What The Fat?

Dr Pawan Patel, Radiology Registrar

Dr Gurinder Nandra, Radiology Registrar

Dr Oliver Duxbury, Radiology Registrar

Dr Mohammad Ali Shah, Consultant Radiologist

Dr Nirav Patel Consultant Radiologist

St George’s Hospital, London

Learning Objectives

- Fat based intra-peritoneal abnormalities are uncommon entities but can cause relative diagnostic uncertainty due to overlapping radiological features. The wide spectrum of fat based pathologies, ranging from acute and chronic to benign and malignant conditions can impact patients' management rather differently and highlights the importance of diagnostic accuracy.

- The aims of this poster are as follows:

1. Review of the most common fat based intra-peritoneal pathologies comprising of their respective clinical presentation, pathophysiology and complications.
2. Review the imaging characteristics of the most common fat based intra-peritoneal pathologies

Background

- Examples of fat based pathology that we will concentrate on include:
  - Epiploic appendagitis
  - Omental infarction
  - Pseudolipoma of Glisson
  - Lipomas
  - Liposarcomas
  - Mesenteric panniculitis
  - Omental caking
  - Dermoid cysts

Epiploic Appendagitis

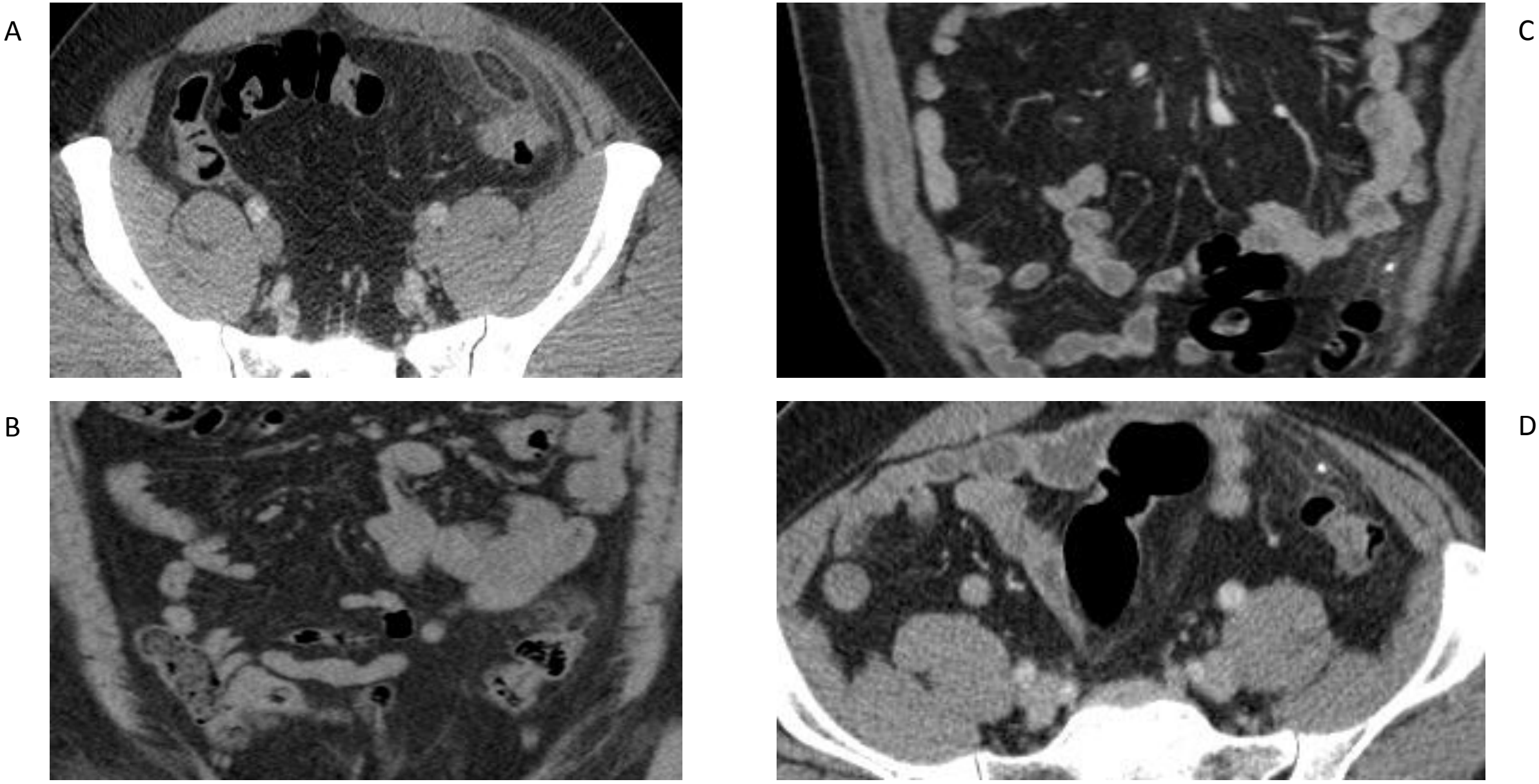
- Epiploic appendages are peritoneal lined pouches of subserosal fat, arising from the serosal surface of the colon. They typically measure 0.5-5cm. There are approximately 50-100 throughout the colon, specifically between the caecum and recto-sigmoid junction.
- Those in the sigmoid are usually the largest. They are absent from the rectum. They are arranged longitudinally in two rows; one row medial, along the taenia libera and one row posterolateral, along the taenia omentalis. There is only one row along the transverse colon.
- They are supplied by two paired nutrient arteries that run through the bowel serosa and drain via one vein. It has been proposed that torsion or spontaneous venous thrombosis of the epiploic appendage leads to ischaemia or haemorrhagic infarction and subsequent appendagitis [(1)].
- Causes of epiploic appendagitis include torsion and inflammation accounting for 73%, hernia incarceration 18%, intestinal obstruction 8% and intraperitoneal loose body <1% [(2)].
- Secondary causes are due to inflammation of adjacent organs for example appendicitis, cholecystitis and diverticulitis.

Epiploic Appendagitis

- In rare cases, complication include adhesions, bowel obstruction, intussusception, intraperitoneal loose bodies, peritonitis and abscesses [(3)].
- Epiploic appendagitis is associated with obesity, hernias and unaccustomed exercise. It occurs commonly in 2nd to 5th decades with slight predominance in men [(4)].
- Epiploic appendagitis presents with acute onset of pain, commonly in the left lower quadrant due to the predominance of sigmoid colon involvement. Usually there is no fever or leucocytosis.
- Before the ease of acquiring CT, the diagnosis of epiploic appendagitis was made at surgery as the clinical examination is frequently similar to other more concerning conditions such as appendicitis or diverticulitis. CT helps to reduce the need of unnecessary surgery.
- The clinical manifestation of epiploic appendagitis usually resolve by 2 weeks and is a self-limiting, conservatively managed condition in the absence of complications.

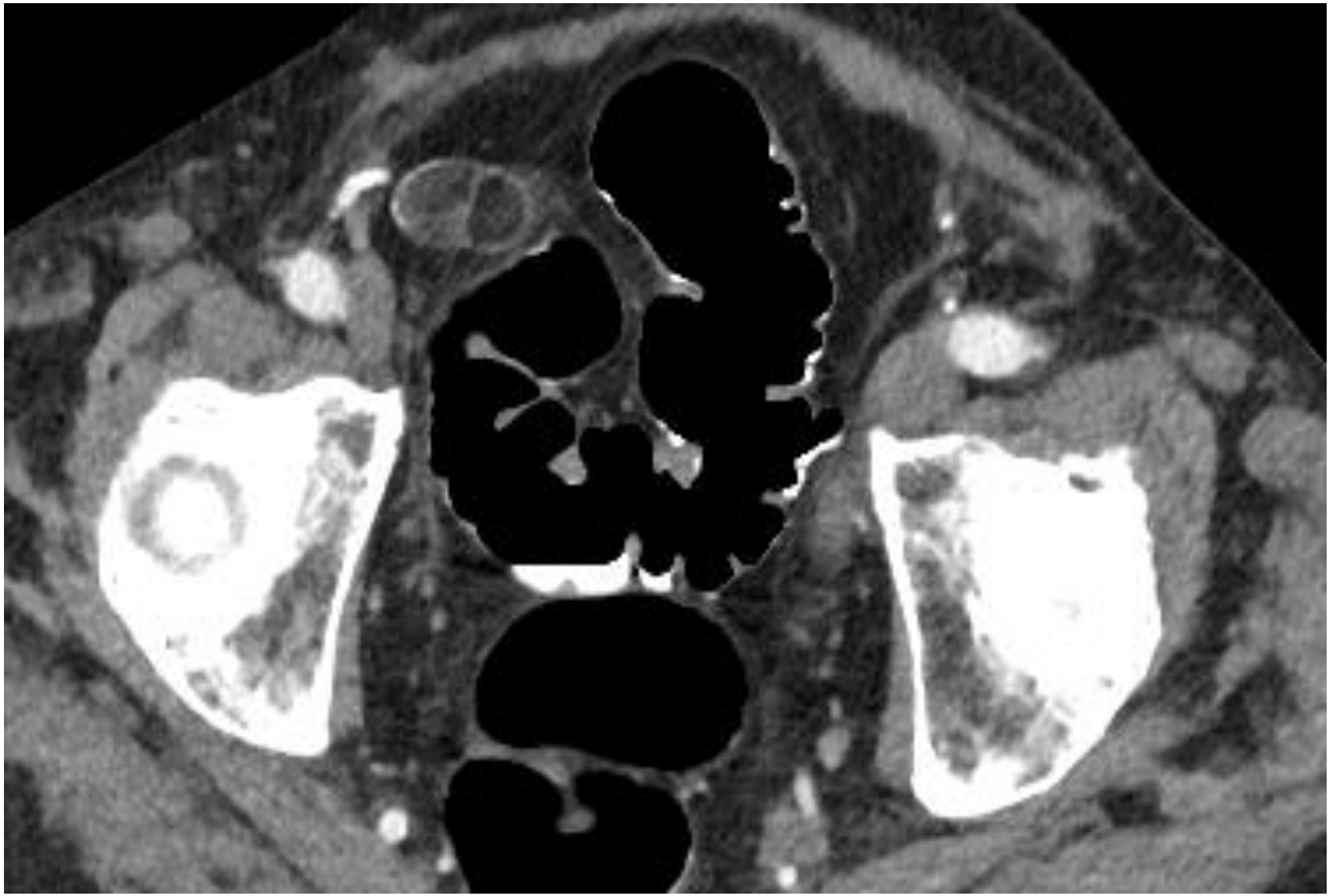
Epiploic Appendagitis - Radiological findings

