Surgical Pathology of Appendix
Acute and Chronic Appendicitis

Catedra de Chirurgie nr.1 „Nicolae Anestiadi”

The appendicitis presents an inflammation (either acute or chronic) of the appendix

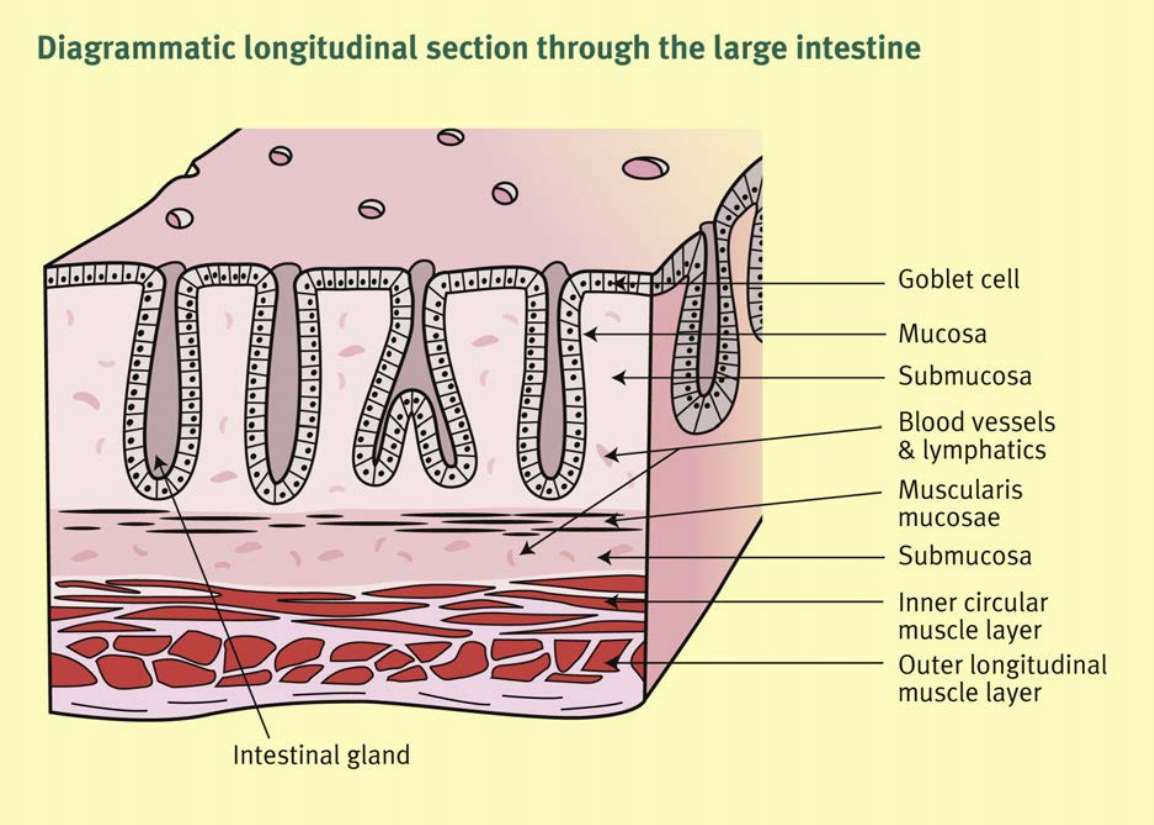
The first description of the appendix was provided by **Berengarius Carpus**, Professor of Surgery at Pavia and Bologna in 1522.

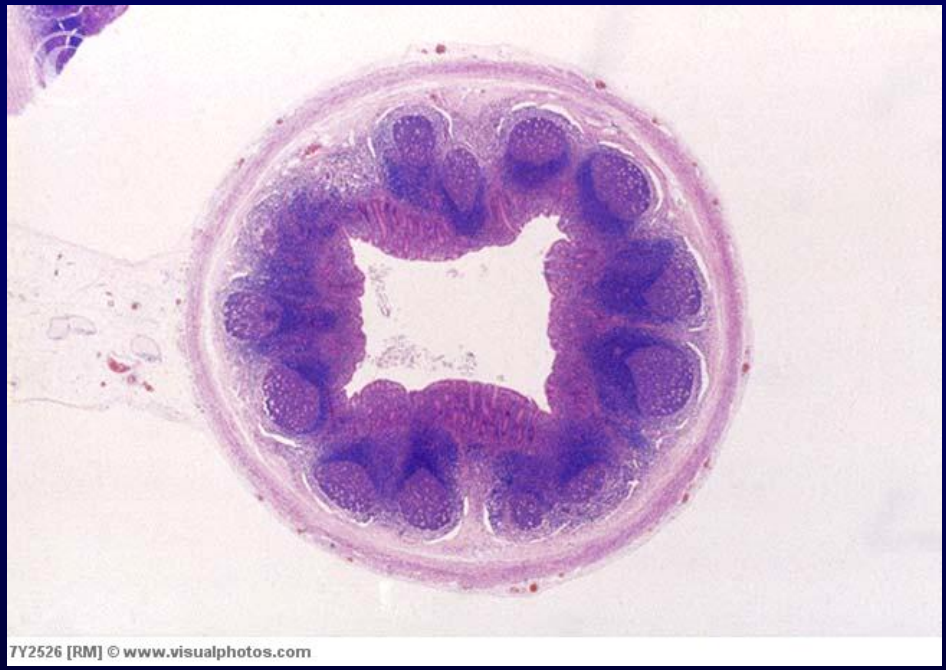
In 1886 **Reginald Fitz**, an american physician, became the first person to describe the entity of acute appendicitis.

Appendicitis occurs in 7% of the US population, with an incidence of 1.1 cases per 1000 people per year. There is a slight male preponderance of 3:2 in teenagers and young adults; in adults, the incidence of appendicitis is approximately 1.4 times greater in men than in women.

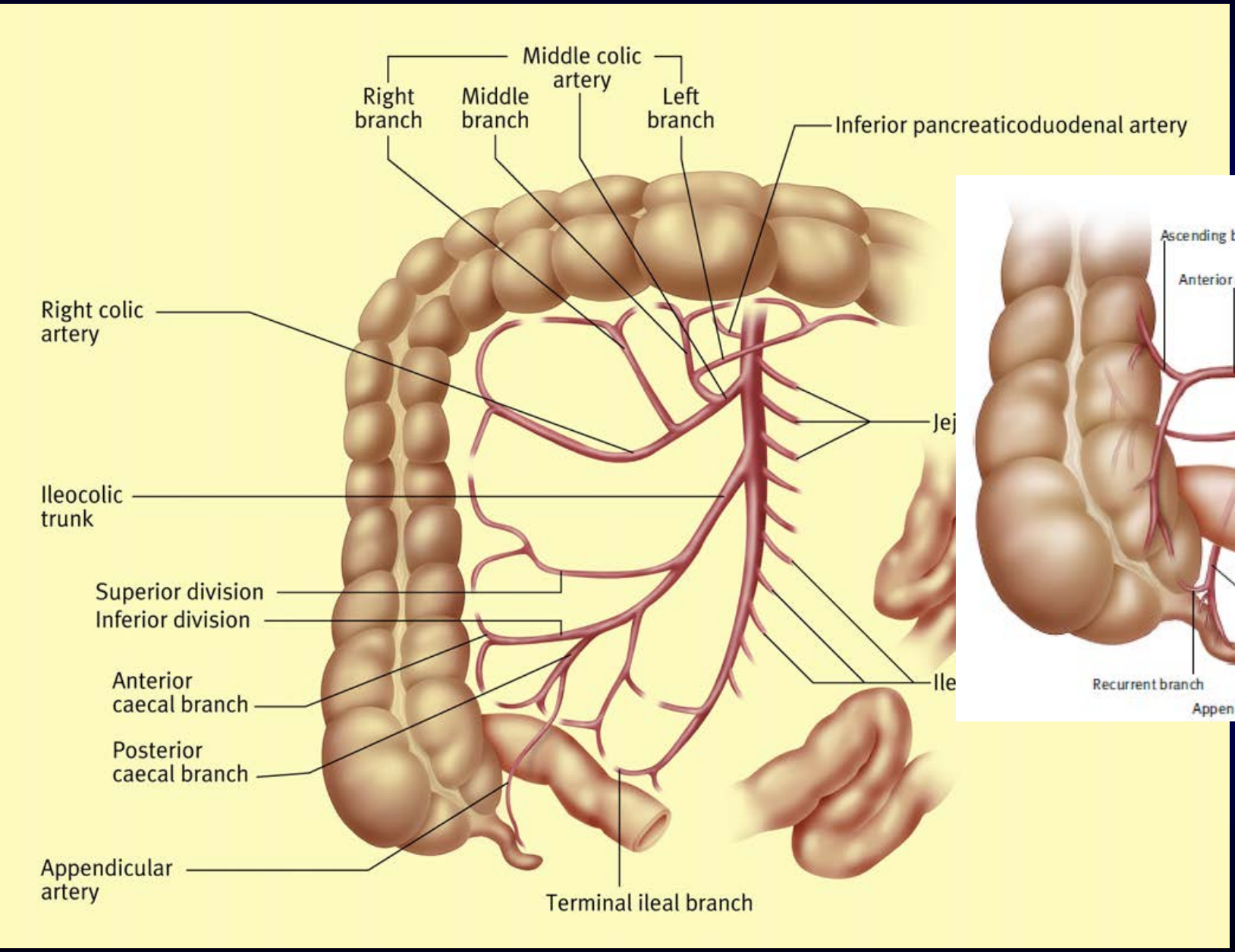
Anatomy of the appendix

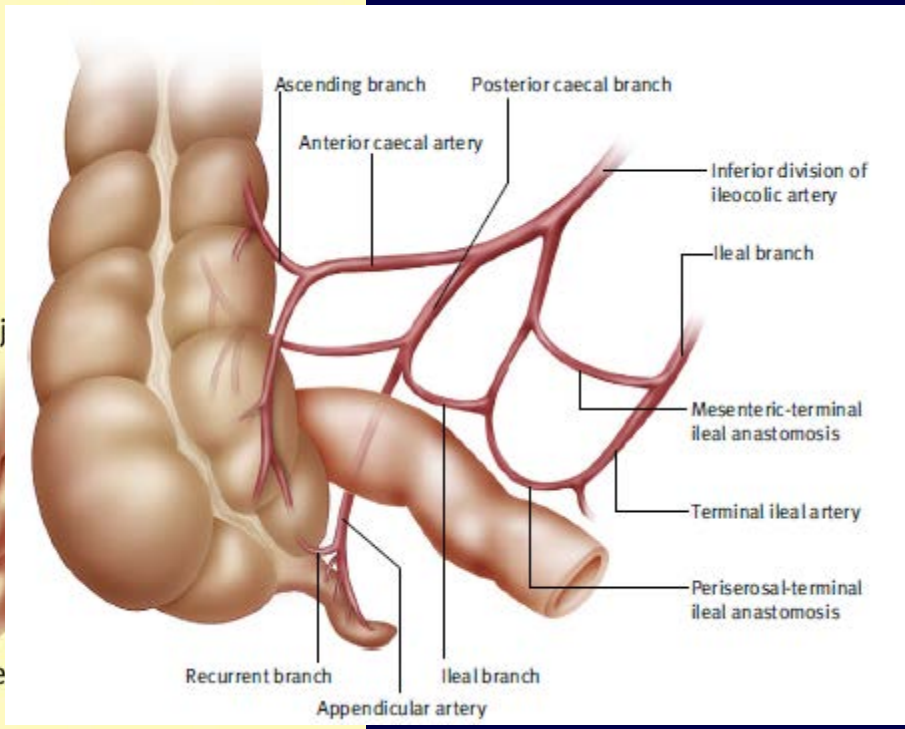
The appendix averages 10 cm in length but can range from 2-20 cm.
The wall of the appendix consists of 2 layers of muscle, an inner circular and outer longitudinal. The longitudinal layer is a continuation of the taeniae coli.
The appendix is lined by colonic epithelium.



