

# UC San Diego

## UC San Diego Previously Published Works

**Title**

CT and MR imaging of the peritoneal fat pad: a pictorial essay

**Permalink**

<https://escholarship.org/uc/item/71t730vt>

**Journal**

Abdominal Radiology, 48(11)

**ISSN**

2366-004X

**Author**

Ghahremani, Gary G

**Publication Date**

2023-11-01

**DOI**

10.1007/s00261-023-04005-w

Peer reviewed



# CT and MR imaging of the properitoneal fat pad: a pictorial essay

Gary G. Ghahremani<sup>1</sup>

Received: 8 May 2023 / Revised: 30 June 2023 / Accepted: 3 July 2023

© The Author(s), under exclusive licence to Springer Science+Business Media, LLC, part of Springer Nature 2023

## Abstract

The properitoneal fat pad is a distinctive anatomical structure located in the midline of anterior abdominal wall between the transversalis fascia and parietal peritoneum. It has variable size and configuration depending on the gender and nutritional status of individuals, but CT and MR images of the upper abdomen can readily depict its shape and adipose composition. The purpose of this essay is to illustrate the CT and MRI features of normal properitoneal fat pad, and the spectrum of pathological processes that affect it among patients. This information can be relevant to the practicing radiologists and clinicians for the correct diagnosis and management of such conditions because most lesions of this fat pad produce nonspecific symptoms.

**Keywords** Properitoneal fat pad · Anatomy and pathology · Abdominal disorders · Radiological diagnosis · Computed tomography · Magnetic resonance imaging

## Introduction

The application of CT and MRI for demonstrating subcutaneous and intra-abdominal fat deposits has been well documented [1, 2]. However, the normal or pathological appearances of the properitoneal fat pad have received scant attention in the radiological publications. An anatomical study of this subject was reported in 1971 by Merklin [3]. Measurements of fat pad size on CT of patients with ascites were investigated in 1990 by Feldberg and van Leewen [4]. A few sonographic studies and isolated case reports of its abnormalities have been presented in the past three decades [5–8]. Therefore, the aim of this article is to review the imaging features of this anterior abdominal wall structure and illustrate its involvement by various pathological processes.

## Normal anatomy and imaging features

Anatomical sections of the abdomen demonstrate the properitoneal fat pad as a well-demarcated adipose tissue located between the transversalis fascia and parietal peritoneum.

From its wide proximal border just below the xyphoid it spans caudally behind the linea alba in the form of an inverted triangle (Fig. 1).

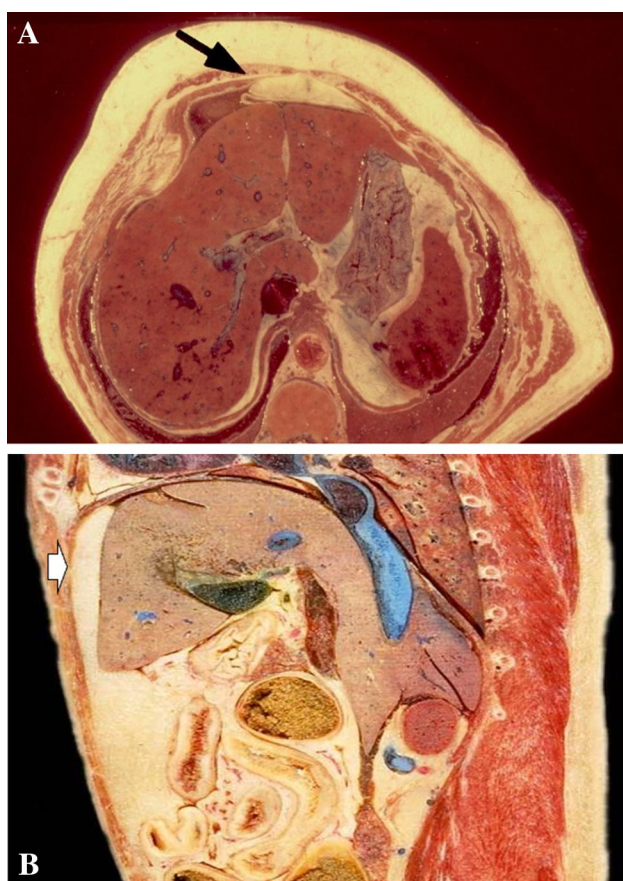
CT and MR images show the properitoneal fat pad as having a shield-like configuration, usually measuring 7–10 cm wide, 12–15 cm long, and about 2 cm in thickness. It has the same or slightly lower attenuation (– 90 to – 100 HU) as compared to the subcutaneous fat (Figs. 2 and 3).

Considerable variations in its size and shape are observed depending on the gender and nutritional status of the individuals. Female and obese patients often have a much larger and thicker fat pad (Fig. 4). Several studies have shown that sonographic measurement of the properitoneal fat thickness correlates closely with the inherent risk of cardiovascular disease, hypertension, non-alcoholic fatty liver, diabetes, and other metabolic complications [6, 9, 10]. Therefore, it would be important that the presence of a large properitoneal fat pad on CT or MRI is mentioned in the radiology report and is brought to the attention of referring clinician.

It may be of interest to note that there was no detectable change in the thickness of properitoneal fat pad in my retrospective review of twenty oncologic patients, who had multiple CT examinations during follow-up periods of up to 12 years despite their considerable loss of weight due to underlying disease. This is in contrast to the decreasing amount of subcutaneous and visceral fat with low carbohydrate diet and exercise that has been described in the medical literature [11].