- On CT, epiploic appendagitis is seen as a non-enhancing ovoid fatty mass attached to the serosal bowel surface by a stalk. It is of slightly higher attenuation than peritoneal fat. There is surrounding inflammatory changes. Often there is a central high attenuation dot, thought to represent the thrombosed vein and is a useful finding for conforming the diagnosis, however its absence does not rule it out. Adjacent bowel thickening is not common.
- Follow up imaging by CT shows variable findings ranging from no change to decreased size of the lesion or residual soft tissue attenuation [5, 6]. Without adequate history or prior imaging for comparison the diagnosis of acute epiploic appendagitis could mistakenly be made again. After 6 months, there is usually resolution of findings on CT.
- On US the findings are of an ovoid, non-compressible, hyperechoic mass with no central blood flow on colour Doppler adjacent to the colon at site of maximum pain [7,8].



A. Axial CECT shows 2.2cm shows peripherally enhancing fat density mass in left iliac fossa anterior to descending colon with extensive surrounding inflammatory changes. B Coronal CECT showing fat density mass adjacent to descending colon with surrounding inflammatory. C-D. Axial and coronal NCCT shows a fleck of calcification surrounded by inflammatory stranding adjacent to descending colon.

A



A. Axial supine CT colonography with IV contrast and faecal tagging. In the right anterior hemipelvis is a thin walled, peripherally enhancing abnormality with thin, internal enhancing septum, separate from the adjacent sigmoid. There is surrounding inflammatory fat stranding. This is in keeping with an avulsed epiploic appendage, which is mobile throughout the peritoneum.

Omental Infarction

- The omenta are peritoneal folds that connect organs to each other and to the abdominal wall. It is divided into the lesser and greater omentum. The greater omentum extends from the greater curvature of the stomach and drapes inferiorly over the small bowel loops before curving back up to the transverse colon then to the posterior abdominal wall. This presentation will focus on the greater omentum as it's the commonest involved site for omental infarction.
- The right and left gastroepiploic arteries supply blood to the greater omentum, which are branches of the gastroduodenal artery and splenic artery respectively.
- Commonest causes of omental infarction include vascular compromise related to insubstantial bloody supply, particularly to the right edge of the omentum and kinking of veins particularly within the right side or anterior deep pelvis [9,10]. A combination of reduced arterial and venous blood flow account for the majority of the remaining causes and include hypercoagulable states, omental torsion, vasculitis, congestive heart failure, surgery, trauma and is predisposed in obesity and after strenuous activity [11].
- Omental torsion will often show swirling of the vessels within the omentum.

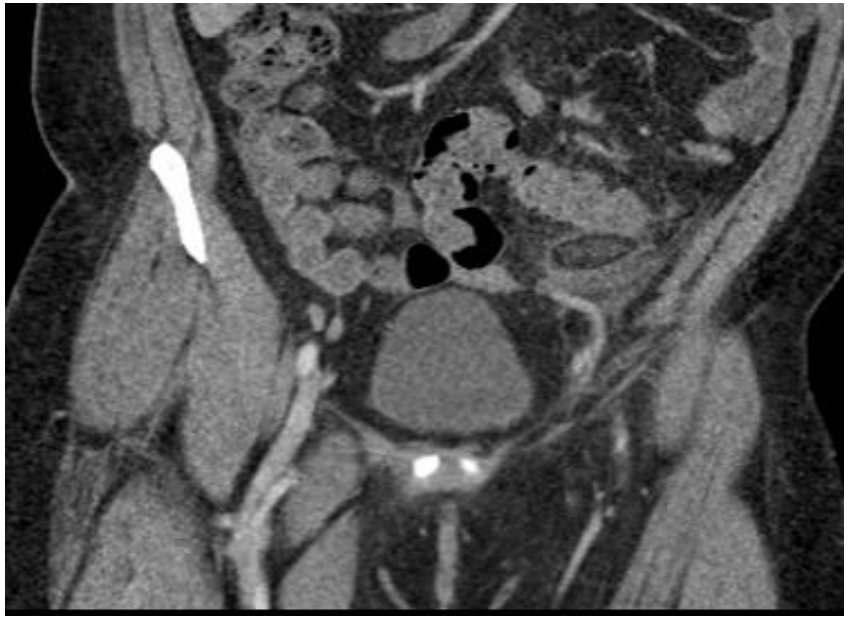
Omental Infarction

- Typical presentation of omental infarction is of sudden onset abdominal pain and tenderness, usually right iliac fossa. No fever or change in bowel habit is recognised. There is slight white cell count elevation [(12)].
- Typical location is in the right lower quadrant but secondary causes of omental infarction such as surgery and trauma mean infarction can occur through-out the greater omentum.
- Clinically the presentation raises the possibility of more serious conditions such as appendicitis, diverticulitis and cholecystitis, in similar fashion to epiploic appendagitis.

Omental Infarction - Radiological findings

- The classic imaging appearances on CT are of a focal area of fat stranding, usually greater than 5 cm with a peripheral enhancing halo. The adjacent colon is usually spared but can show mild thickening due to the adjacent inflammatory change.
- On ultrasound a focal area of echogenic fat at the site of pain suggests the diagnosis. It can infrequently become infected and develop into abscess.

