation on epicardial adipose tissue in chest CT. *Br J Radiol.* 2022; 95(1135): 20211274.

Address for correspondence

Patrycja S. Matusiak
Jagiellonian University
Medical College
Krakow, Poland
E-mail: patrycja.s.matusik@gmail.com

Received: 21.08.2025

Accepted: 15.09.2025

Online publication: 28.09.2026