✉ Gary G. Ghahremani  
gghahremani@ucsd.edu

<sup>1</sup> Department of Radiology, University of California-San Diego Medical Center, 200 West Arbor Drive, San Diego, CA 92103, USA

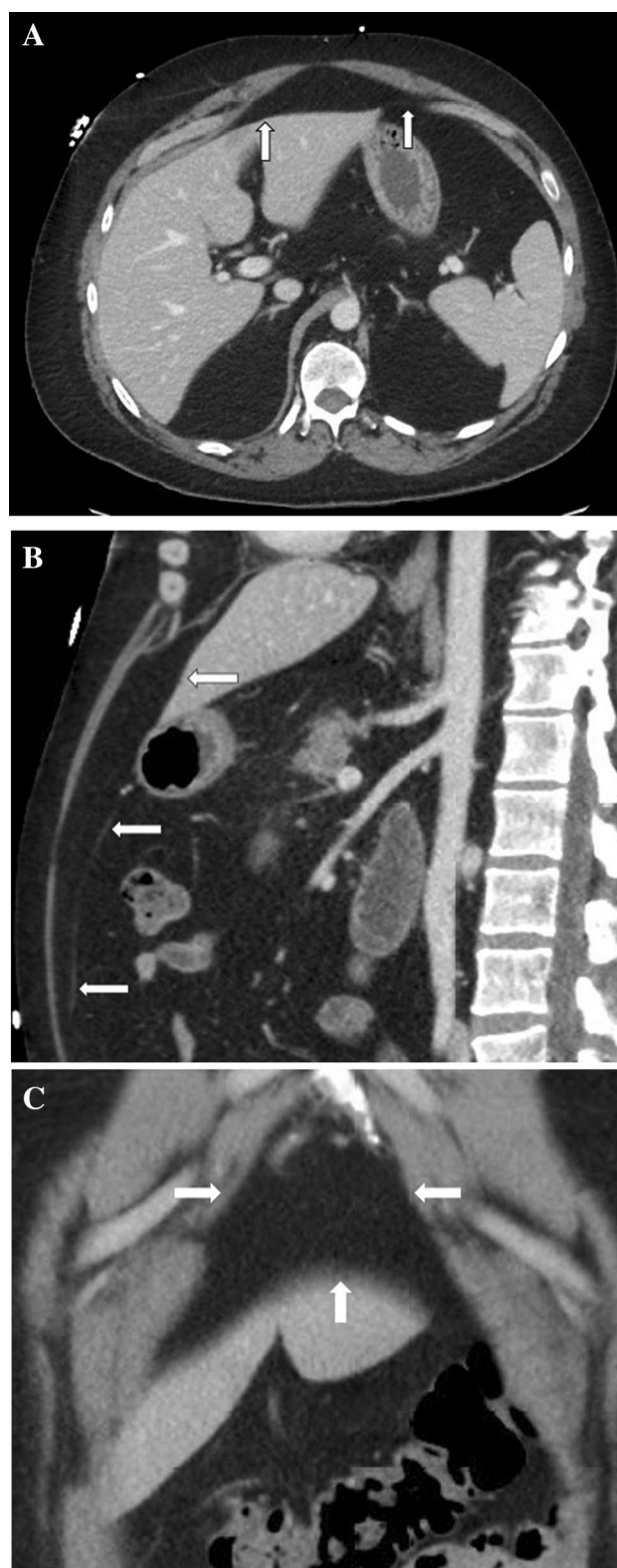


**Fig. 1** Anatomical sections of the abdomen. **A, B** Axial and sagittal sections demonstrate the properitoneal fat pad beneath the linea alba and anterior to the liver (arrow).

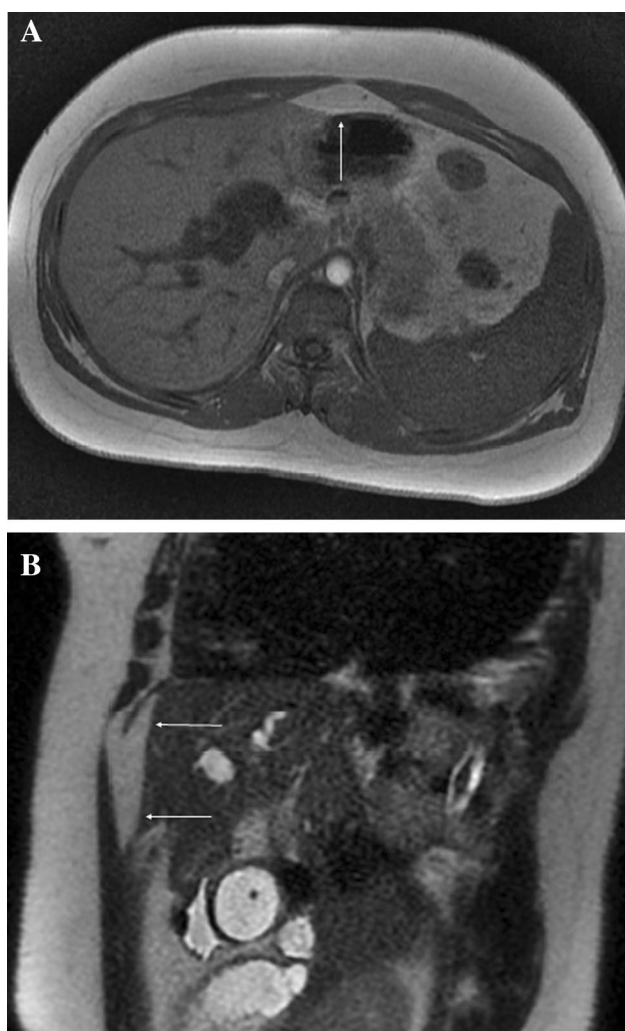
The right edge of properitoneal fat pad extends to the interlobar fissure of the liver and surrounds the falciform ligament, whereas the left border of it abuts the fat-containing gastrocolic and splenocolic ligaments. These contact areas may account for contiguous spread of inflammatory or neoplastic processes to the properitoneal fat pad [7, 8, 12, 13].