A



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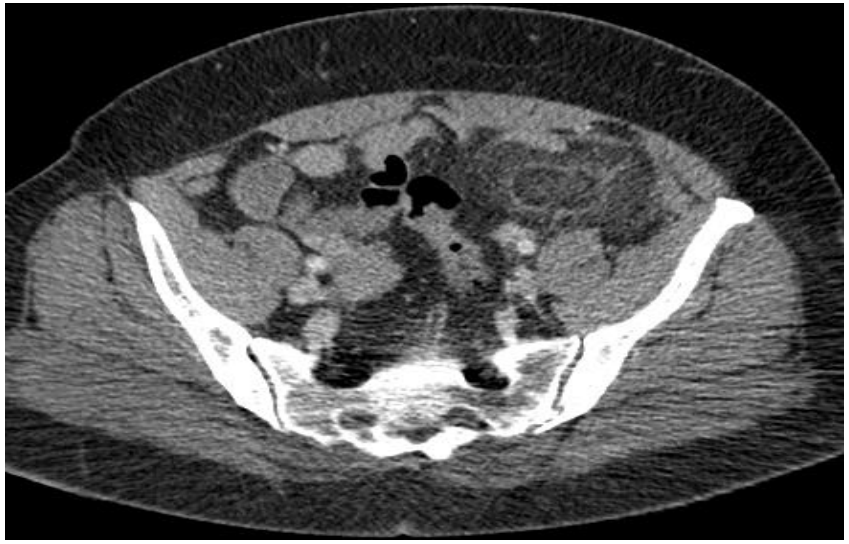
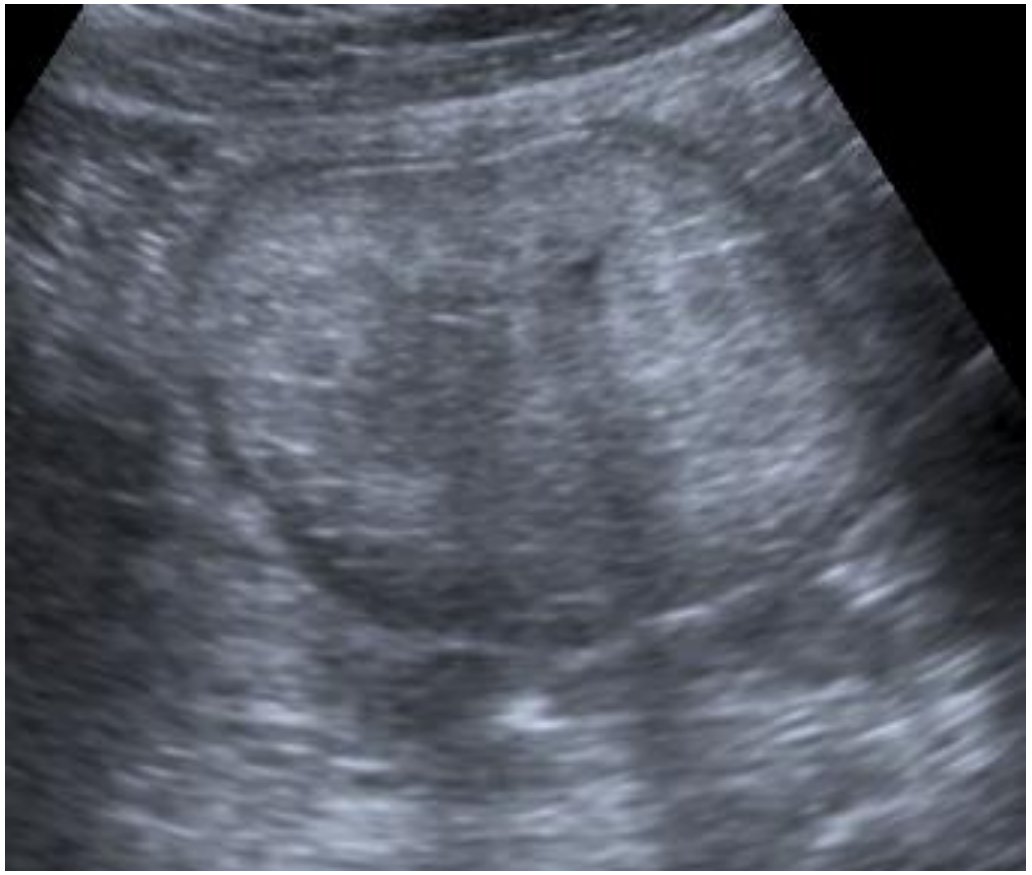
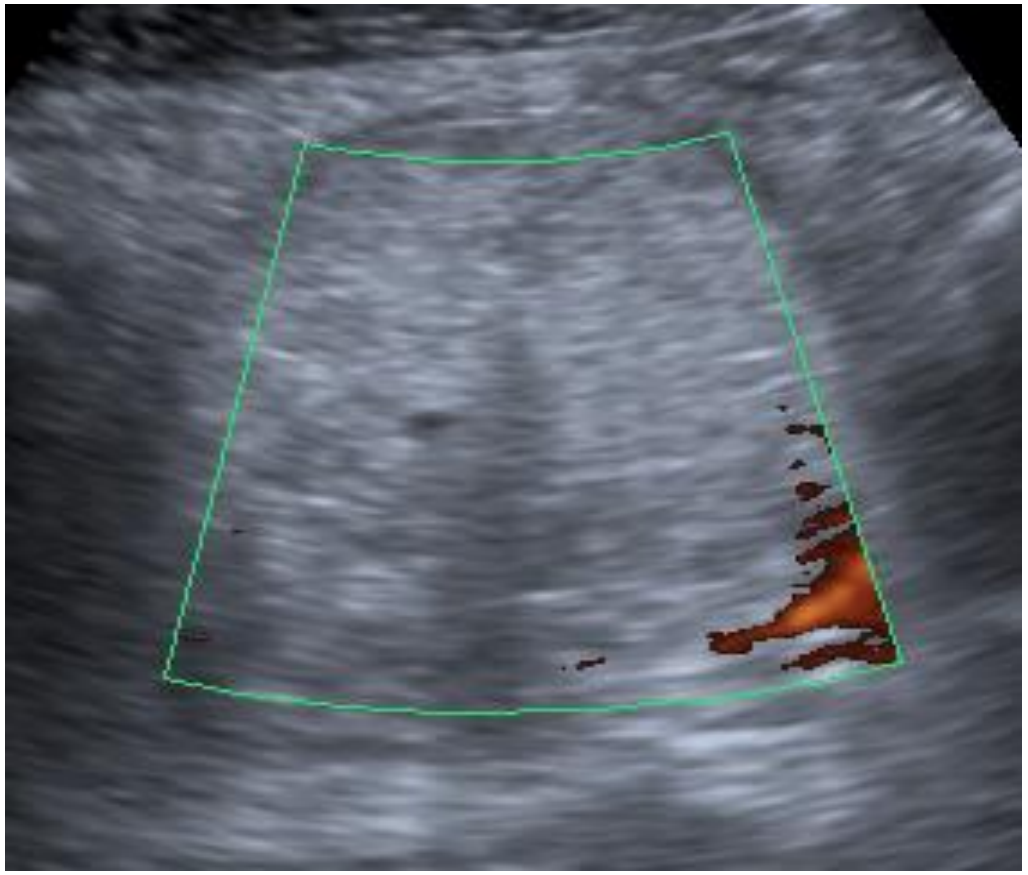


D

A-B. Coronal and axial CECT shows ovoid ring enhancing focal area of fat stranding in the left iliac fossa. C. NCCT of inflammatory fat stranding in the left iliac fossa, adjacent to descending colon, which shows slight wall thickening due to reactive changes. D. 7 months post acute changes seen in image C of same patient, shows resolving omental infarction.

A





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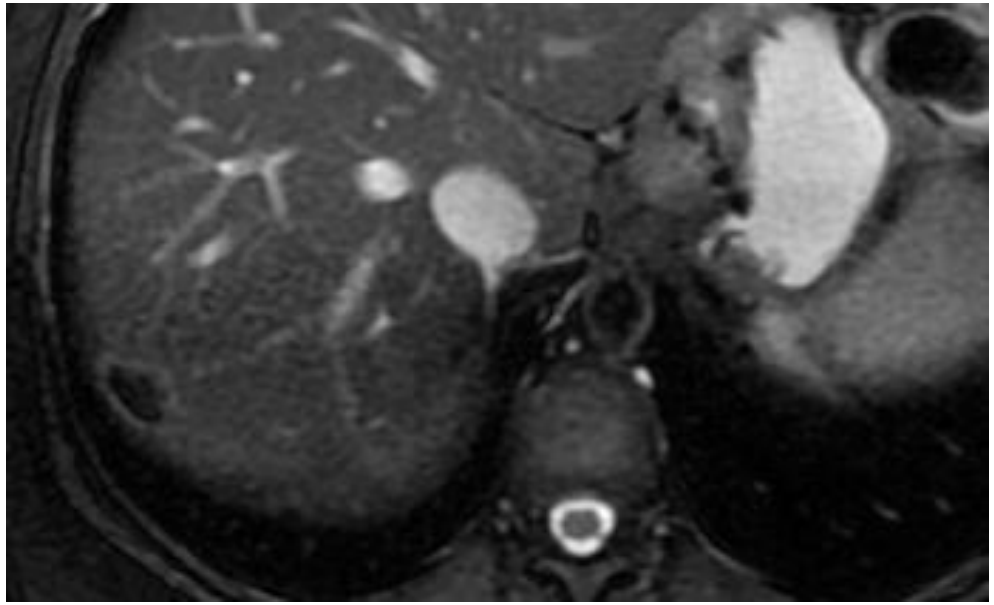
A-B. Focussed ultrasound grey scale images of focal, well defined hyperechogenic fat area, adjacent to ceacum in right iliac fossa which shows no signal on power doppler imaging in keeping with area of omental infarction