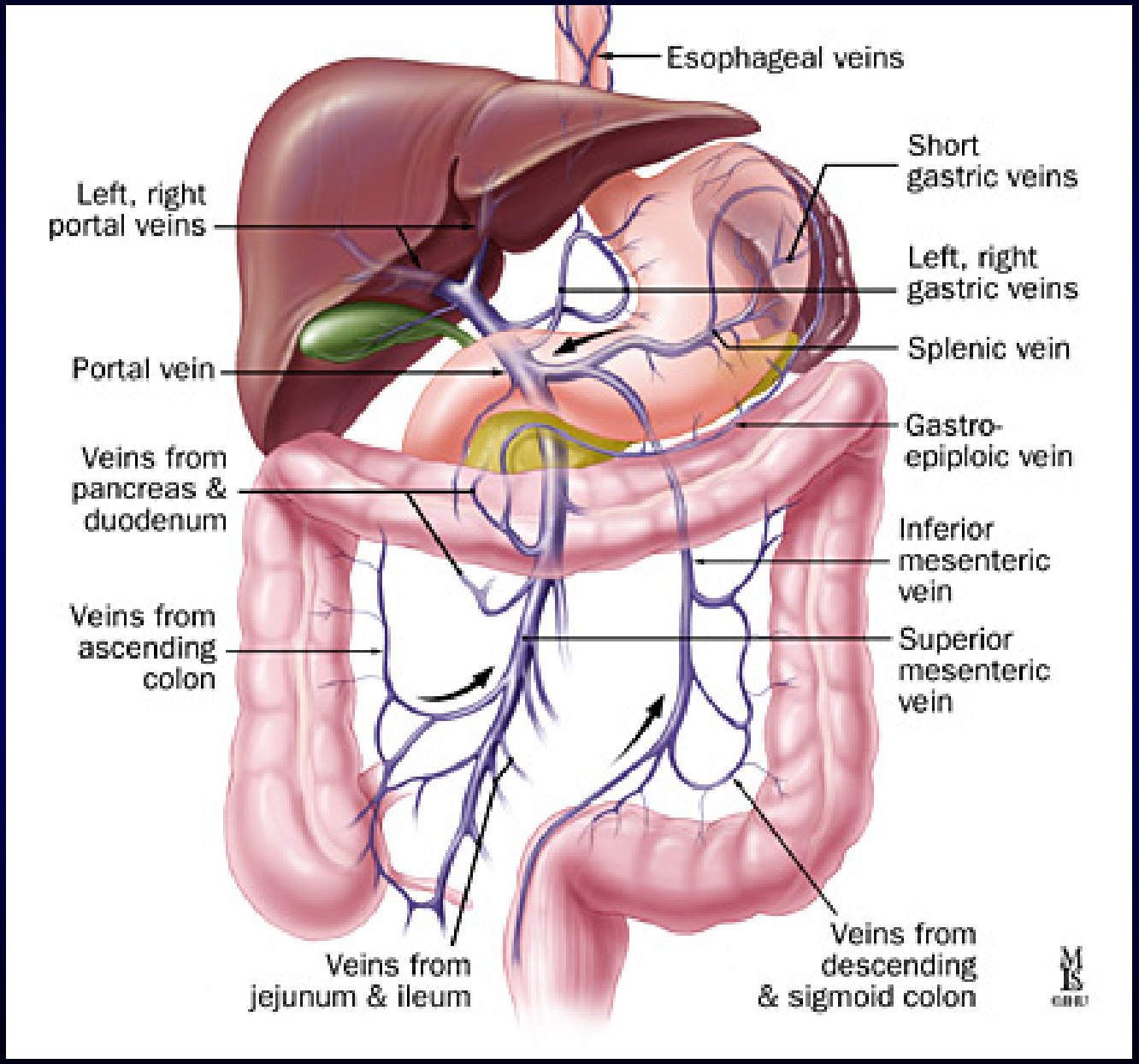


Arterial blood supply

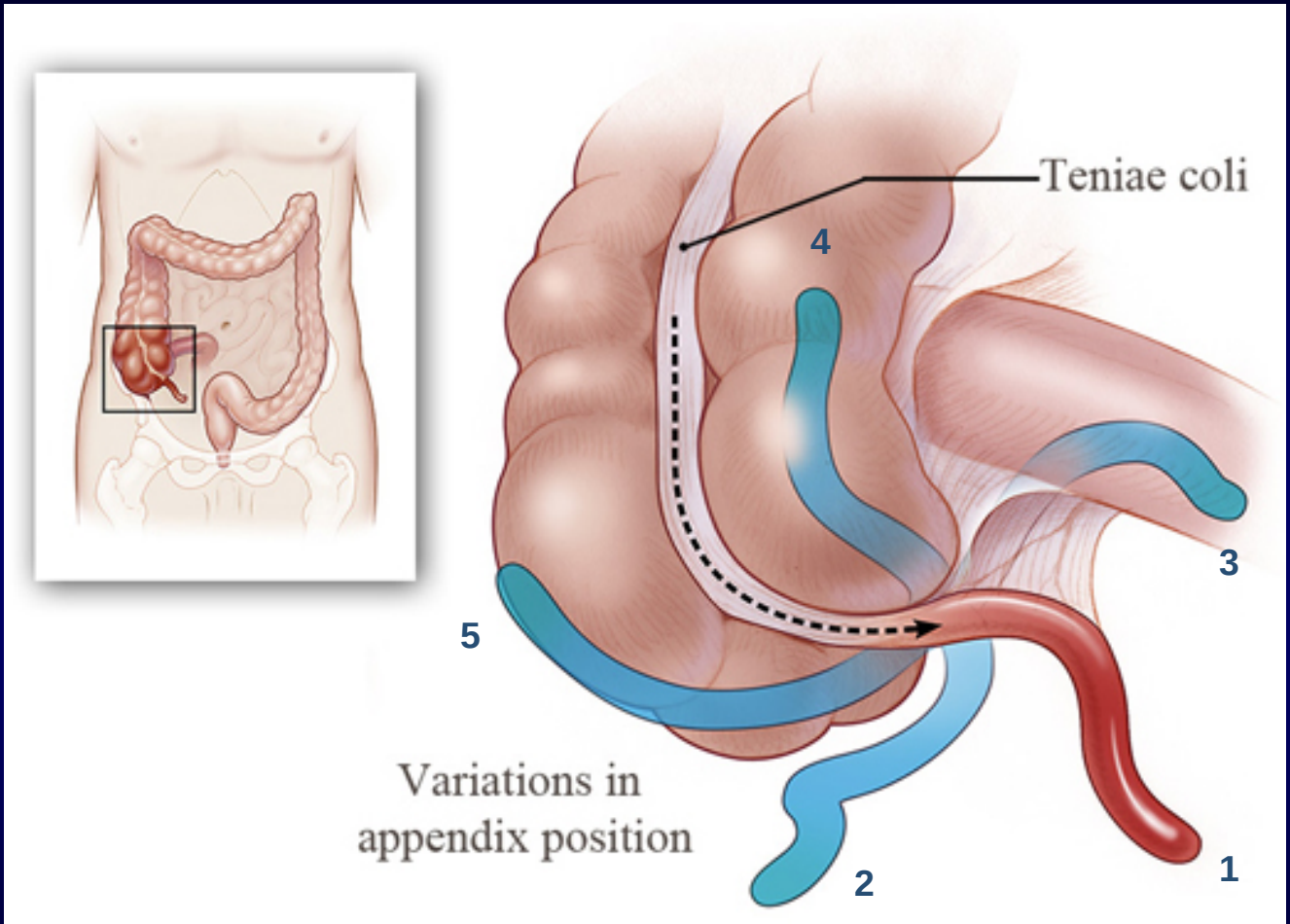




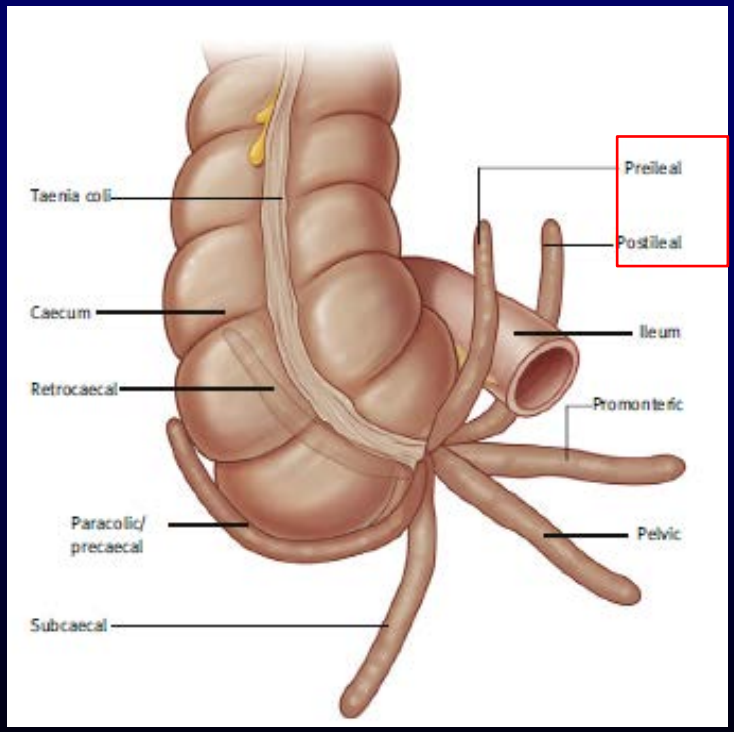
Venous blood supply



Positions of the Appendix



1. Descending
2. Lateral
3. Medial
4. Ascending
5. Retrocecal



Congenital agenesis

Number Anomalies

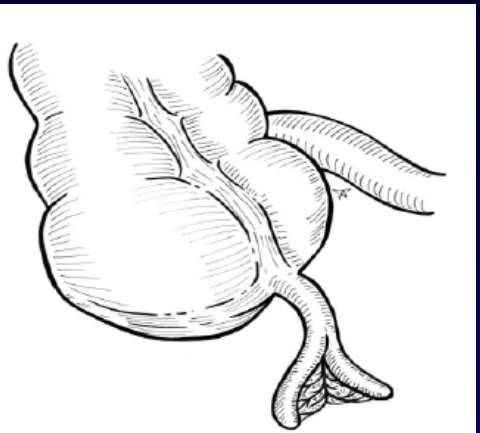


Figure 2. Appendiceal duplication (partially) in "Y-shaped"

A

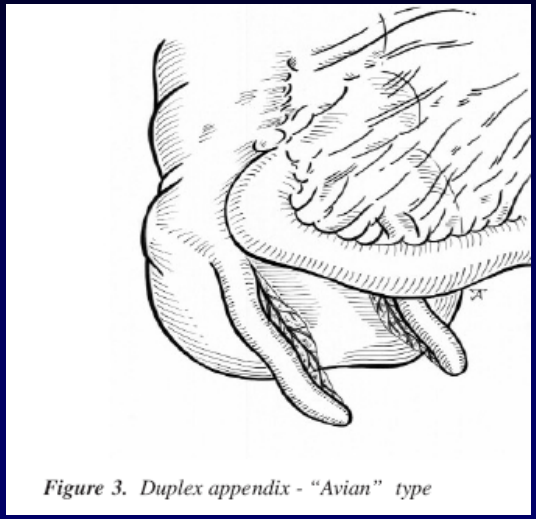


Figure 3. Duplex appendix - "Avian" type

B1

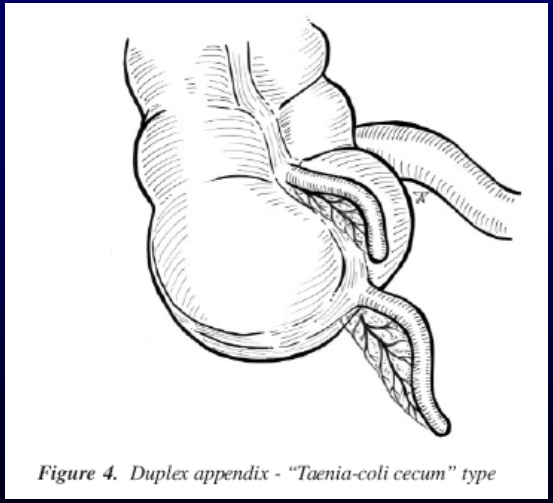


Figure 4. Duplex appendix - "Taenia-coli cecum" type

B2

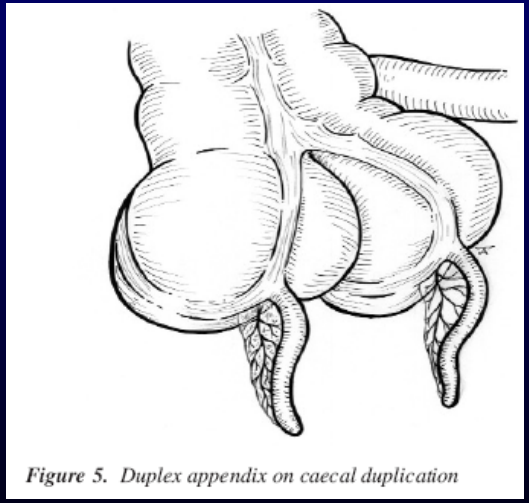


Figure 5. Duplex appendix on caecal duplication

C

Shape anomalies

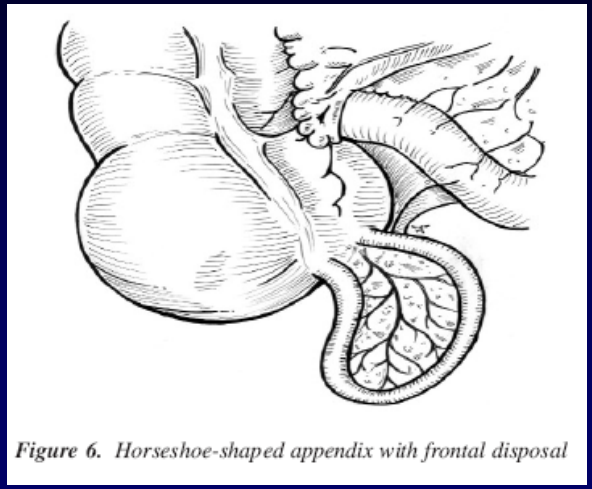


Figure 6. Horseshoe-shaped appendix with frontal disposal

Horseshoe-shaped appendix

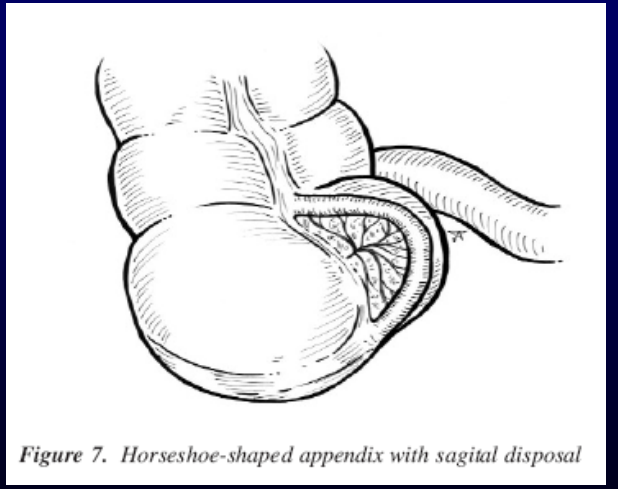
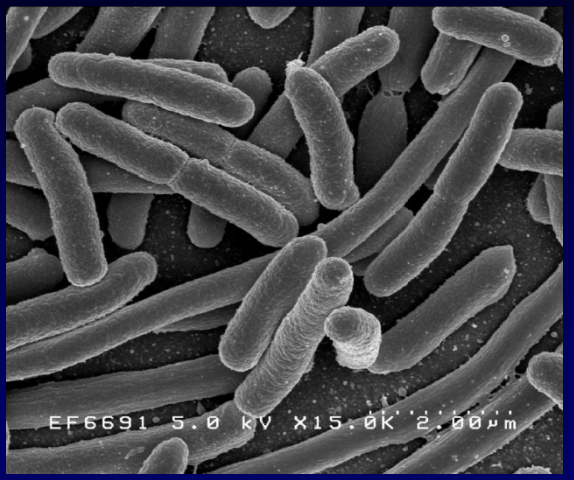