The blood supply of properitoneal fat pad is through the ensiform branches of internal mammary and superior epigastric arteries and its venous drainage is via ensiform veins connected to the portal system [3]. The vessels within this fatty tissue are normally too small to be visible on contrast-enhanced CT. However, they can become dilated and recognizable as portosystemic collaterals in patients with portal hypertension or superior vena cava obstruction [14, 15].

The terms pro- and pre-peritoneal are often used interchangeably. However, the properitoneal fat pad should be distinguished from the pre-peritoneal fat which is also known as the flank stripe. The latter is located retroperitoneally along the postero-lateral walls of the abdomen, and it serves as the pathway for inflammation caused by an acute pancreatitis to extend to and produce a discoloration of flank



**Fig. 2** CT of normal properitoneal fat pad in a 32-year-old man. **A** Axial image shows it as a triangular adipose structure measuring 2.5 cm thick and 12 cm wide (arrows). **B** Sagittal section demonstrates its 18-cm long dimension anterior to the parietal peritoneum (arrows). **C** Coronal section of the upper abdominal wall shows the large properitoneal fat pad extending between the xyphoid and liver (arrows).

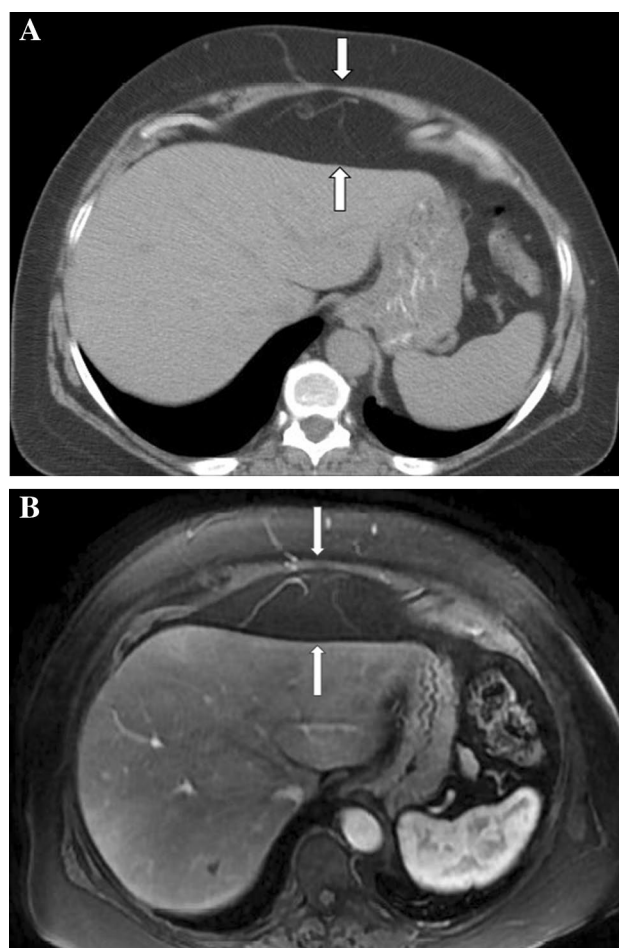


**Fig. 3** MR images of the properitoneal fat pad in an 18-year-old female. **A, B** Axial and sagittal sections show a rather small fat pad (arrows) in this patient with biliary ductal dilatation and cholestasis. T2-weighted pre-contrast sequence.

skin called “Gray Turner Sign” [16]. Since the herein presented fat pad is in front of the peritoneum, the use of prefix pro- would be more accurate designation to better distinguish from pre-(before) or Retro-(behind) peritoneal fat.

### Abnormal conditions

In patients with large ascites the low attenuation of properitoneal fat pad on CT may mimic and mistaken for a pneumoperitoneum (Fig. 5A). This problem occurs when the abdominal images are viewed on soft tissue window, but using the lung window and determining the attenuation