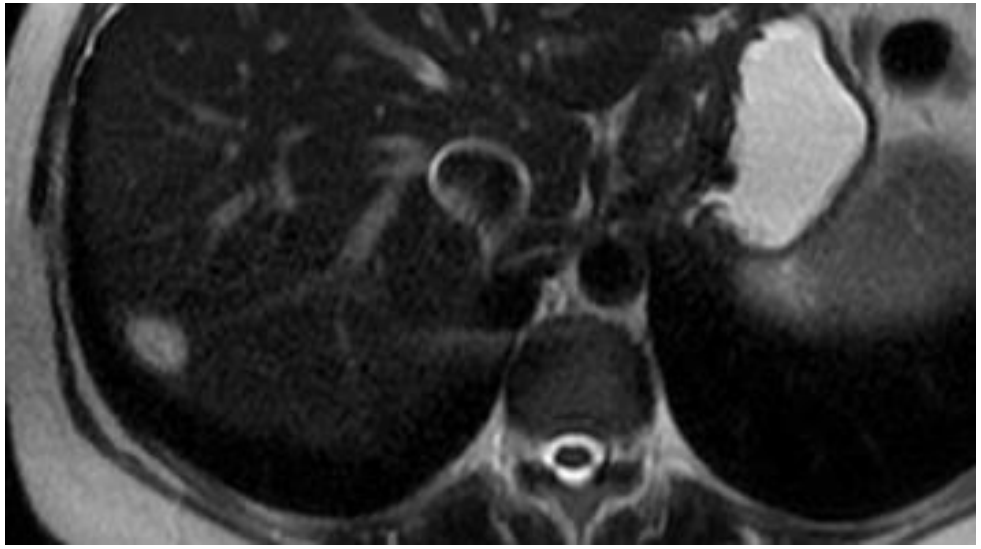
Pseudolipoma of Glisson Capsule

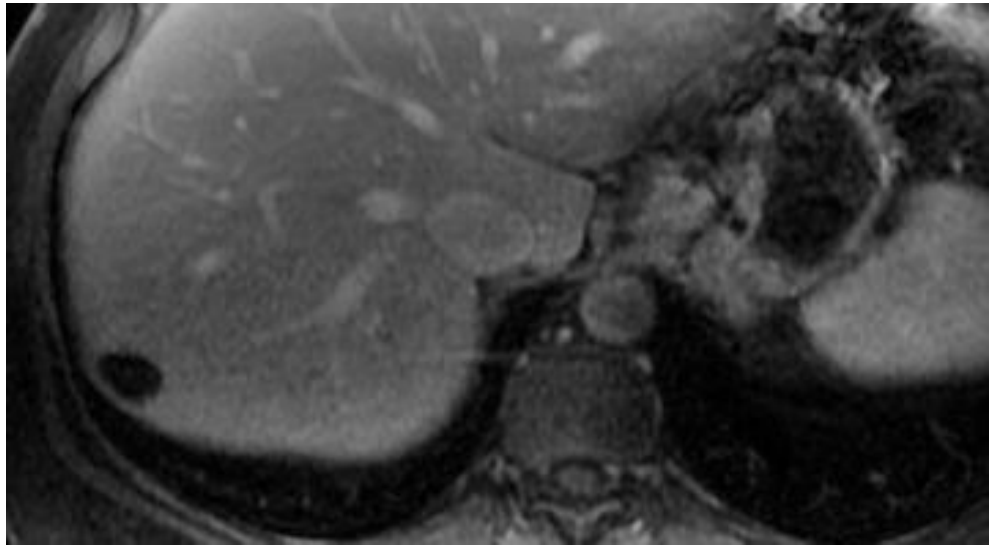
- The liver capsule is made of two layers – a thick fibrous inner layer called Glisson's capsule, which covers the entire surface of the liver and a serous outer layer originating from the peritoneum, which covers the entire liver apart from the bare area adjacent to the diaphragm, porta hepatis and where the gallbladder attaches to the liver.
- The subscapular space is between the liver parenchyma and the Glisson's capsule [(13)]. A subscapular abnormality causes mass effect on the underlying hepatic parenchyma and is indistinct to free intraperitoneal fluid adjacent to the liver, which causes no mass effect.
- Given its location it infrequently needs to be distinguished from serosal metastases and necrotic metastatic nodules as pseudolipomas are incidental findings with no clinical detrimental effect.

Pseudolipoma of Glisson Capsule – Radiological findings

- Pseudolipoma of Glisson Capsule is an encapsulated, often degenerated piece of fat that has arisen from a detached colonic epiploic appendix and has lodged in the liver capsule ectopically as a consequence of developmental abnormality or traumatic inclusion from prior surgery or liver biopsy [14,15].
- It is a well circumscribed, fat attenuation nodule measuring approximately between 0.5-2cm [16]. It follows the fat signal on all MRI sequences and loses signal on out of phase chemical shift imaging.







A. NCCT of focal hepatic subcapsular, fat density lesion. Coarse high density in region of gastric cardia, in keeping with evidence of previous gastro-oesophageal surgery. B. Long TE T2 MRI sequence shows this area of high signal. C. FIESTA FATSAT MRI sequence shows this area to be of low signal intensity. D. No enhancement is seen on the post IV Gadolinium contrast sequences.

Liposarcoma

Most common primary neoplasm of retroperitoneum, rarely arise in the mesentery or peritoneum [17]

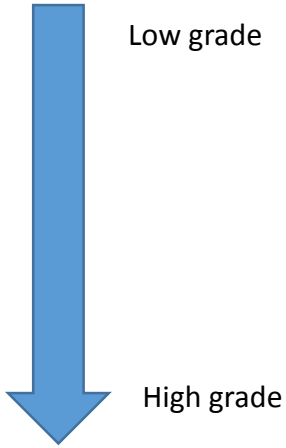
Mesenchymal origin

Can occur at any age but most commonly adults

Non specific symptoms

Subtypes

- **Well differentiated** (3 further subtypes)
  - Adipocytic
  - Sclerosing
  - Inflammatory
- **Myxoid**
- Round cell (non fatty)
- Pleomorphic (non fatty)



[18]

Management:

- Surgical resection is only curative option
- Consideration of neoadjuvant or adjuvant chemo in tumours >5cm
- Radiotherapy considered in high grade [19]

Liposarcoma - Radiological Findings

Well differentiated:

- No reliable radiological differences between the subtypes of well differentiated
- Mostly fat, but with thick septations (>2mm)
- Do not metastasise but potential risk of de-differentiating over time

Myxoid:

- Multilobulated, often high water content along with fat and can be misdiagnosed as cystic lesion on non contrast study, however following contrast enhancement of septae is seen.
- More aggressive and greater risk of metastasis

Round cell and Pleomorphic:

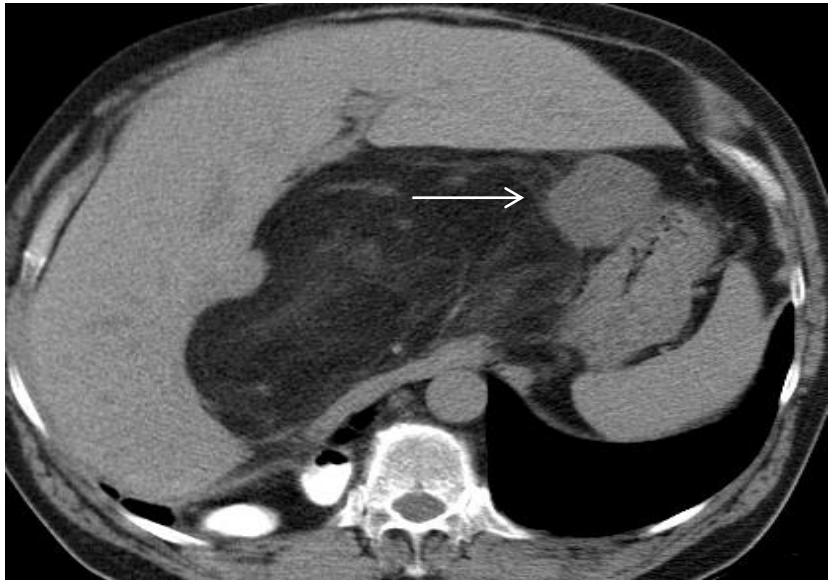
- Non fat containing with no specific signs, heterogeneous mass, indistinguishable from other sarcomas
- High grade and aggressive

(18,19,20)