Figure 7. Horseshoe-shaped appendix with sagital disposal

Ethiology and Pathogenesis



- **Microbial factor**

  Escherichia coli (Gram-negative)

  Bacteroides fragilis (Gram-negative bacillus)

- **Mechanical factor (obstruction of the appendiceal lumen)**

  fecal stasis and fecaliths

  parasites

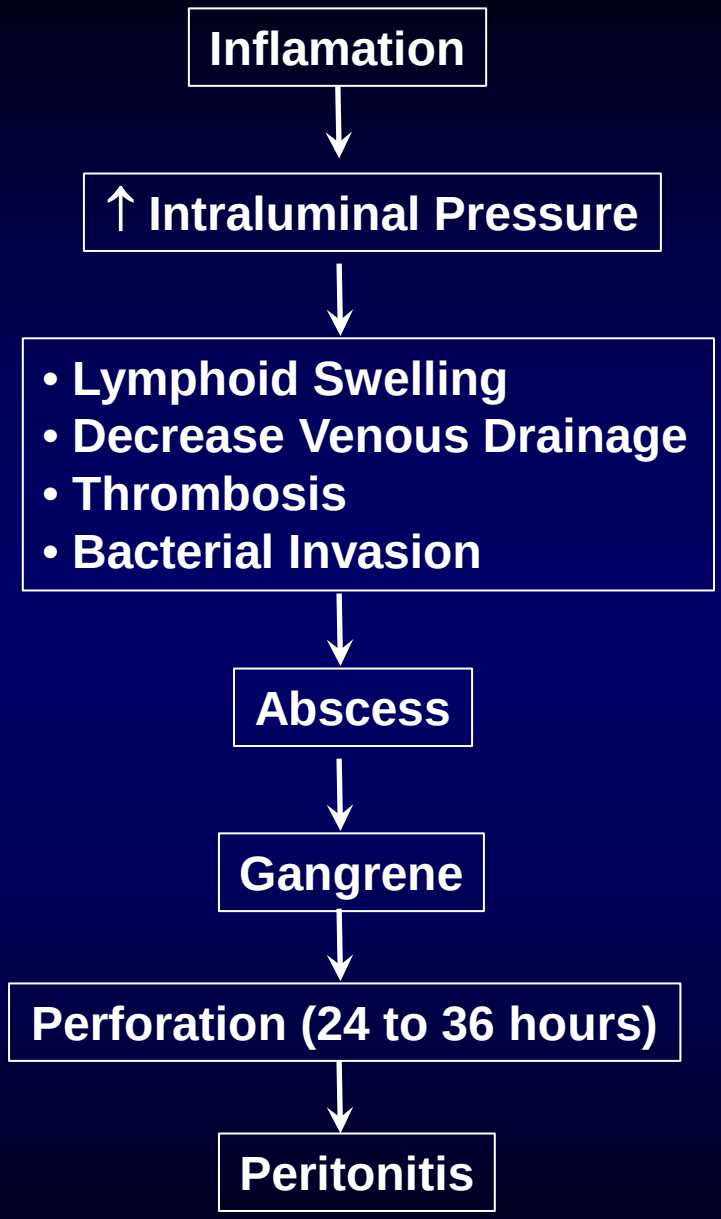
  or, more rarely, foreign bodies and neoplasms

- **Chemical factor**

  Intestinal contents penetrates in appendiceal lumen (mucosa inflamation)

- **Neurogen factor**

  cortical neuro-reflex disturbances → neuro-trofical changes in the appendix


Inflamation
↑ Intraluminal Pressure
• Lymphoid Swelling
• Decrease Venous Drainage
• Thrombosis
• Bacterial Invasion
Abscess
Gangrene
Perforation (24 to 36 hours)
Peritonitis

Classification

- Catarrhal (edematous, simple) appendicitis

  Inflamation of mucosal and submucosal layers

- Flegmonous appendicitis

  Inflamation of all layers

- Gangrenous appendicitis

  wall necrosis (& abscesses)

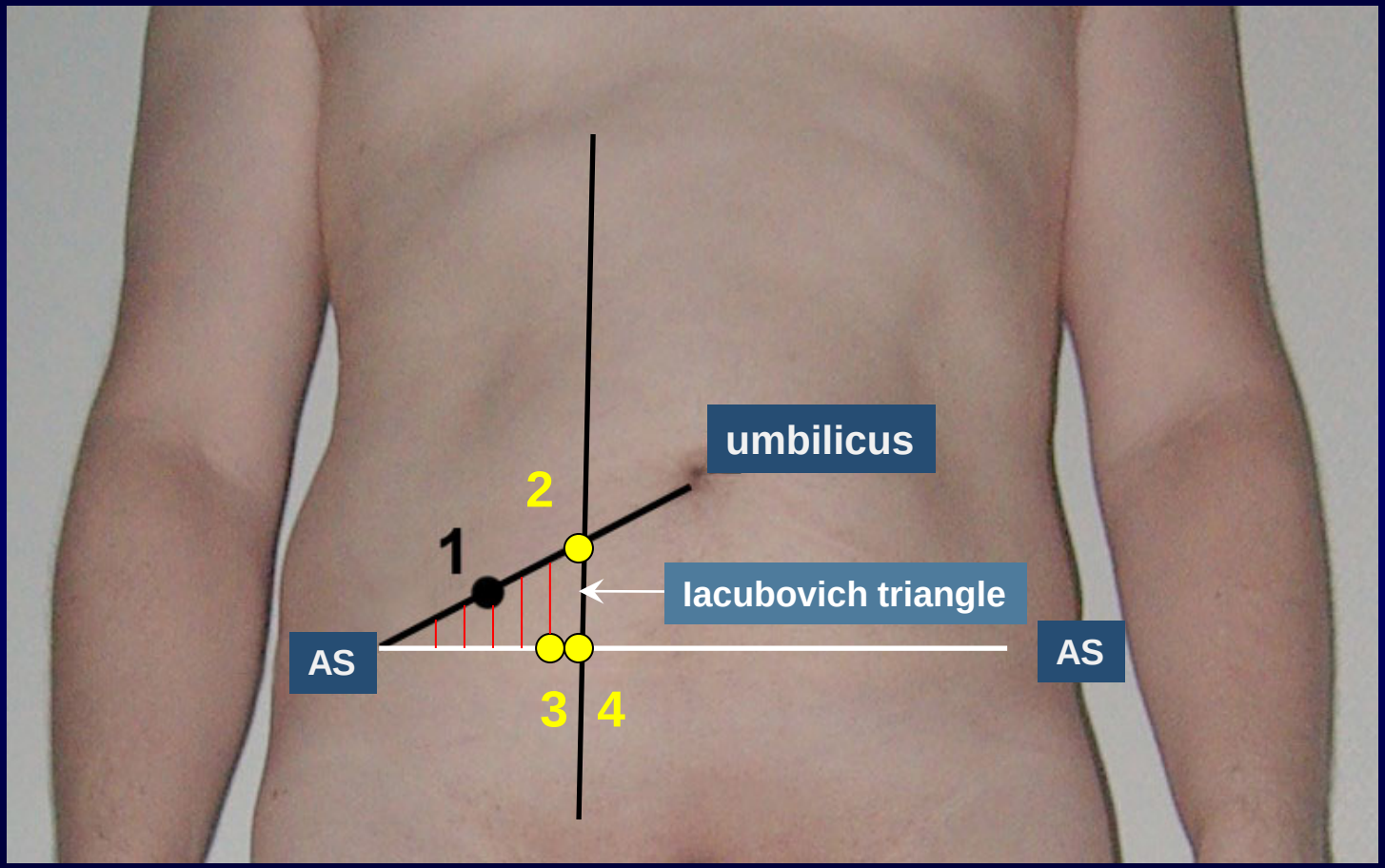
- Perforated appendicitis

History of disease

- Sudden onset
- Abdominal pain in the right iliac fossa
- Kocher's sign (35% of cases)

  the appearance of pain in the epigastric region or around the stomach at the beginning of disease with a subsequent shift to the right iliac region
- Nausea
- Single vomiting episode
- Low fever (37.2 to 37.5°C)
- Pulse is slight accelerated

Points of pain in acute appendicitis



1. McBurney point
2. Morris-Kummel point
3. Lanz point
4. Sonnenberg point

Symptoms and Signs

Triad of Dieulafoy	**Hypersensitivity of the skin, tenderness and muscular contraction at McBurney's point in acute appendicitis**
Blumberg sign	**Also referred as rebound tenderness. Deep palpation of the viscera over the suspected inflamed appendix followed by sudden release of the pressure causes the severe pain on the site indicating positive Blumberg's sign and peritonitis**
Rovsing's sign	**Continuous deep palpation starting from the left iliac fossa upwards (counterclockwise along the colon) may cause pain in the right iliac fossa, by pushing bowel contents towards the ileocaecal valve and thus increasing pressure around the appendix.**
Sitkovskiy (Rosenstein)'s sign	**Increased pain in the right iliac region as patient lies on his/her left side**
Bartomier-Michelson's sign	**Increased pain on palpation at the right iliac region as patient lies on his/her left side compared to when patient was on supine position.**

Symptoms and Signs

Dunphy's sign

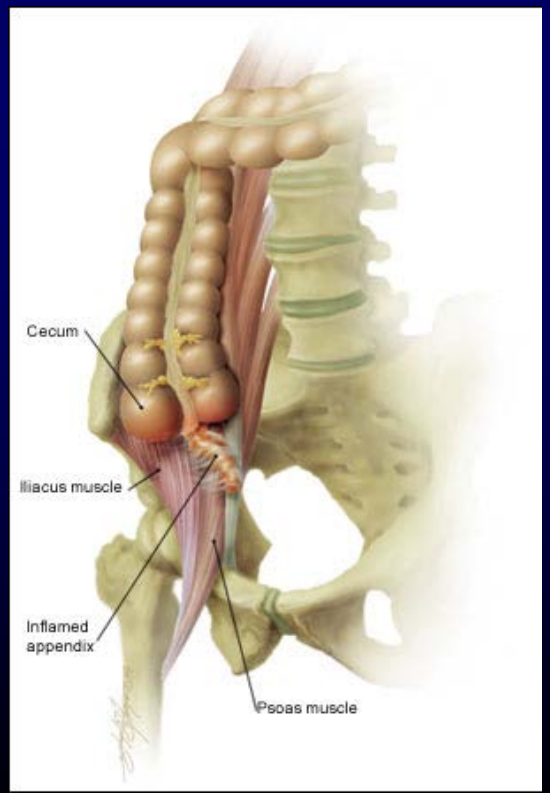
Increased pain in the right lower quadrant with coughing