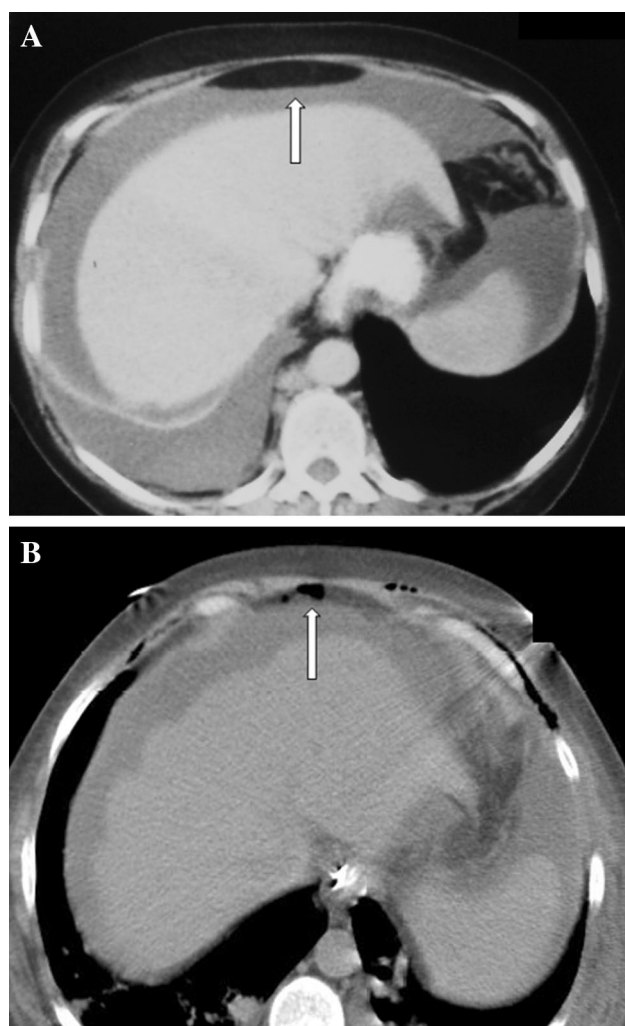


**Fig. 4** Large properitoneal fat pad in a 60-year-old diabetic woman. **A** CT reveals a 4-cm thick and 16-cm wide fat pad between linea alba and the liver (arrows). **B** MR image shows the ensiform vessels supplying this adipose structure (arrows). Postcontrast T2-weighted LAVA sequence.

number would allow the distinction of this fat content from air. This potential source of misdiagnosis is also observed in abdominal radiography [17]. A similar problem may be encountered when abdominal wall emphysema extends to the properitoneal fat and causes its radiolucency that may be confused with free air (Fig. 5B).

Postsurgical changes of the properitoneal fat pad often occur following its transection during midline incision for laparotomy or median sternotomy for coronary bypass graft. These operations can result in edema, hematoma, fat necrosis, fibrotic scar, and inflammation of this adipose tissue due to panniculitis (Fig. 6).

In some instances, the surgical sutures or metallic clips are retained in this fat pad and visible on postoperative CT

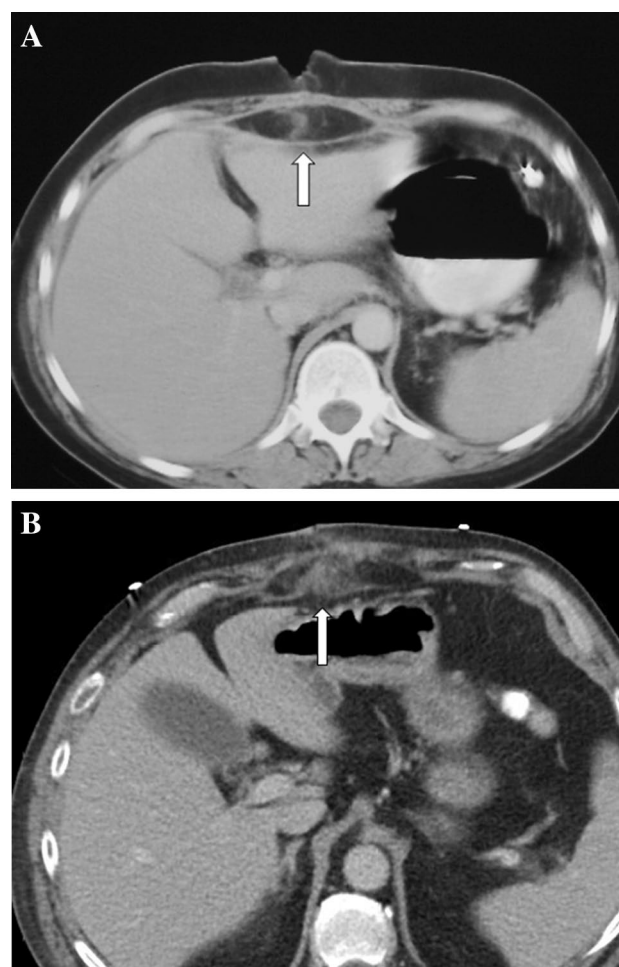


**Fig. 5** **A** CT examination shows the properitoneal fat pad simulating pneumoperitoneum (arrow) in this patient with large ascites and right pleural effusion. **B** Gas collection within this fat pad due to abdominal wall emphysema closely resembles and may be mistaken for free air (arrow).

examinations (Fig. 7). These objects can sometimes lead to the formation of a foreign body granuloma presenting as a soft tissue mass in the subxiphoid region.

In patients who undergo median sternotomy the transection of properitoneal fat pad can lead to the development of a subxiphoid incisional hernia in 2%-4% of cases. It may contain a protruding part of the left hepatic lobe, transverse colon, or the greater omentum and require subsequent repair by mesh placement [18].