A

B

C



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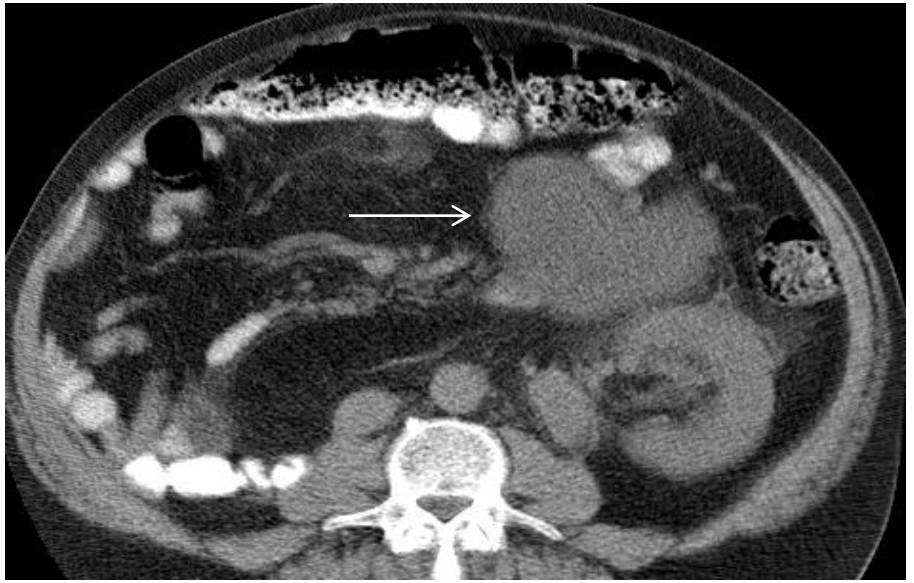
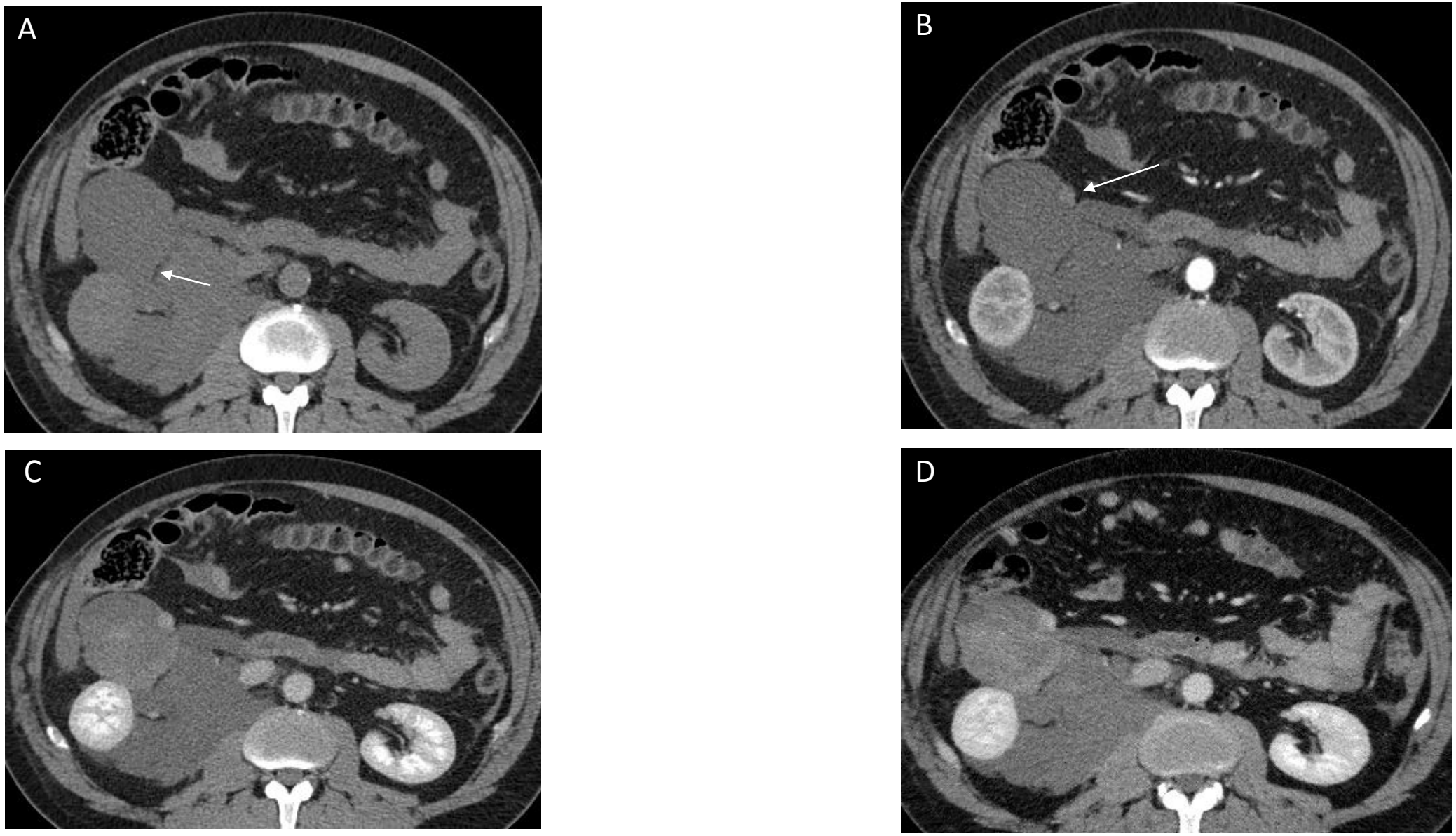


A-B. Large fat attenuation lesion within the retroperitoneum with thick internal septations (closed arrow heads) and mass effect. C-D. Soft tissues nodules also present in keeping with lymph node disease (open arrow heads).



Axial pre (A), arterial (B) and portal venous (C & D) acquisitions

Right sided retroperitoneal lesion with mass effect displacing the kidney laterally. The pre contrast acquisition (A) demonstrated a predominantly low attenuation lesion and could be mistaken for a cystic lesion, however note fine linear areas of fat density (closed arrow head) and the nodular enhancement initially seen on arterial phase (B closed arrow head) and becomes more apparent on the later phases (D).

Lipoma

Benign mesenchymal tumour arising from mature adipocytes

Resembles fat

Can arise anywhere in abdomen including the gastrointestinal tract (GIT)

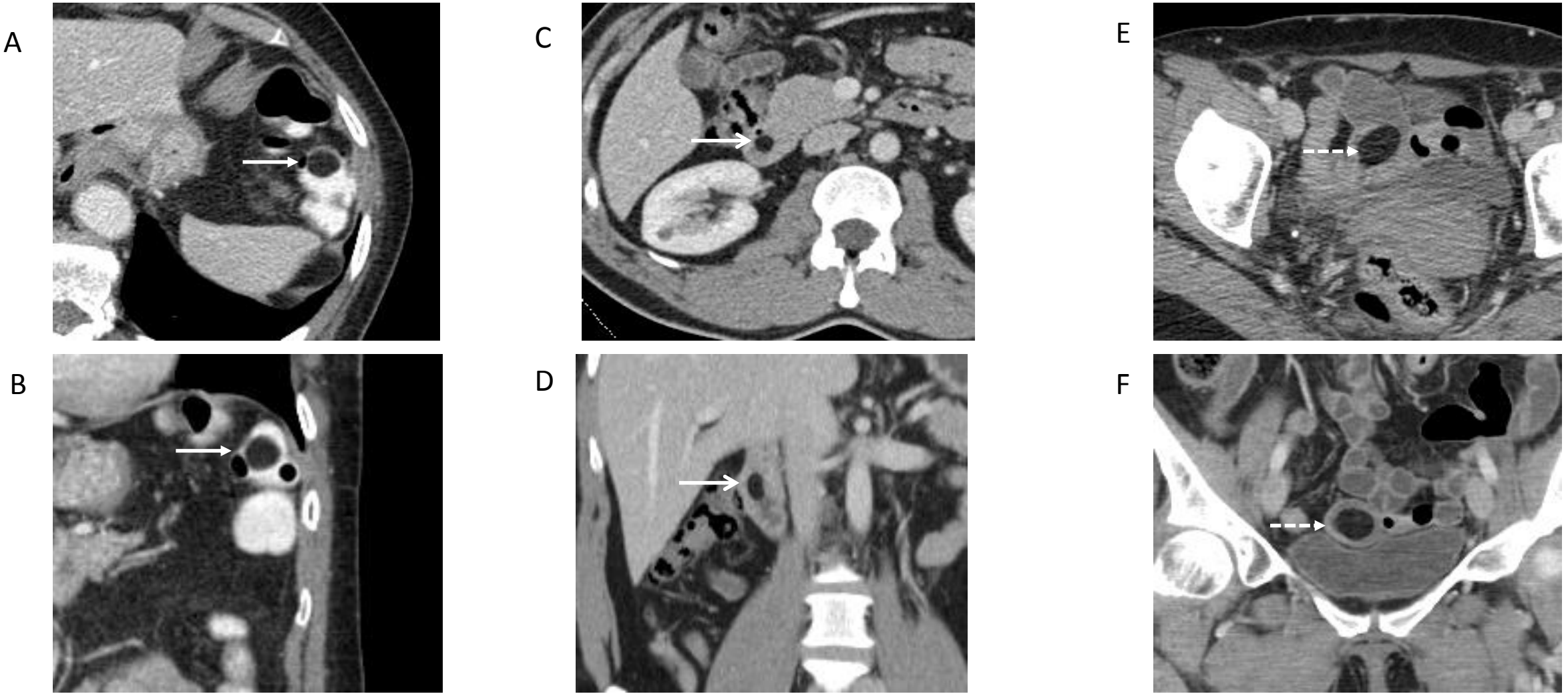
- Colon most commonly affect part of GIT (65%) followed by small bowel (25%) [21]
- 90-95% arise from submucosa [20]
- Most asymptomatic
- Can be pedunculated and therefore risk of intussusception

Management:

None required unless symptomatic with pain or intussusception if in GIT

Lipoma - Radiological Findings

- Homogenous fatty attenuation
- Thin fibrous capsule
- Often only appreciated by mass effect
- Possible thin fibrous septae <2mm
  - therefore can mimic low grade liposarcoma
- If within the GIT can confidently be diagnosed on imaging alone [20]



Axial and coronal reformats showing gastrointestinal lipomas; colonic (A-B closed arrow head), duodenal (C-D open arrow head) and ileal (E-F dashed arrow) respectively.

Well defined low attenuation lesions which could act as lead points resulting in intussusception.

Mesenteric Panniculitis

Mesenteric Panniculitis belongs to a spectrum of pathology labelled as “sclerosing mesenteritis”.

Presentation –

3-9th decades. Mean age 70’s with slight male preponderance.

May be incidental finding in an asymptomatic patient.