Mandel-Razdolski sign

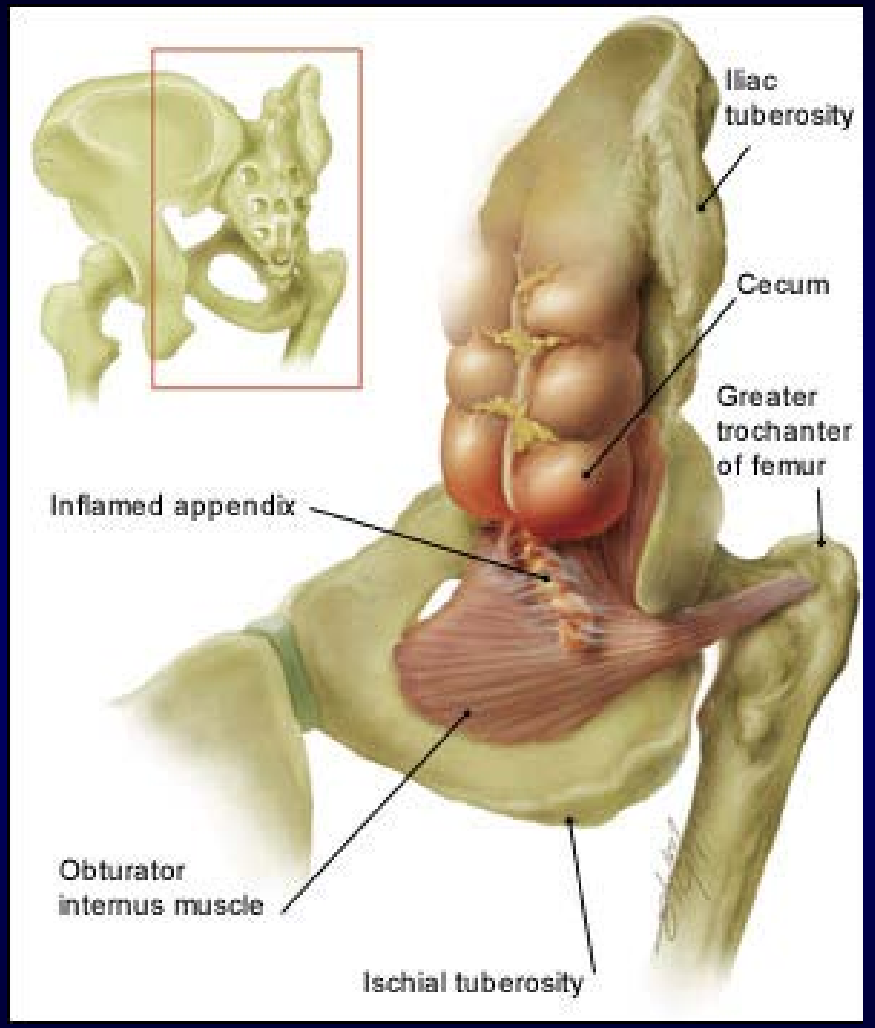
pain, due to peritoneal irritation upon percussion in the RLQ

The psoas sign (Cope)

right lower-quadrant pain that is produced with either the passive extension of the patient's right hip (patient lying on left side, with knee in flexion) or by the patient's active flexion of the right hip while supine.



The obturator sign



If an inflamed appendix is in contact with the obturator internus, spasm of the muscle can be demonstrated by flexing and internal rotation of the hip.

The Alvarado Scoring System

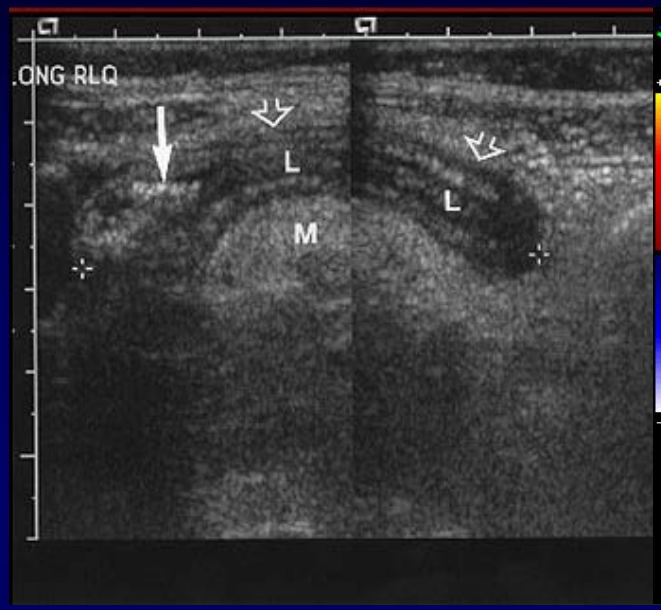
Features	Score
• Migratory right lower quadrant pain	1
• Anorexia	1
• Nausea and vomiting	1
• Right lower quadrant tenderness	2
• Right lower quadrant rebound tenderness	1
• Elevated temperature ≥ 37.3°C	1
• Leukocytosis ≥ $10.0X10^9/L$	2
• Neutrophilic shift to left N 75%	1
Total	**10**

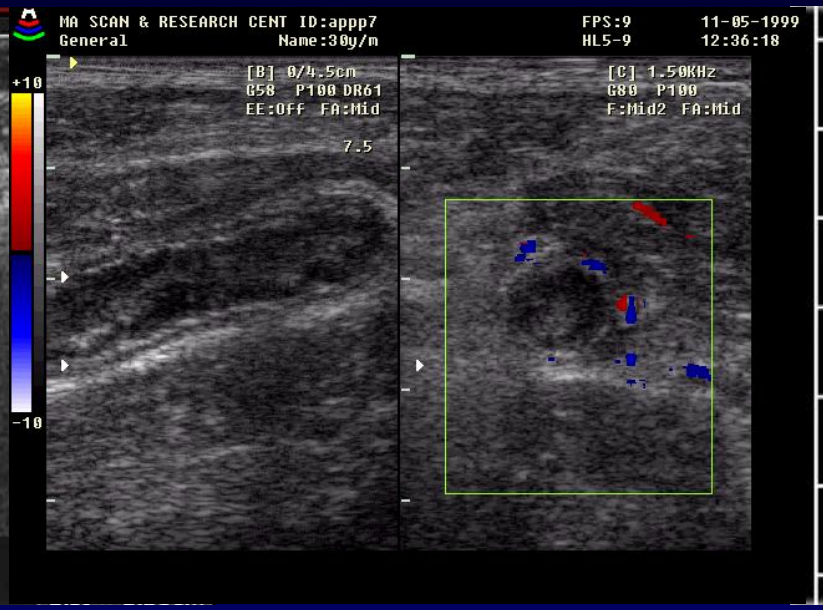
0-3 Discharge with advice to return if no improvement, subject to social circumstances

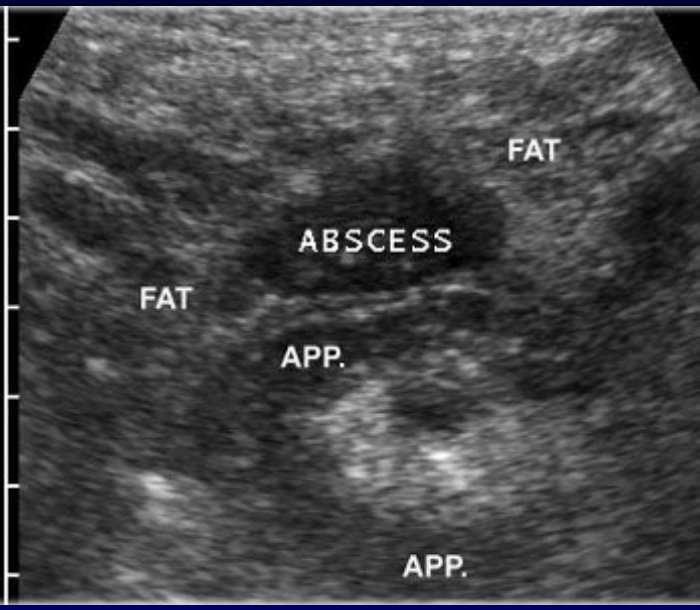
4-6 Review after 12 h and reassess score, if still 4-6 then treat operatively as below

7-9 Male/child Appendicectomy
Female Laparoscopy then proceed

Ultrasonography in Acute Appendecitis







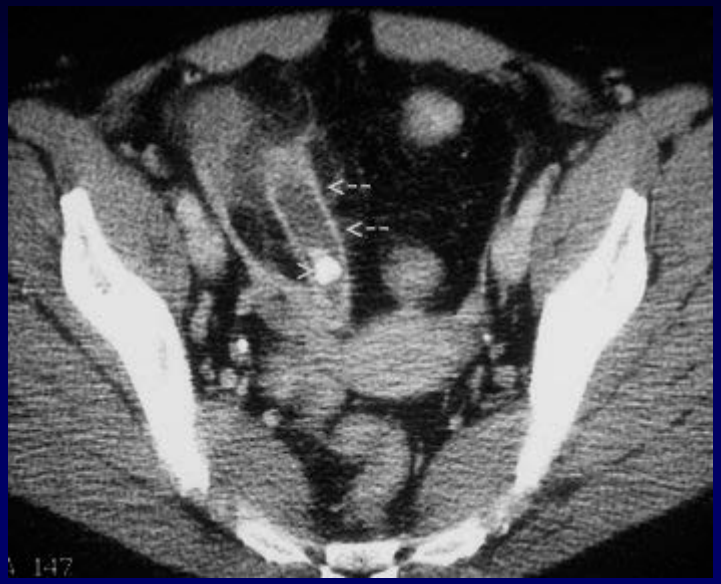
Normal appendix:

- blind-ended, tubular structure
- maximum wall thickness of 2 mm
- outer diameter of 6 mm
- have no peristalsis
- and originate from the base of the cecum

AA

- Thickened wall >3 mm
- Diameter >6 or 7 mm
- Blind-ended tubular structure
- Noncompressible
- Appendolith
- Circumferential color flow
- Echogenic mesentery
- Free fluid
- Abscess

CT scan in Acute Appendecitis



Advantages of CT include:

- more accurate in staging periappendiceal inflammation & abscesses
- more likely to provide alternate diagnosis in patients without appendicitis
- more sensitive for detecting normal appendix
- operator independent
- not limited by pt body habitus

Acute appendicitis in children

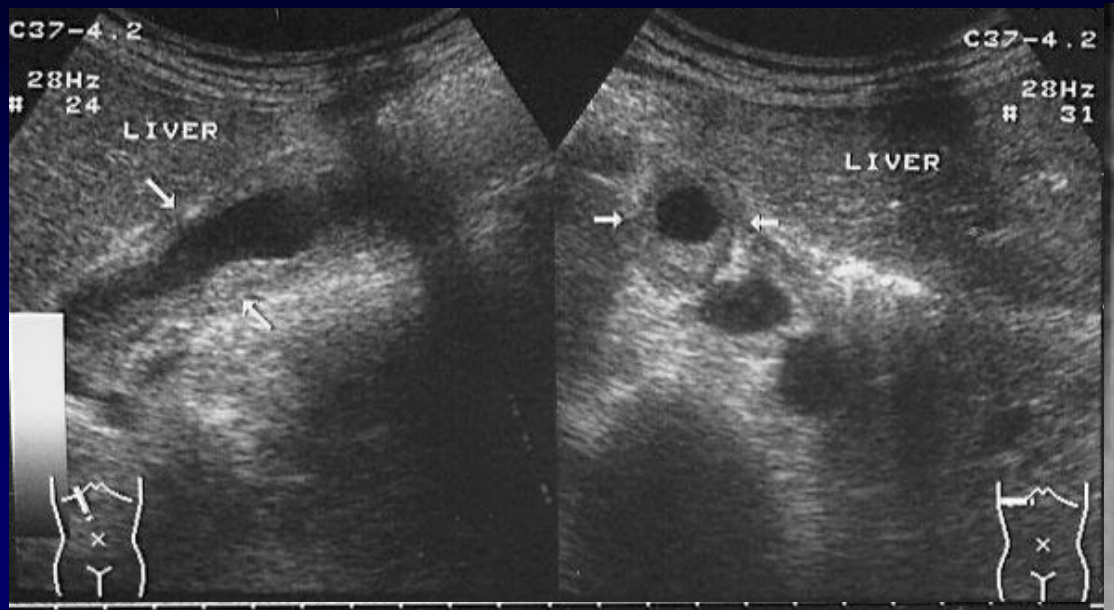
- acute appendicitis uncommon in children younger than 2 or 3 years
- the diagnosis of appendicitis is difficult
- illness develops dramatically rapidly
- violent pain (atypical, unlocalized diffuse periumbilical)
- high grade temperature (39-40°C)
- persistent vomiting
- diarrhea (12%)
- hyperleukocytosis (15.000 – 20.000/mL)
- intoxication (oliguria and anuria)
- physical examination with natural or medicamentous sleep (enema with chloralhidrate or relanium i.m.)
- appendix situated in pelvic and ascending position
- functional insufficiency of the peritoneum and omentum →gangrene (or perforations)