Development of an abscess in the properitoneal fat pad can be the result of hematogenous spread of infection or direct extension from the adjacent organs. Because the

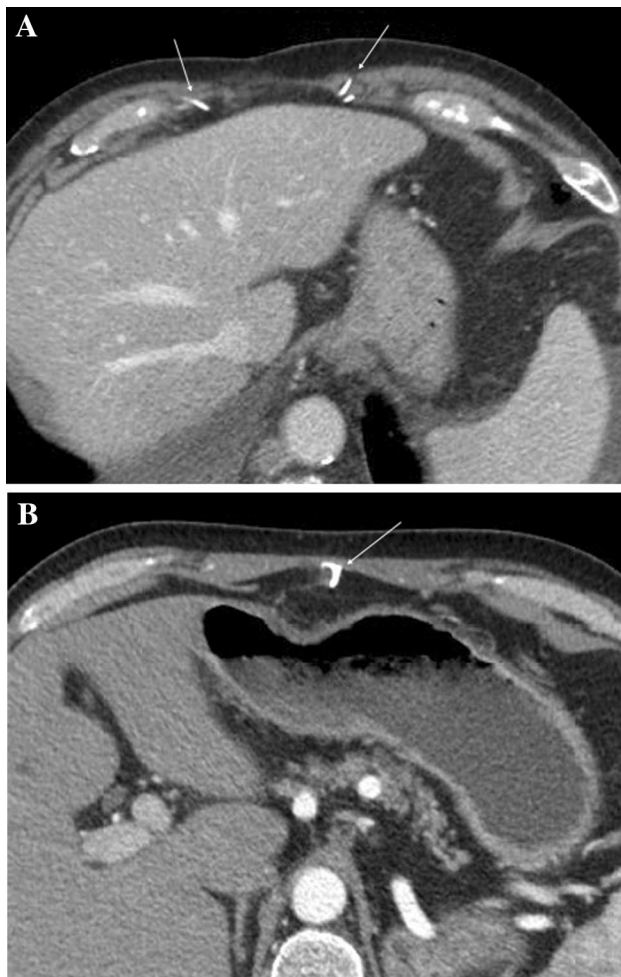


**Fig. 6** Postsurgical abnormalities of the properitoneal fat pad in 2 patients. **A** CT image reveals a small hematoma within the fat pad caused by intraoperative injury during recent laparotomy through a midline incision (arrow). **B** CT shows more extensive involvement of the fat pad by inflammatory changes (arrow).

right border of the fat pad protrudes in to the interlobar fissure, it can be affected by an inflammatory process originating in the liver or the falciform ligament. There have been several reported cases of falciform ligament abscess or its spontaneous inflammation and necrosis affecting the attached fat pad [7, 8].

Inflammatory processes involving the properitoneal fat may manifest with epigastric pain, fever, and leukocytosis. The patient's clinical symptoms can simulate peptic ulcer disease or cholecystitis, and imaging studies will play a crucial role in its differential diagnosis [7, 8, 19].

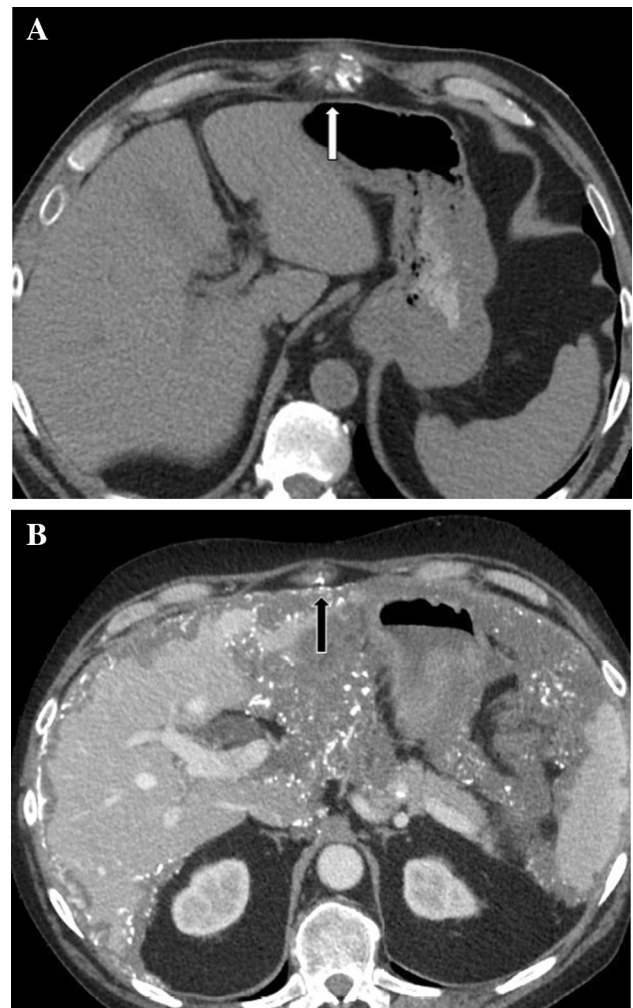
Calcifications within the properitoneal pad can occur due to surgical injury and fat necrosis and usually associated with similar changes of the abdominal wall scar.



**Fig. 7** CT of retained surgical foreign bodies in the properitoneal fat pads of 2 patients. **A** CT image shows several wire pieces after median sternotomy for coronary bypass graft (arrows). **B** A surgical clip is visible as a retained metallic object in this fat pad (arrow).

They often appear as a cluster of confluent calcifications (Fig. 8A). In contrast, the calcifications caused by mucinous adenocarcinomas of ovarian or gastrointestinal origin usually present as discrete punctate or focal densities (Fig. 8B), and they are typically associated with more extensive involvement of the peritoneum by the same process [20].