If symptomatic present with abdominal pain, pyrexia, weight loss, change in bowel habit. On examination - palpable abdominal mass may be present

Pathophysiology –

Chronic, non-specific inflammation of the adipose tissue of the mesenteric root.

Stages: Difficult to differentiate on radiological features, requires histological analysis

Mesenteric lipodystrophy →	Mesenteric panniculitis →	Retractile mesenteritis
Foamy macrophages replace lipid in mesentery	Recruitment of plasma cells, leucocytes, foamy macrophages	Collagen deposition, fat necrosis, fibrosis

Associations -

Possible association with malignancy most common of which are lymphoma, melanoma colo-rectal cancer.

Inflammatory disorders – eg retroperitoneal fibrosis, orbital pseudotumour, sclerosing cholangitis

Surgery/trauma have also been linked as possible causes.

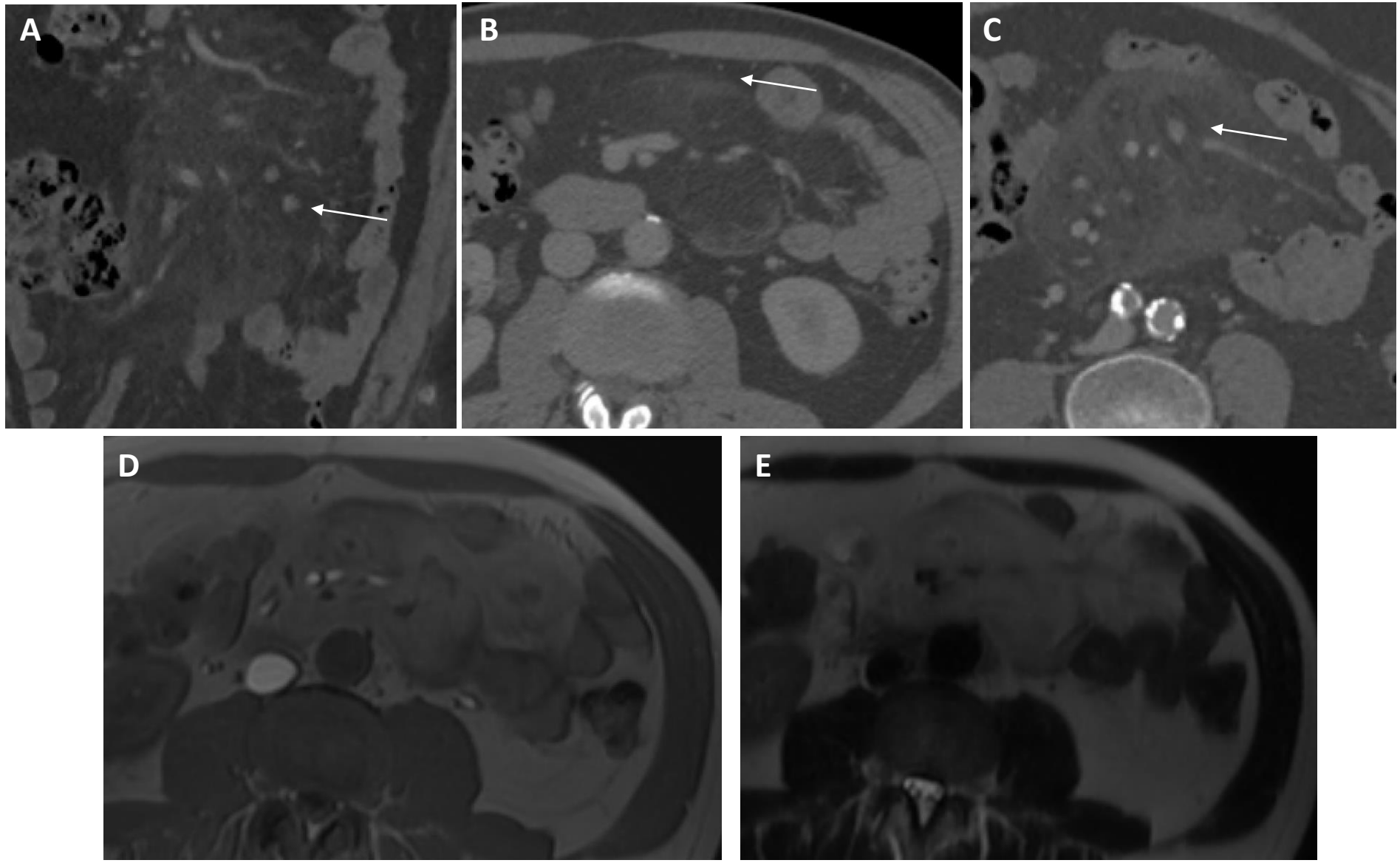
Treatment =

Variable, majority are conservatively managed sometimes anti inflammatory rx - if complications secondary to mass effect such as bowel obstruction.

Mesenteric Panniculitis – Radiological Findings

- “Misty mesentery” – haziness of the fat associated with the root of the mesentery.
- Superior mesenteric vessels enveloped, but not narrowed
- Displacement of bowel loops
- Presence of prominent/enlarged lymph nodes
- Hypoattenuating halo surrounding nodes and vasculature
- Well demarcated border by a pseudocapusule

No set guidelines or consensus at present regarding imaging follow up.



Features of Mesenteric panniculitis

CT - (A) Mesenteric haziness with prominent lymph nodes. Changes within mesentery displace bowel loops. (B) Well defined pseudocapsule (C)Hypoattenuating halo around nodes and vessels (remain patent).

MRI - Similar morphological features on (D) T1 & (E) T2 Imaging with ill defined low signal mesenteric change.

Omental Cake

Greater omentum is fat containing structure containing gastroepiploic vessels, lymphatics, and “milky spots” (accumulations of macrophage rich-immune cells). Infiltration of the omental fat is termed “omental cake”.

Causes:

In the absence of ancillary features the aetiology of omental cake is difficult to differentiate without histological analysis.

Malignancy: Metastatic disease - Ovarian carcinoma is the most common cause. Colonic, pancreatic, and gastric cancers are also prevalent along with other tumours capable of intraperitoneal spread. Primary omental/peritoneal malignancy is rare.

Mechanism for metastatic spread to greater omentum:

(1) direct extension of tumour along peritoneal ligaments,

(2) intraperitoneal seeding

(3) haematogenous spread

(4) lymphatic spread of disease

Infection, including:

Tuberculous peritonitis – may have associated necrotic nodes, and enlarged nodes

Actinomycosis & Coccidiomycosis

Other rare causes: sclerosing omentitis and amyloidosis.

Omental Cake – Radiological Findings

Progression of Radiological findings:

Ill defined appearance of the omental fat.

↓

Enhancing soft tissue nodules.

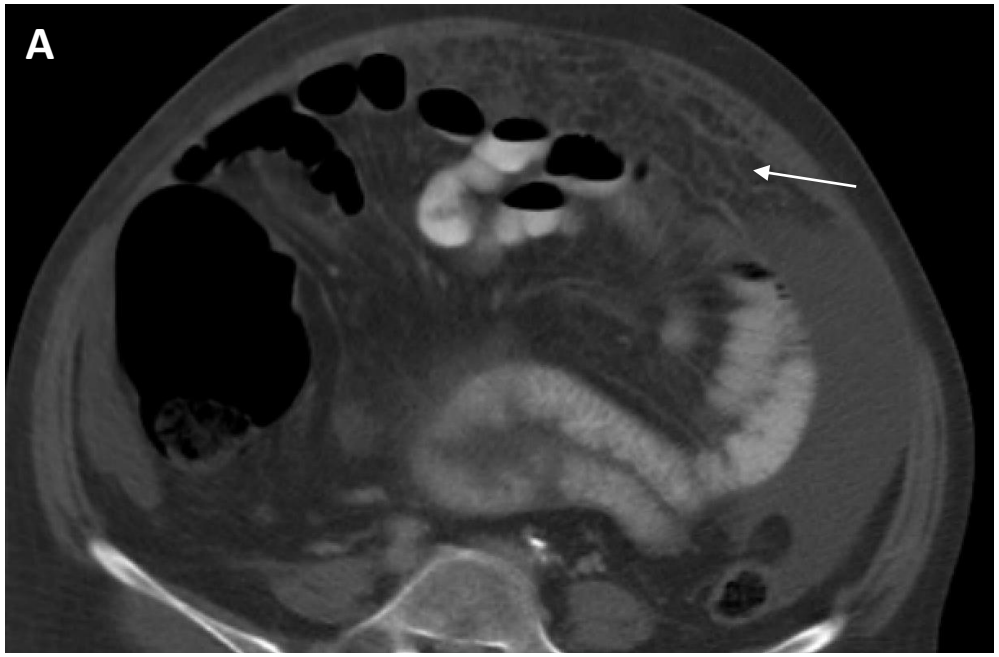
↓

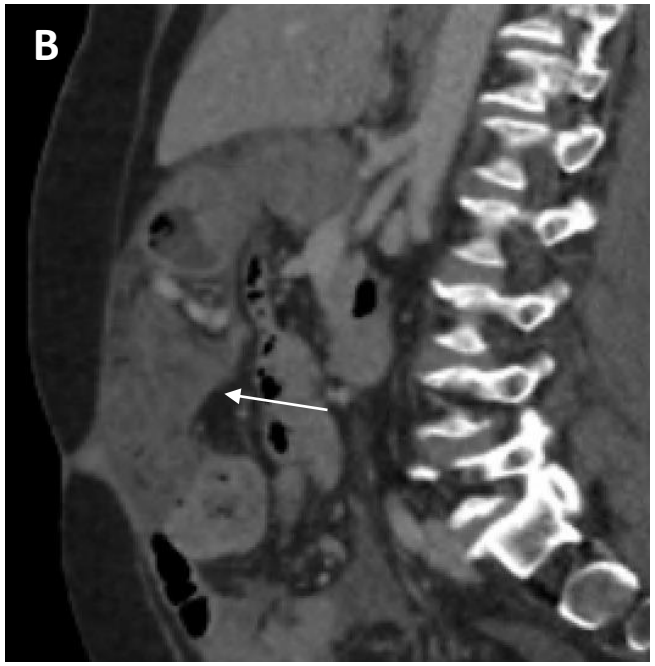
Nodules coalesce to form a diffusely thickened mass.