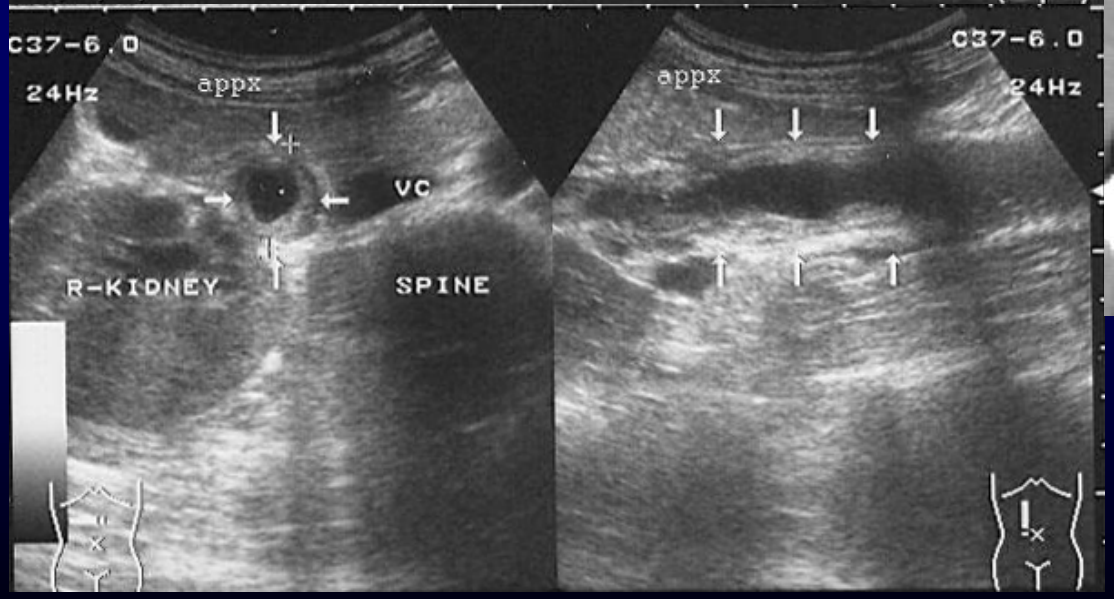
Acute appendicitis in elderly

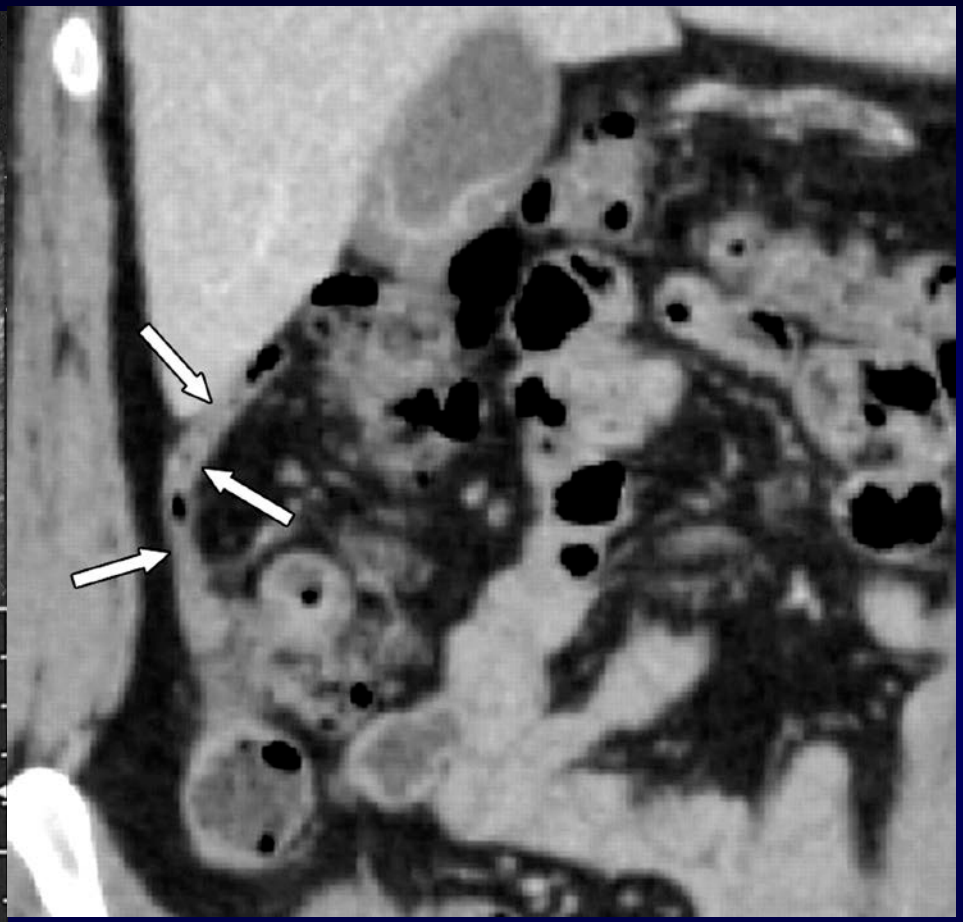
- > 60 yrs – 12% from total number of appendectomies
- clinical signs are less evident (pain is less severe, local tenderness less acute, low grade temperature)
- the basic symptoms – pain on palpation and alteration of the bowel motility
- elevation in the WBC – moderate or nonexistent
- higher incidence of destructive forms of appendicitis (vascular factor)
- ½ of pts >70 yrs – ruptured appendix at time surgery
- **right-sided colon carcinoma?**
- Main clinical forms of acute appendicitis in elderly

1. like intestinal obstruction form
2. pseudo-tumorous form
3. acute appendicitis with peritonitis in two times

Subhepatic Appendicitis

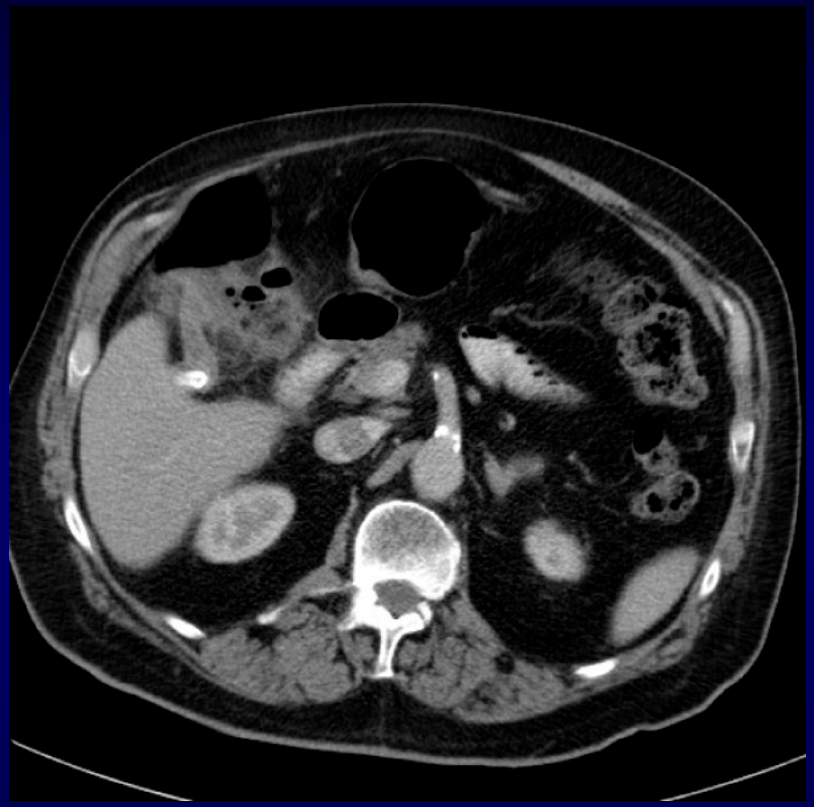




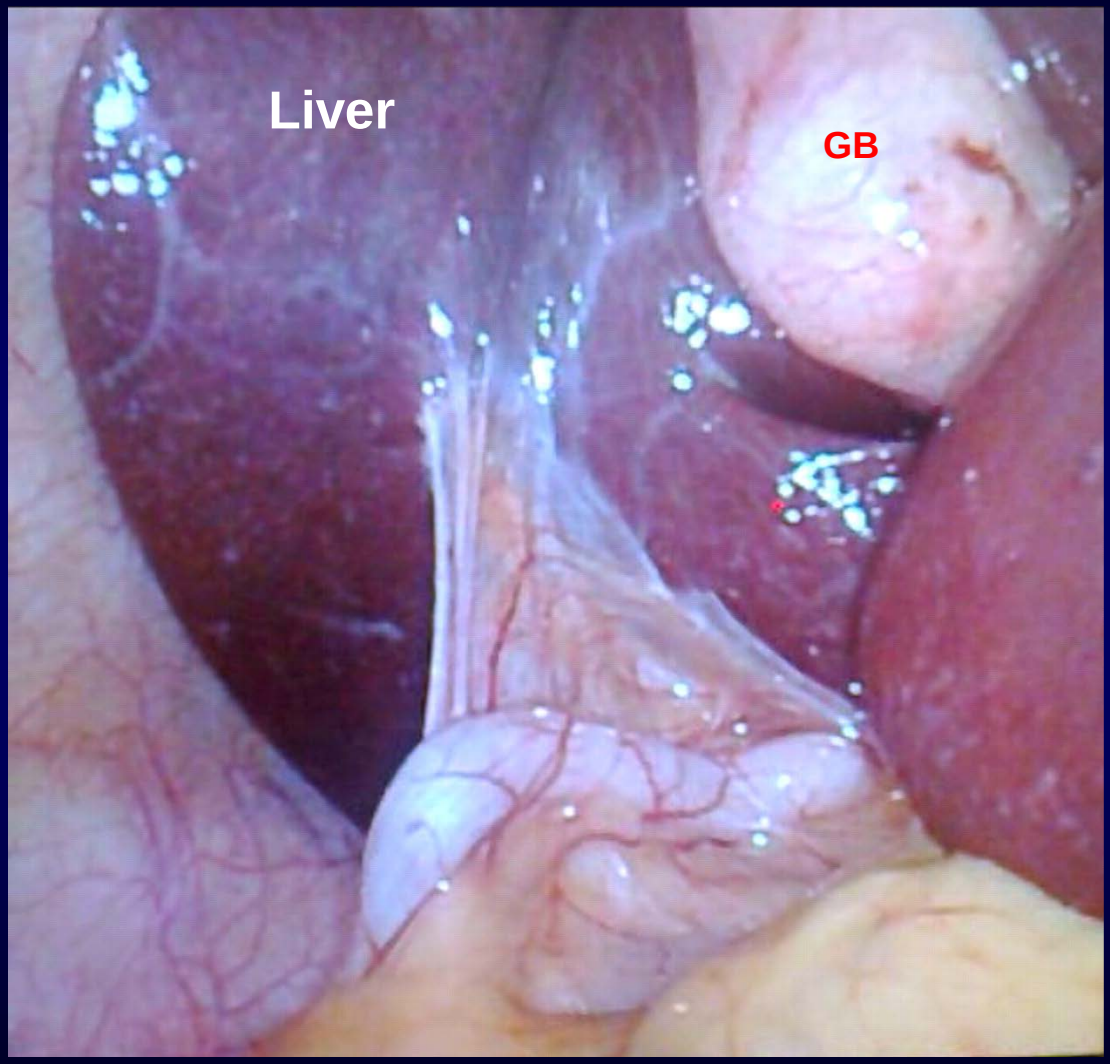


CT: Subhepatic location of a normal appendix

Subhepatic Appendicitis

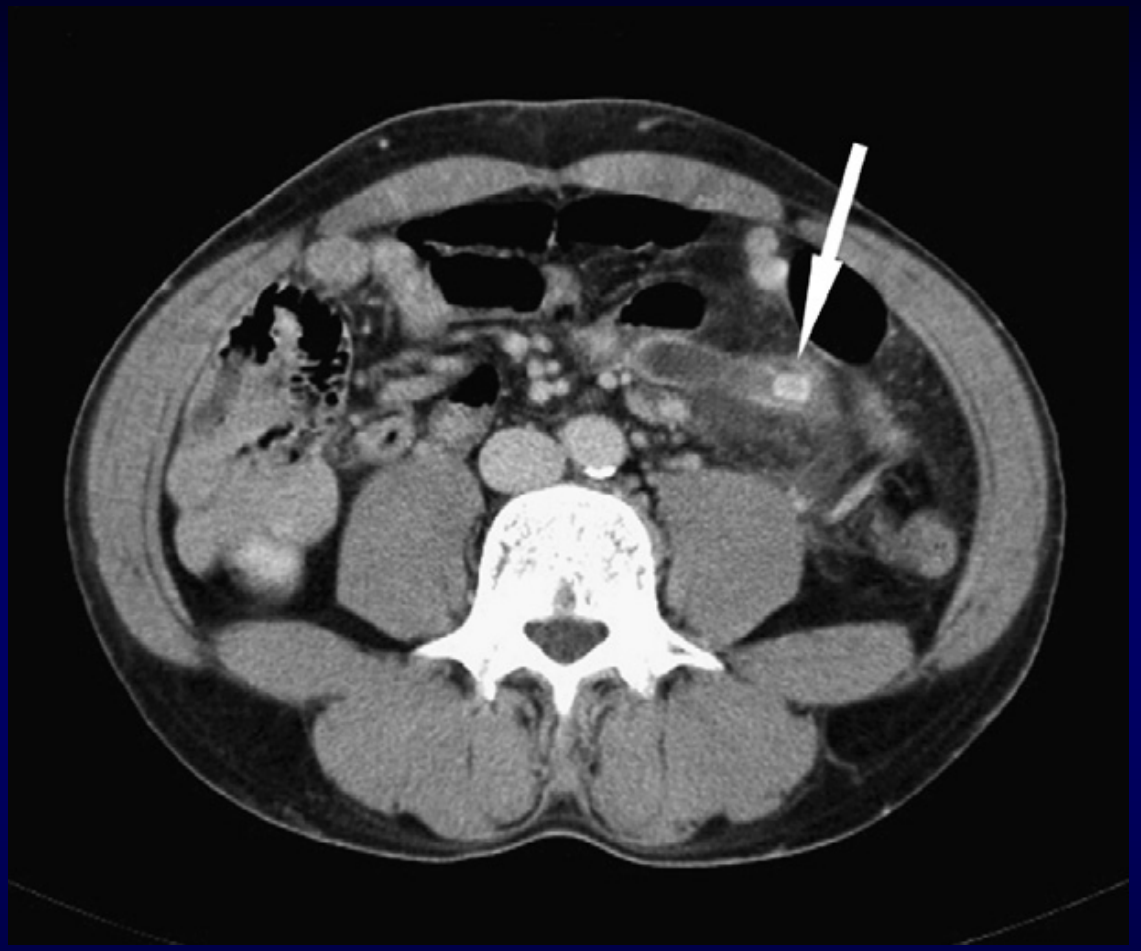


Subhepatic appendicitis with faecolith *in situ*.