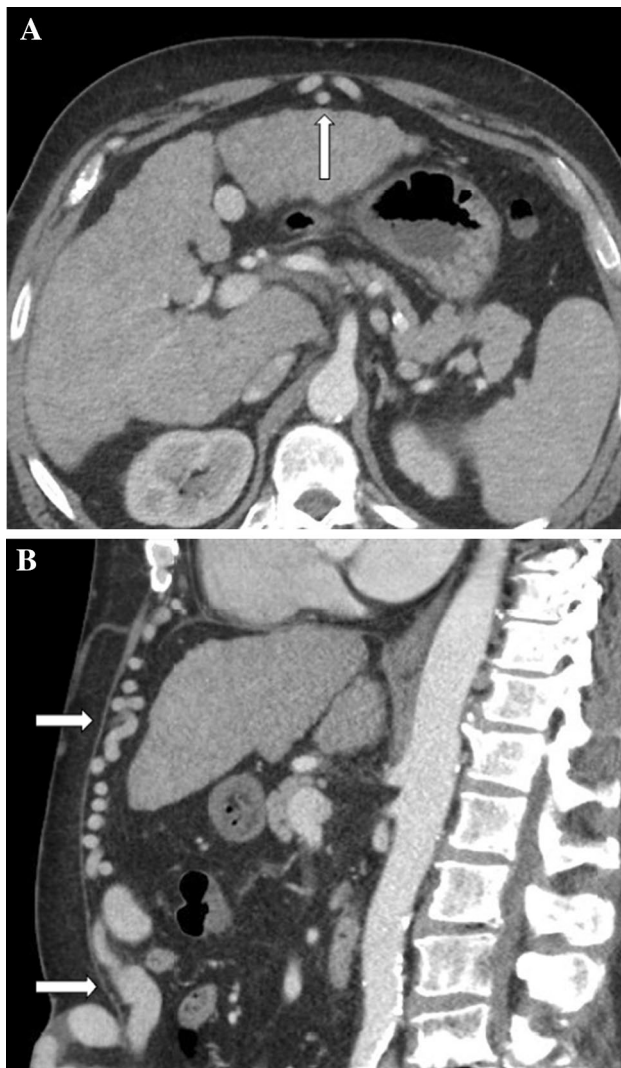
The adipose tissue content of properitoneal fat pad derives its blood circulation mainly from the superior epigastric and internal thoracic vessels through the ensiform artery and vein. These are too small to trace on CT or MR images, but occasionally present as varices due to collateral flow in patients with cirrhosis and portal hypertension (Fig. 9) [3, 14, 15].



**Fig. 8** CT appearances of calcifications involving the properitoneal fat pad. **A** CT image of confluent calcifications that had developed after laparotomy through a midline incision (arrow). **B** Calcified metastasis in the properitoneal fat pad (arrow) associated with diffuse peritoneal calcifications due to mucinous adenocarcinoma of the colon.

Marked hypervascularity of the properitoneal fat pad can be visible on imaging studies of some patients (Fig. 10). This finding usually reflects vascular congestion as the consequence of involvement by various inflammatory or neoplastic processes [8, 12–15].

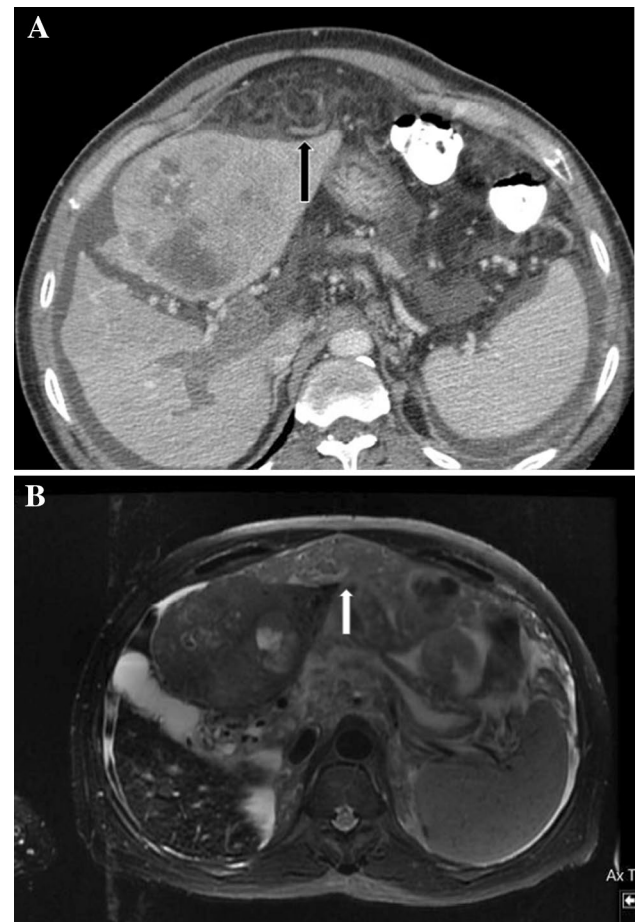
Development of benign or malignant tumors in this fat pad is very unusual and a search of medical literature through MEDLINE database did not reveal any previously reported cases. Nevertheless, it should be noted that a transformation of this adipose tissue to a lipoma can occur and present as a mass in the upper abdomen (Fig. 11). This



**Fig. 9** CT demonstration of varices in the properitoneal fat pad in a 50-year-old man with cirrhosis and portal hypertension. **A** Axial section shows dilated ensiform veins within this adipose tissue (arrow). **B** Sagittal view reveals a markedly distended paraumbilical vein with large varices extending to the fat pad under the anterior abdominal wall (arrows).

is in contrast to the more frequent occurrence of lipomatous tumors in the subcutaneous or retroperitoneal fat and other sites within the abdomen [2, 21].