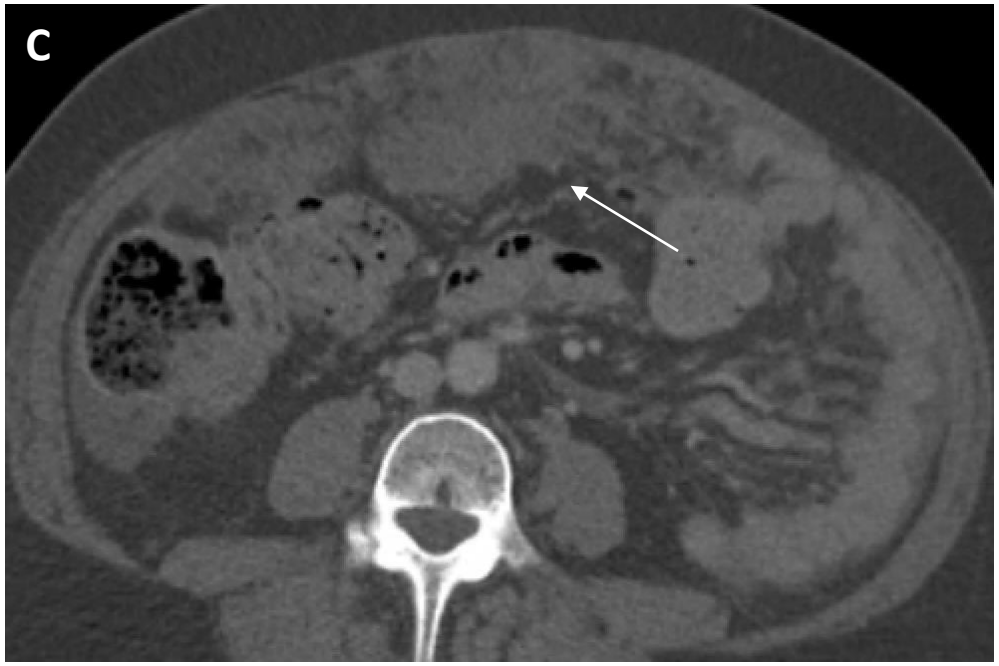
Other possible features present:

- Site of primary malignancy e.g. ovarian mass and metastatic disease
- Ascites
- Calcification (TB & Serous ovarian malignancy)

Features of Omental caking.
(A) Subtle infiltration and haziness of the omentum with displacement of bowel loops. (B) Sagittal and (C) axial images demonstrating coalesced nodular thickening of the omental soft tissue with minimal remaining omental fat.







Ovarian Teratoma

Ovarian Teratoma's are the most common germ cell tumour of the ovary.

- They are slow growing tumours (1.8m/yr)
- Bilateral in 12% cases. If unilateral, they are more common on right (72%).
- When ectodermal tissues predominate, these teratomas are labelled "dermoid cysts".

Sub-categories-

- mature cystic teratomas (MCT) – most common, immature teratomas, monodermal (highly specialised), teratomas (struma ovarii, carcinoid tumours, neuroectodermal tumours, sebaceous tumours) & fetiform teratomas.

Histology-

- MCT – cyst - unilocular or septated, sebaceous material (93)%, squamous epithelial wall, Rokitansky nodule (evident as a protuberance into the cyst, mural thickening or bridge across the cyst). Rokitansky nodule may contain fat, calcium (bone/teeth) or hair. Hair may also be floating within the cyst with keratin and sebum.

Presentation-

- Young females (mean age 30yrs). Most are benign and asymptomatic and they are often detected incidentally. Usually large in size when diagnosed.
- May be symptomatic if there is an associated complication and/or a paraneoplastic syndrome develops.
- Complications include: torsion (16%), rupture (1–4%), malignant transformation (1% - Rokitansky nodule is a common site of malignant transformation), infection (1%) and autoimmune haemolytic anaemia (<1%)

Ovarian Teratoma – Radiological Findings

There are multiple shared characteristics that are demonstrated across imaging modalities.

Ultrasound

- Non-specific appearance (cystic, solid or a complex mass) – difficult diagnosis based solely on US.
- If 2+ of the characteristic signs are present, a diagnosis of MCT can be made with high positive predictive value.
- **Rokitansky nodule -** may cause acoustic shadowing (due to hair, teeth and /or fat content).
- **Diffuse or focal high echogenicity -** from sebum and hair.
- **Tip of the iceberg sign -** echogenic focus in near field causes posterior shadowing, obscuring the lesion.
- **Dot-dash sign –** floating hair appears as hyperechoic lines and dots.
- **Fat-fluid or fluid-fluid level**
- **Mobile, floating balls sign -** hyperechoic floating balls comprising sebaceous material, keratin and hair.
- **Comet tail appearance -** at the interface between hair and fluid.

Ovarian Teratoma – Radiological Findings

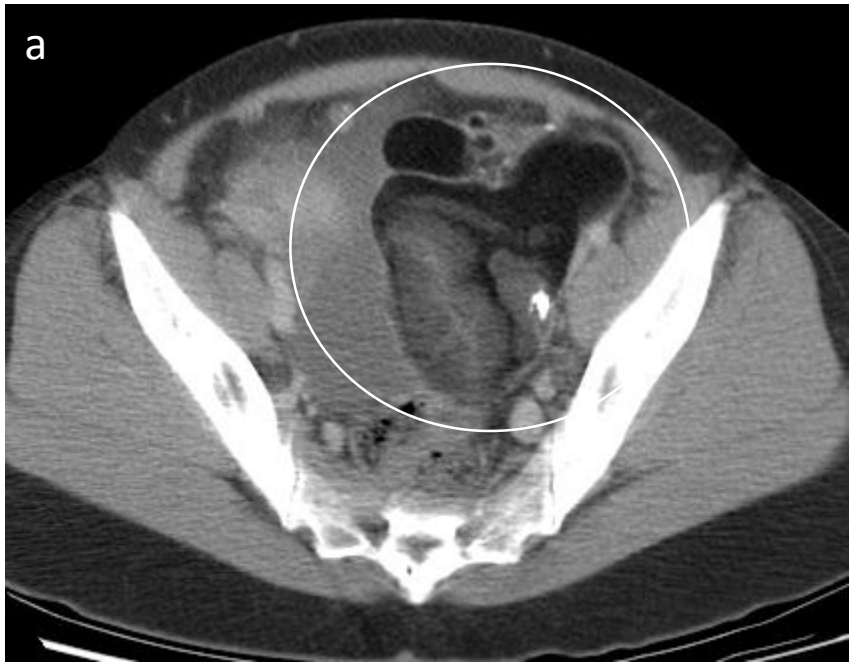
CT

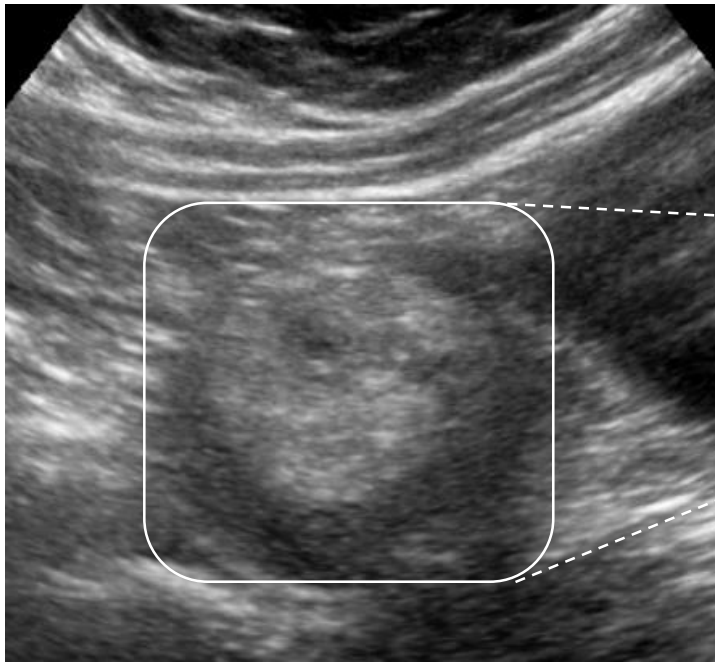
- High sensitivity (93–98%). Excellent at identifying fat and calcification.
- **Intratumoral fat -** evident at the interface between two liquids, layering /floating within the lesion or within the cyst wall/Rokitansky nodule
- **Tooth/calcification -** calcification with attenuation values higher than bone suggests the presence of enamel.
- **Rokitansky nodule (dermoid plug)**, **Fat-fluid level , Floating (fat) ball sign** .