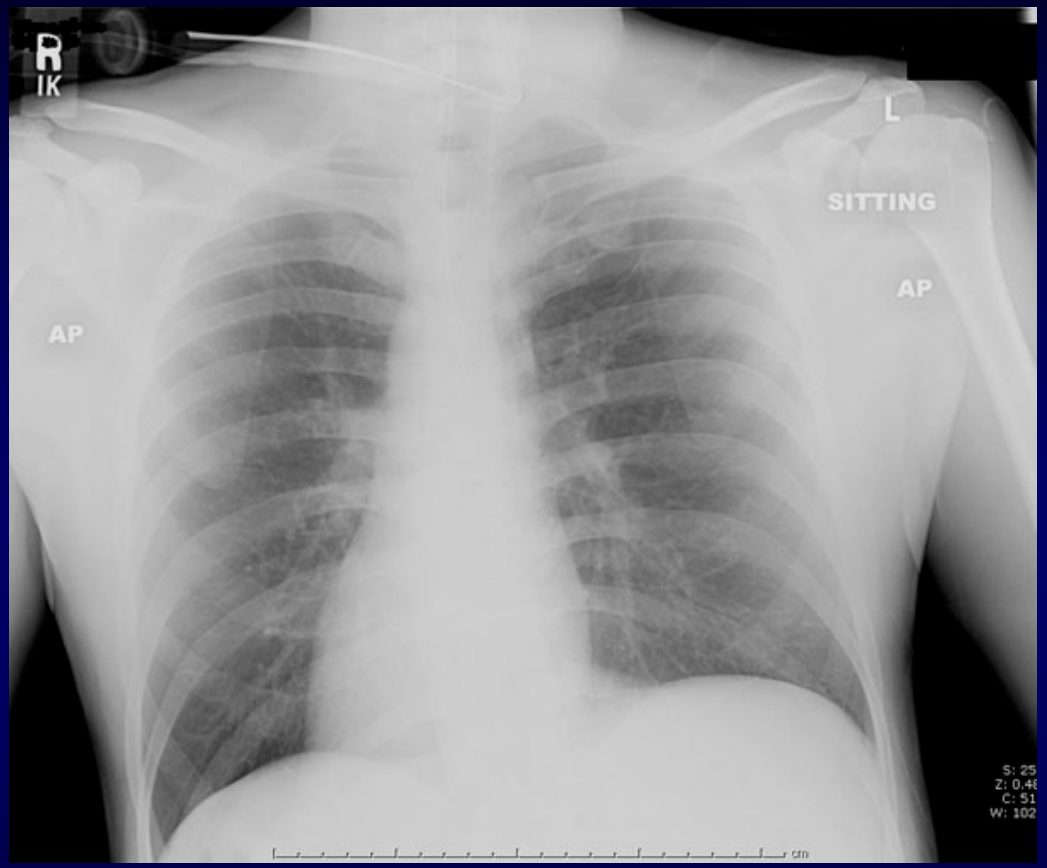
Subhepatic appendicitis

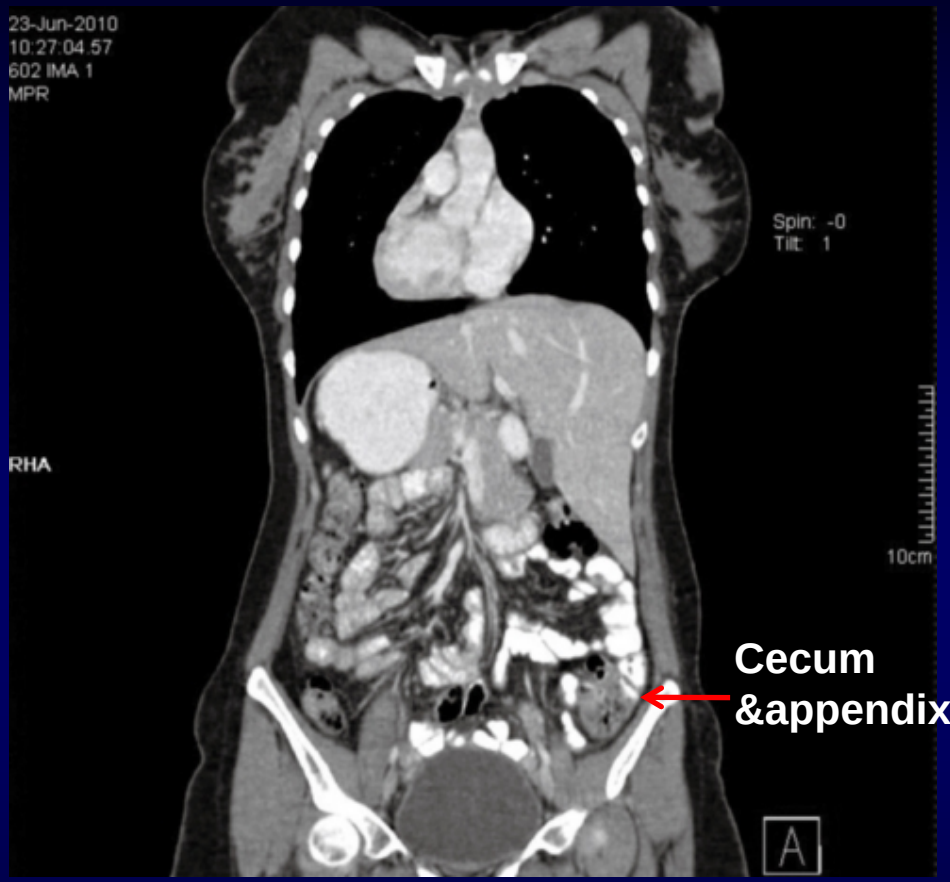
Left-sided acute appendicitis



- excessively moveable cecum
- intestinal malrotation
- the long appendix, which riches the left iliac fossa

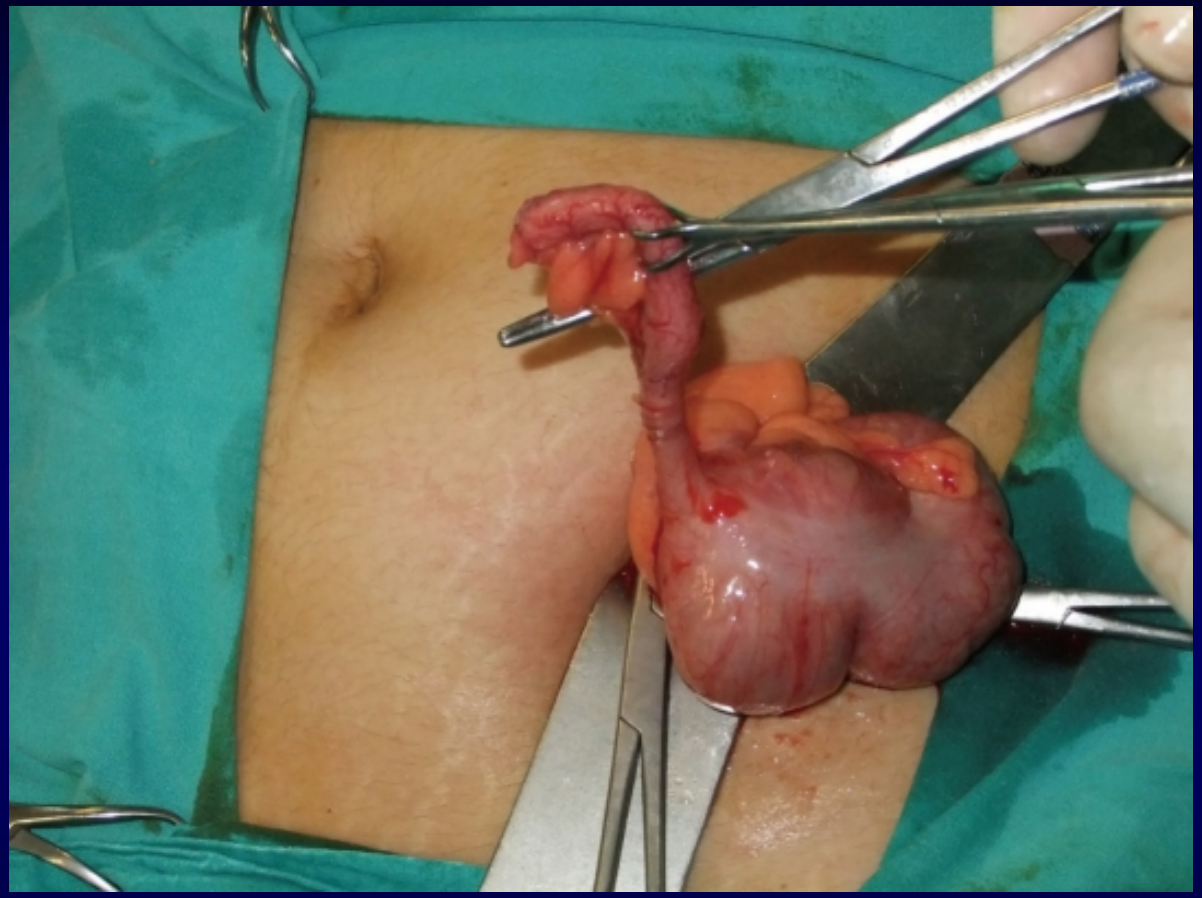
Situs Viscerum Inversus





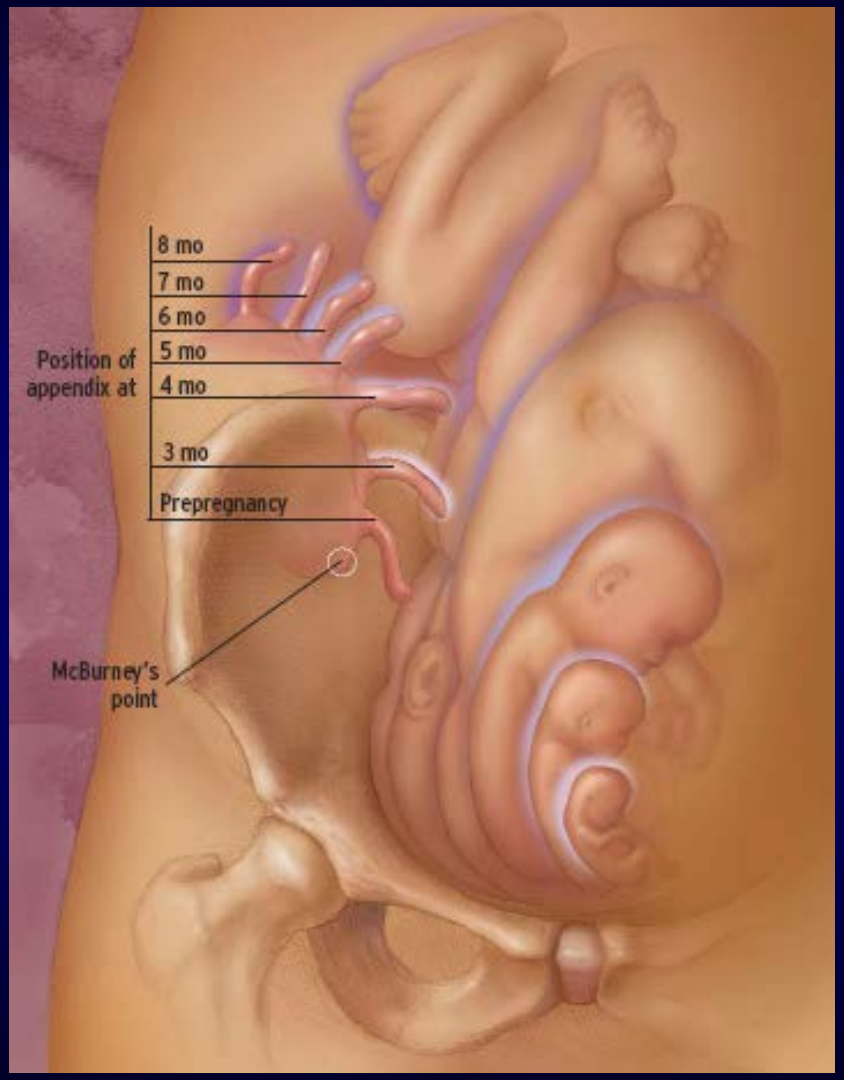
X-ray and computed tomography showed situs inversus totalis (SIT) including dextrocardia, right-sided gastric bubble and reversed spleen and liver.