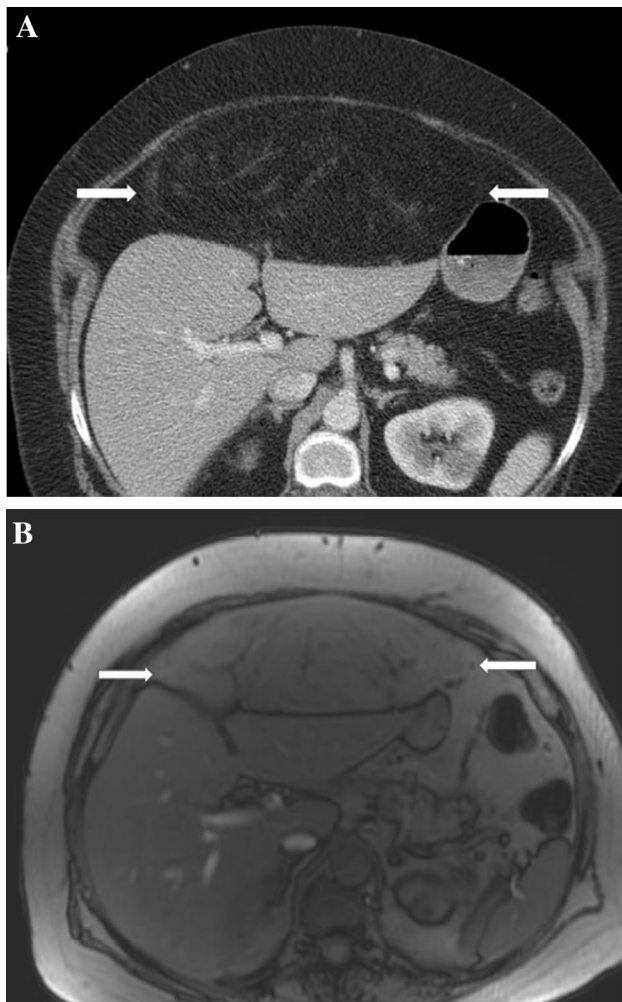
A more commonly observed finding in patient with malignancy is direct extension of hepatocellular carcinoma and hepatic metastases through the liver capsule or via



**Fig. 10** Vascular congestion of the properitoneal fat pad. **A, B** CT and MR studies of a man with multifocal hepatocellular carcinoma and portal hypertension demonstrate marked vascular engorgement of the fat pad due to collateral flow (arrow). T2-weighted pre-contrast with fat suppression.

its ligamentous attachments to involve the properitoneal fat pad (Fig. 12). The various pathways for extrahepatic spread of such tumors have been described in several radiological publications [12, 13, 19].

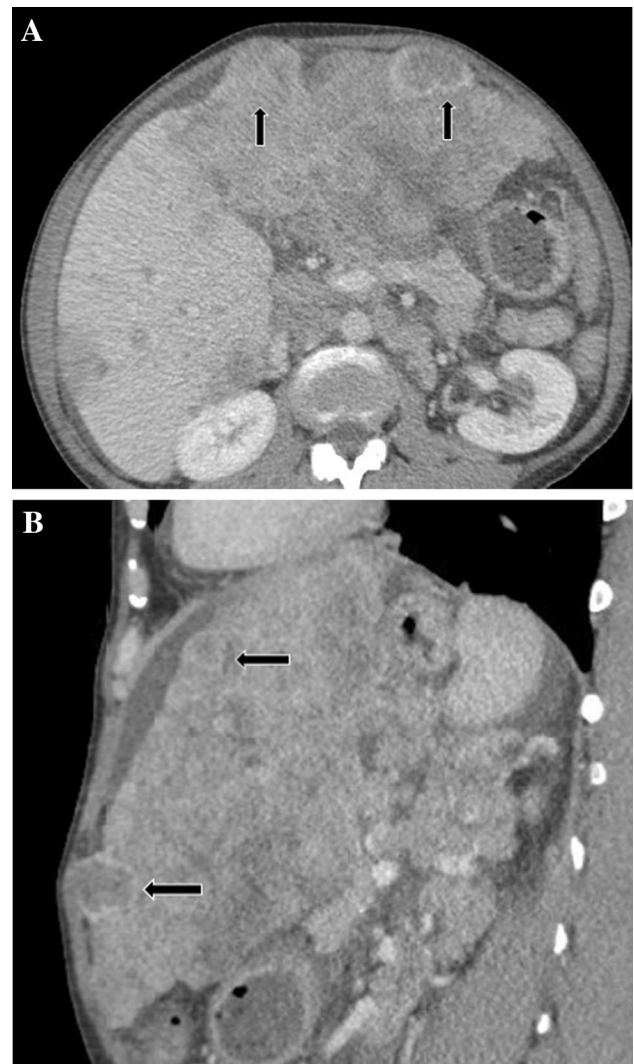
The cases illustrated in this article show that both CT and MRI are useful methods for evaluating the properitoneal fat pad. However, the modern ultrafast and high-resolution CT offers an advantage despite its inherent risk of radiation exposure.