MRI

- **Intra-tumoral fat -** high T1 signal with signal drop on fat-saturated T1-weighted images
- **Chemical shift artefact -** chemical shift imaging (in/out phase, Dixon methods) can detect minor fat .
- **Reversed chemical shift artefact -** boundary artefact perpendicular to the direction of the frequency encoding gradient (differentiates from blood products)
- **Rokitansky nodule (dermoid plug), Fat-fluid level**
- **Tuft of hair -** low signal on T2-weighted images
- **Floating (fat) balls sign -** may have a T2 hyperintense and T1 hypointense nidus of debris, desquamative material and/or hair.
- **Intratumoral keratinoid material -** low T1-signal/ high T2 signal with restricted diffusion.[27]

Ovarian Teratoma

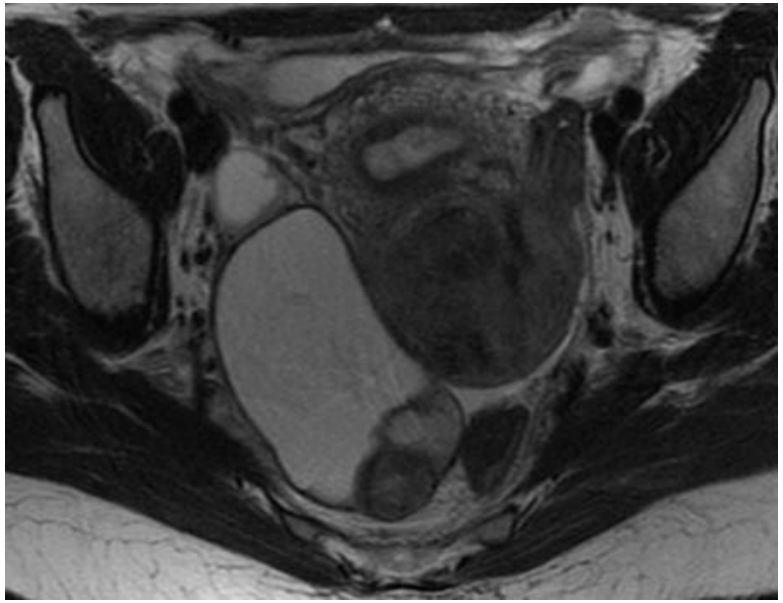




Three cases of ovarian dermoids of varying sizes (white circles), all demonstrate fat attenuation along with soft tissue components and calcification.

Case b) was initially identified with US as a pelvic lesion with areas of increased echogenicity suggesting fat content (white box) and therefore raised the possibility of dermoid and subsequent CT confirmed the diagnosis.

A



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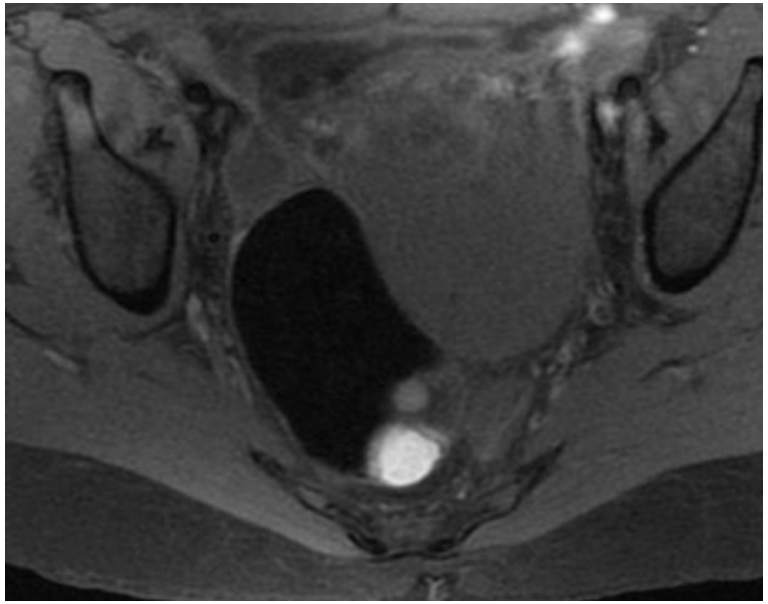

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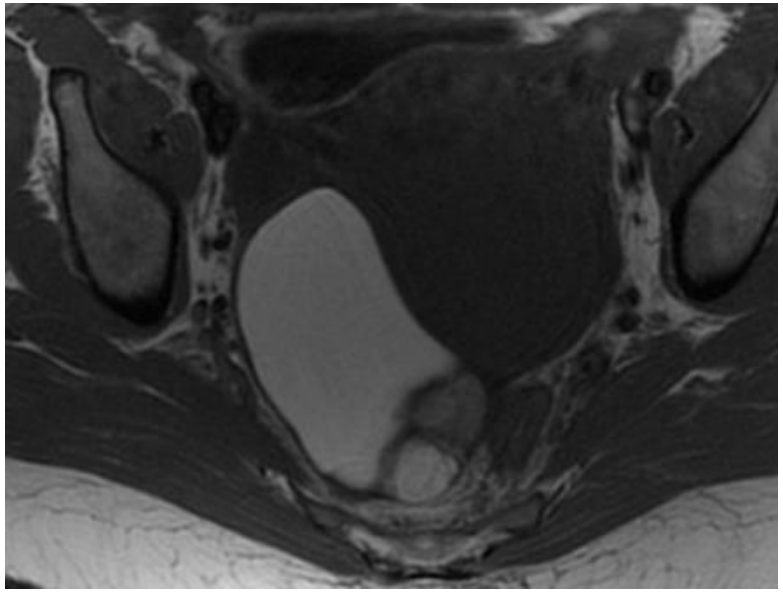

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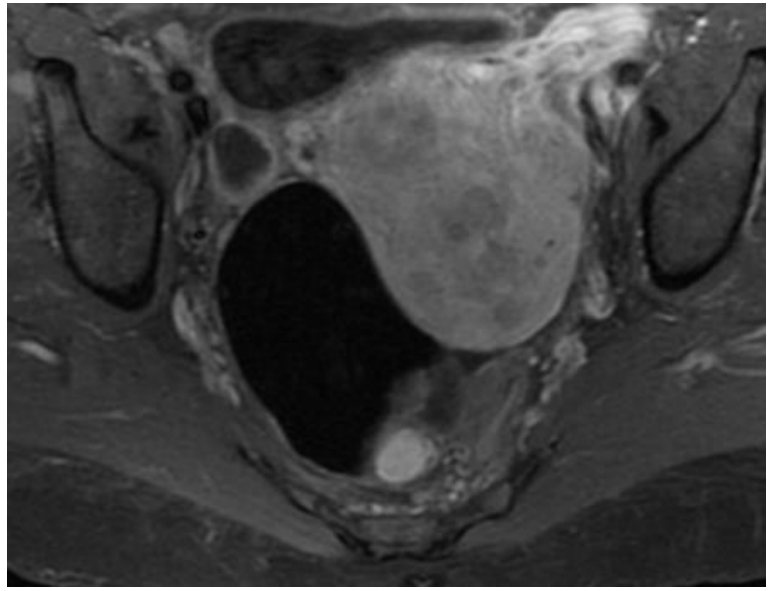

A-B. Axial T2 and T1 images shows large high signal intensity cyst in the right adnexa with a smaller low T2, high T1 haemorrhagic component posteriorly. C. Axial T1 FATSAT images shows the larger component is low signal in keeping with fat. D. There is no enhancement post contrast or internal complexity. The findings show a large right dermoid cyst with haemorrhagic component.

Conclusion

- It is important for the radiologist to be aware of the breadth of fat based peritoneal abnormalities and their imaging characteristics to provide a suitable differential diagnosis and to help guide patient management.
- Accurate characterisation of fat-based peritoneal lesions is important as some entities will require conservative management or medical treatment whilst others require surgery and multi-disciplinary team care.

References

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Author Information

- Dr Pawan Patel Radiology Registrar, St George's Hospital, London
- Dr Gurinder Nandra Radiology Registrar, St George's Hospital, London
- Dr Oliver Duxbury Radiology Registrar, St George's Hospital, London
- Dr Mohammad Ali Shah, Consultant Radiologist, St George's Hospital, London
- Dr Nirav Patel Consultant Radiologist, St George's Hospital, London