Situs Viscerum Inversus



The incidence of SIT reported in the literature varies from 0.001% to 0.01% in the general population. The incidence of acute appendicitis associated with SIT is reported to be between 0.016% and 0.024%

Appendicitis during pregnancy

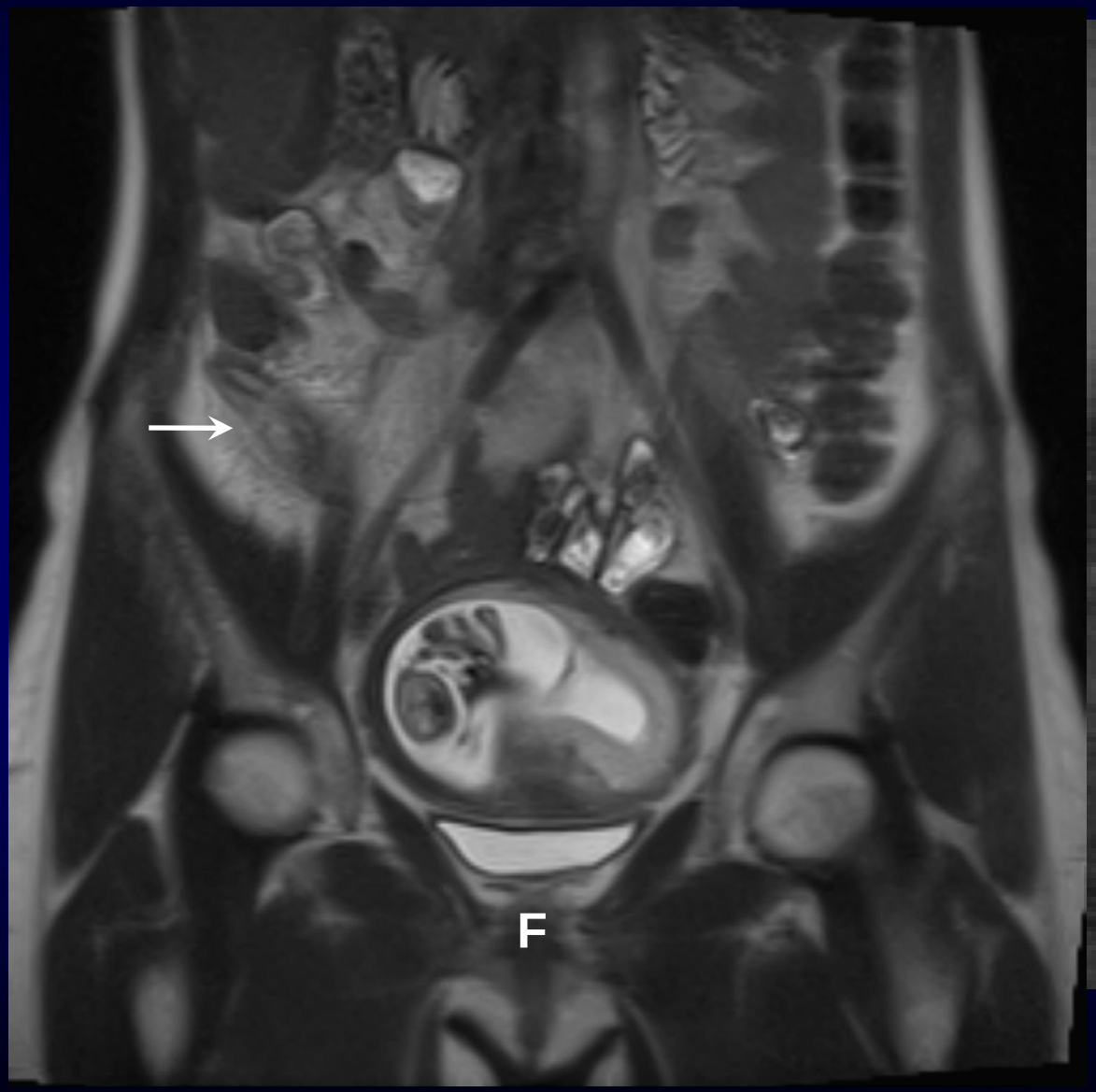


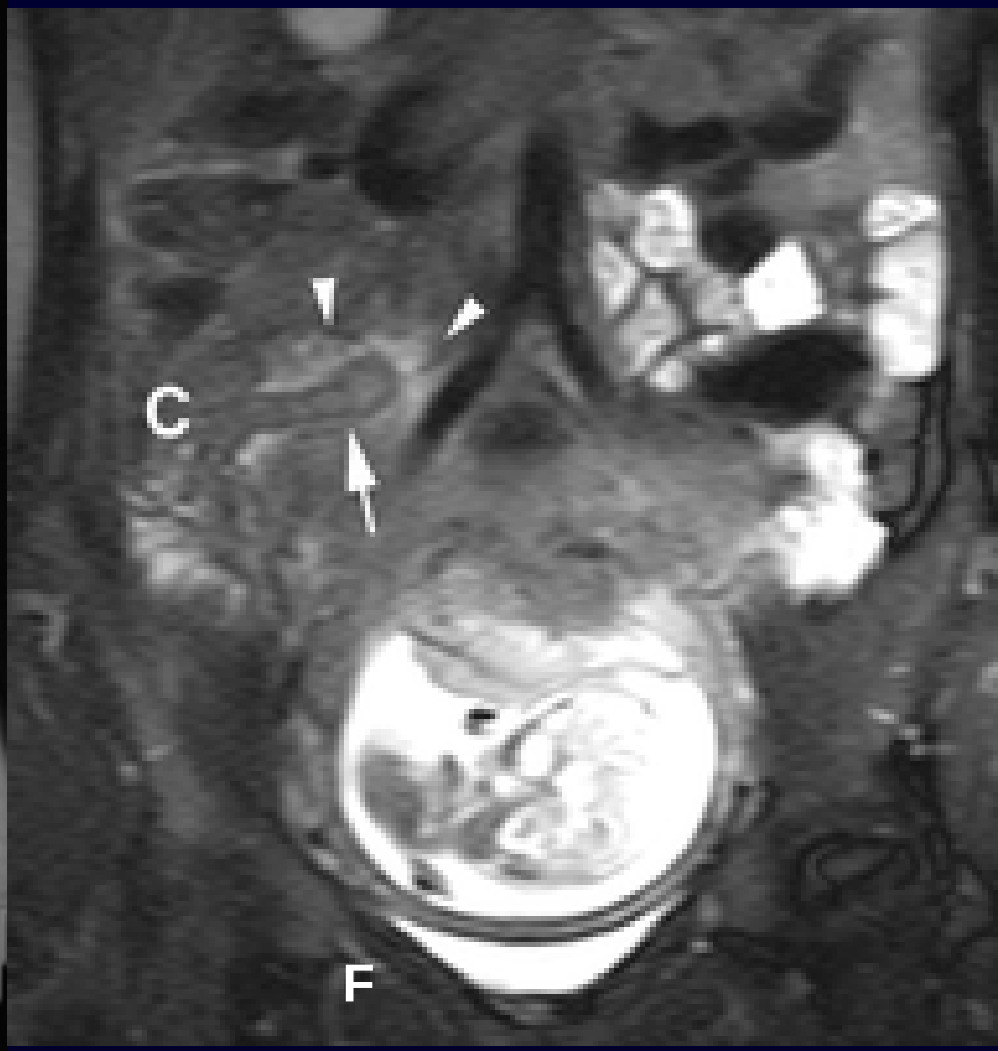
Appendicitis during pregnancy is a relatively rare condition, though it is thought that the incidence is similar to that of the non-gravid population at approximately 1 in 1500 pregnancies.

The majority of appendicitis in pregnancy occurs during the second trimester when they are difficult to diagnose both clinically and by imaging.

The pathologic diagnosis of appendicitis is confirmed in only 30% to 50% of cases. Fetal loss rate approaches 40% for perforated appendicitis.

Appendicitis during pregnancy





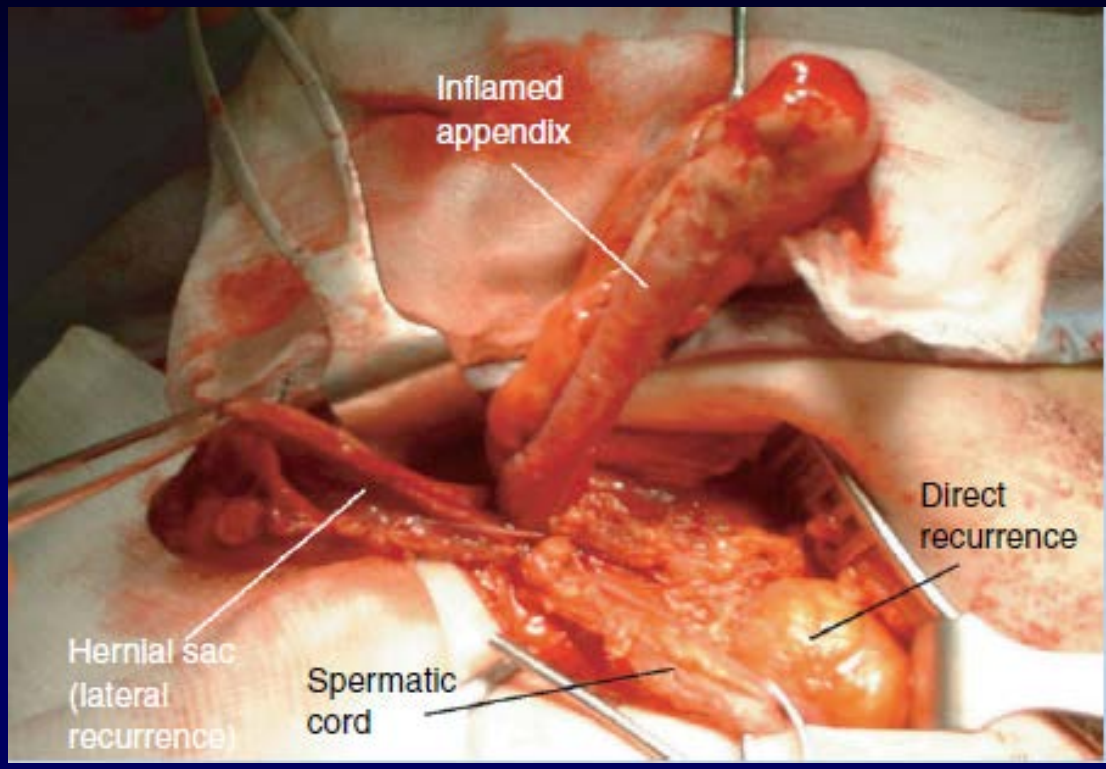
Amyand's hernia (acute appendicitis In inguinal hernia)

Claudius Amyand (1660–1740) is variously reported as having held the title of “surgeon-in-ordinary” or “sergeant– surgeon” to King George II of England.

On 6 December 1735 he performed the first recorded successful appendectomy.

Incidence - 0.13% - 1%

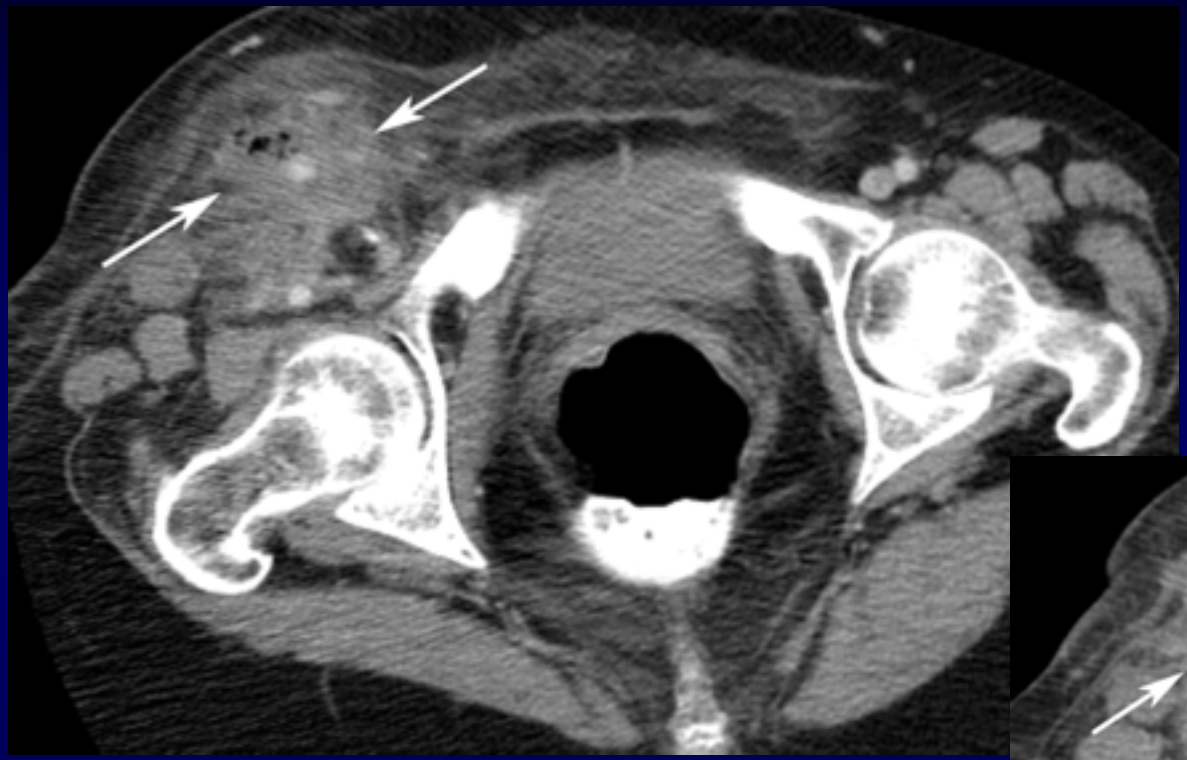
Amyand's hernia (acute appendicitis In inguinal hernia)