**Fig. 11** Lipoma of the properitoneal fat pad in a 62-year-old woman. **A** CT section reveals a large lipoma measuring 7x19 cm and containing some fibrotic strands (arrows). **B** MR image shows the same features of this lipoma, which appears slightly darker as compared to the subcutaneous fat (arrows). T2-weighted dual FFS.

## Conclusion

The properitoneal fat can be easily evaluated by CT or MRI because of its distinct anatomical location and adipose composition. These studies can demonstrate the normal appearance and various pathological processes that may affect this structure. Often its visualized abnormalities produce nonspecific



**Fig. 12** Properitoneal fat pad involvement by hepatic metastases from rectal cancer in a 63-year-old man. **A, B** Axial and sagittal sections of a contrast-enhanced CT examination demonstrate 2 metastases protruding through the liver capsule into the adjacent fat pad (arrows).

abdominal symptoms and are difficult to diagnose by physical examination alone. Therefore, it is important for the practicing radiologists to be familiar with the spectrum of herein illustrated features and report such findings to the referring clinicians.

## Declarations

**Conflict of interest** The author declares no conflict of interest and has no disclosure relevant to the subject matter of this article.

**Ethical approval** Due to the retrospective review of the already performed and medically warranted examinations, the patients consent, and IRB approval were waived.

## References

- Klopfenstein BJ, Kim MS, Krisky CM, et al (2012) Comparison of 3 T MRI and CT for the measurement of visceral and subcutaneous adipose tissue in humans. *Br J Radiol* 85(1018):e826-830.
- Pereira JM, Sirlin CB, Pinto PS, Casola G (2005) CT and MR imaging of extrahepatic fatty masses of the abdomen and pelvis: techniques, diagnosis, differential diagnosis, and pitfalls. *RadioGraphics* 25: 69-85.
- Merklin RJ (1971) The anterior abdominal fat body. *Am J Anat* 132: 33-44.
- Feldberg MA, van Leeuwen MS (1990) The properitoneal fat pad associated with the falciform ligament. Imaging of extent and clinical relevance. *Surg Radiol Anat* 12: 193-202.
- Vlachos IS, Hatzioannou A, Perelas A, Perrea DN (2007) Sonographic assessment of regional adiposity. *AJR* 189: 1545-1553.
- Tadokoro N, Murano S, Nishide T, et al (2000) Preperitoneal fat thickness determined by ultrasonography is correlated with coronary stenosis and lipid disorders in non-obese male subjects. *Int J Obes* 24: 502-507.
- Sones PJ, Thomas BM, Masand PP (1981) Falciform ligament abscess: appearance on computed tomography and sonography. *AJR* 137: 161-162.
- Bhatt A, Robinson E, Cunningham SC (2020) Spontaneous inflammation and necrosis of the falciform and round ligaments: a case report and review of the literature. *J Med Case Rep* 14:17. doi.10.1186.
- Parente DB, Neto JAO, Americano Brasil PEA, et al (2018) Preperitoneal fat as a non-invasive marker of increased risk of severe non-alcoholic fatty liver disease in patients with type 2 diabetes. *J Gastroenterol Hepatol* 23: 511-517.
- Tayama K, Inukai T, Shimomura Y. (1999) Preperitoneal fat deposition estimated by ultrasonography in patients with non-insulin-dependent diabetes mellitus. *Diabetes Res Clin Pract* 43: 49-58.
- Merlotti C, Ceriani V, Morabito A, Pontiroli AE (2017) Subcutaneous fat loss is greater than visceral fat loss with diet and exercise, weight-loss promoting drugs and bariatric surgery: a critical review and meta-analysis. *Int J Obes* 41: 672-682.
- Hong SS, Kim TK, Sung KB, et al (2003) Extrahepatic spread of hepatocellular carcinoma: a pictorial review. *Eur Radiol* 13: 874-882.
- Arora S, Harmath C, Catania R, et al (2021) Hepatocellular carcinoma: metastatic pathways and extra-hepatic findings. *Abdom Radiol* 46: 3698-3707.
- Casullo J, Zeng H, Belley G, Artho G (2018) CT of the paraumbilical and ensiform veins in patients with superior vena cava or left brachiocephalic vein obstruction. *PLoS One* 13(4):e 0196093.
- Ibukuro K, Tsukiyama T, Mori K, Inoue Y (1998) Hepatic falciform ligament artery: angiographic anatomy and clinical importance. *Surg Radiol Anat* 20: 367-371.
- Wong E, Sayed-Hassen A (2021) Grey Turner's sign in acute pancreatitis. *Clin Case Rep* 9(5): e04313.
- Chung H, Jacks T, Lilien LD (2011) Properitoneal fat mimicking free air in an infant of a diabetic mother. *J Perinatol* 31: 687-688.
- Mackey RA, Brody FJ, Berber E, et al (2005) Subxiphoid incisional hernias after median sternotomy. *J Am Coll Surg* 201: 71-76.
- Mori H, Aikawa H, Hirao K, et al (1989) Exophytic spread of hepatobiliary disease via perihepatic ligaments: demonstration with CT and US. *Radiology* 172: 41-46.
- Agarwal A, Yeh BM, Breiman RS, et al (2004) Peritoneal calcification: causes and distinguishing features on CT. *AJR* 182: 441-445.
- Al-Ali MHM, Salih AM, Ahmed OF, et al (2019) Retroperitoneal lipoma; a benign condition with frightening presentation. *Int J Case Rep* 57: 63-66.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor (e.g. a society or other partner) holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.