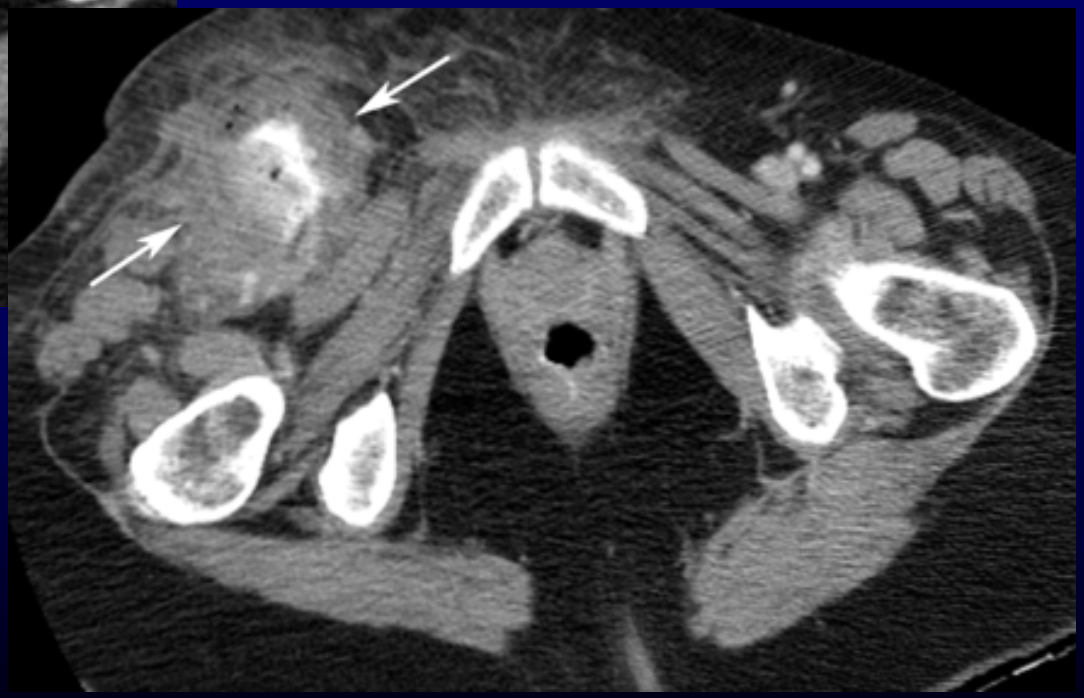


Pathological types of Amyand's hernia

I - normal appendix
II - acute appendicitis localized in the sac
III - acute appendicitis, peritonitis
IV - acute appendicitis, other abdominal pathology

DeGarengot hernia





Herniation of the appendix into a femoral hernia sac was first reported by DeGarengot in 1731.

Differential Diagnosis of Acute Appendicitis

Gastrointestinal
Duodenal ulcer (perforation)
Pancreatitis
Cholecystitis
Crohn's disease
Diverticulitis
Gastroenteritis
Intestinal obstruction
Intussusception
Meckel's diverticulitis
Mesenteric lymphadenitis
Necrotizing enterocolitis
Neoplasm (carcinoid, carcinoma, lymphoma)
Omental torsion
Perforated viscus
Volvulus

Gynecologic
Ectopic pregnancy
Endometriosis
Ovarian torsion
Pelvic inflammatory disease
Ruptured ovarian cyst (follicular, corpus luteum)
Tubo-ovarian abscess

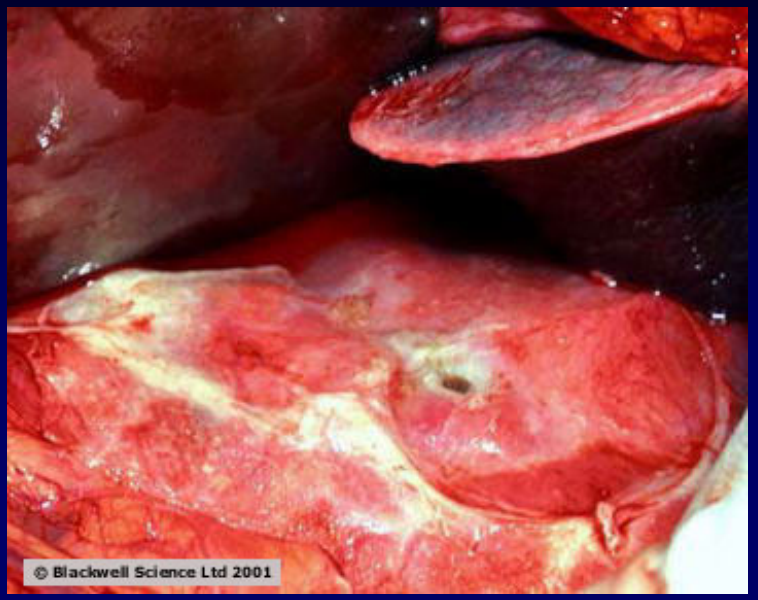
Systemic
Diabetic ketoacidosis
Porphyria
Sickle cell disease
Henoch-Schönlein purpura

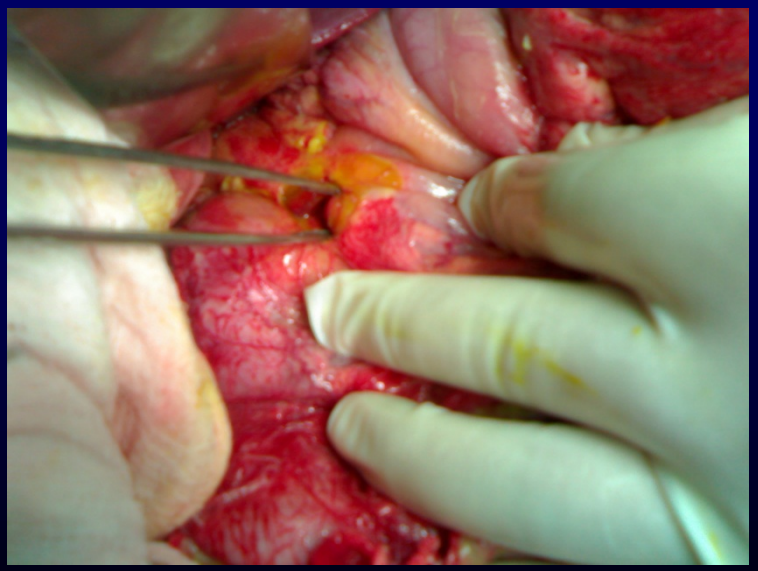
Pulmonary
Pleuritis
Pneumonia (basilar)
Pulmonary infarction

Genitourinary
Kidney stone
Prostatitis
Pyelonephritis
Testicular torsion
Urinary tract infection
Wilms' tumor

Other
Parasitic infection
Psoas abscess
Rectus sheath hematoma

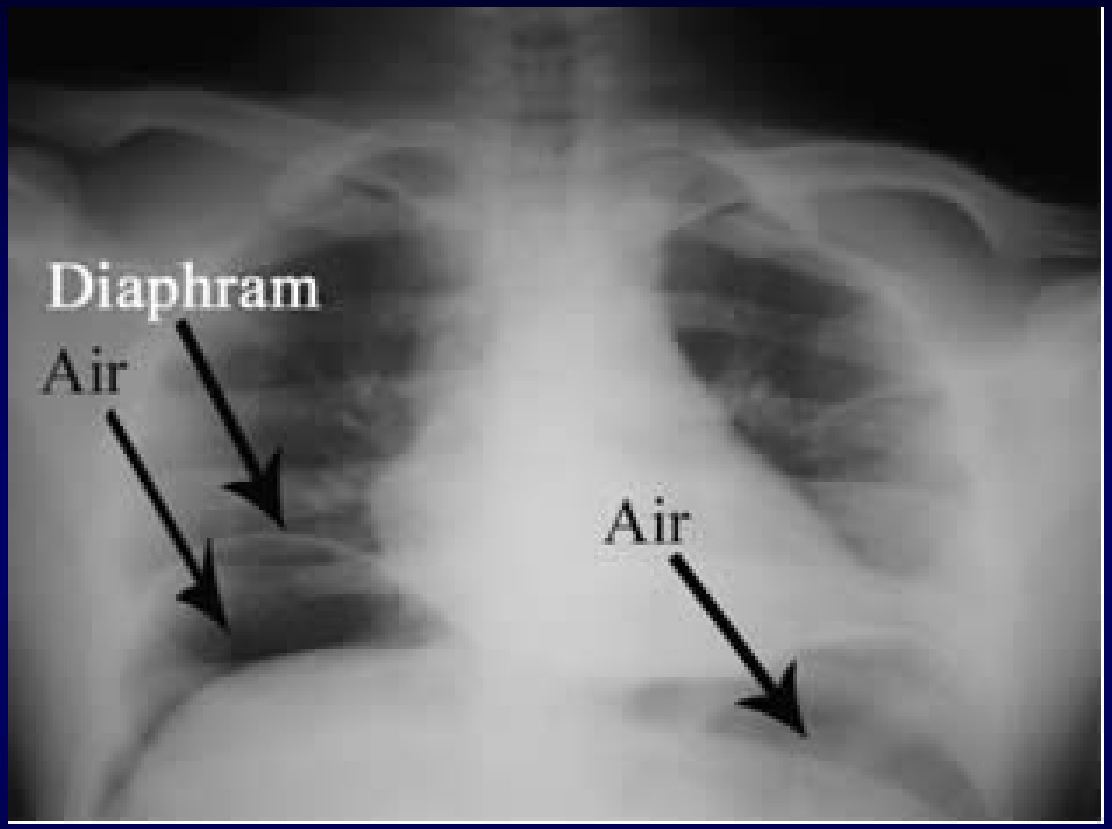
Perforated ulcer

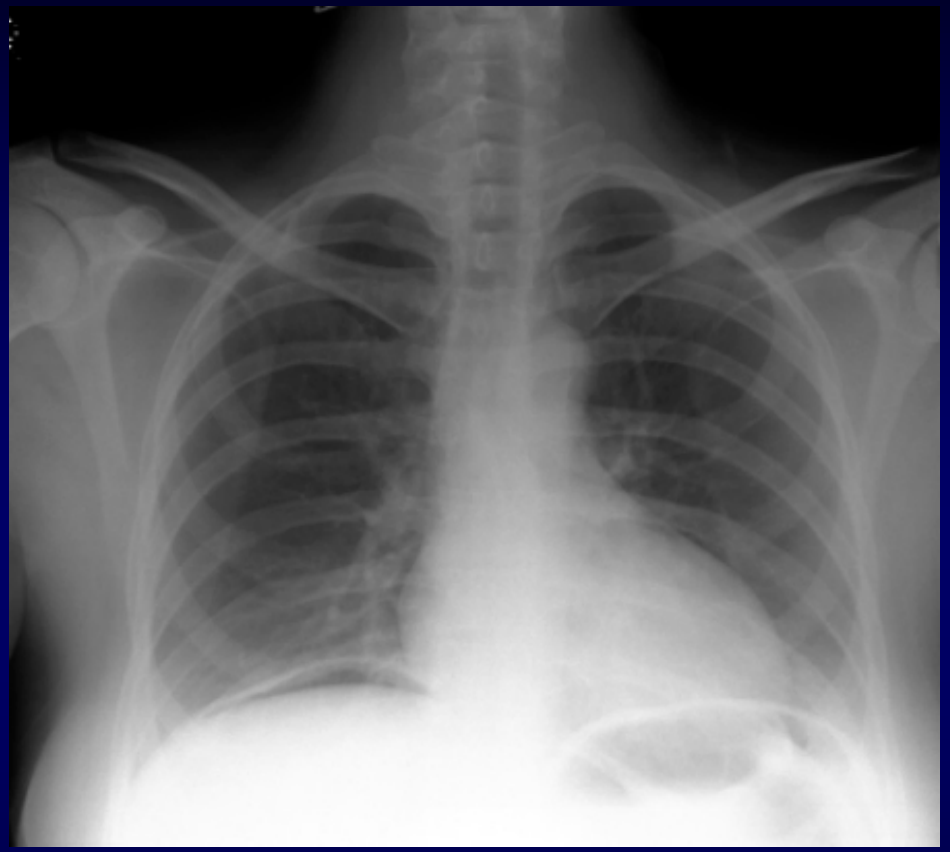




- peptic ulcer history
- a severe pain (Dieulafoy sign)
- hypotension or schock
- absence of vomiting
- bradycardia
- absence of fever
- absence of abdomen movement on respiration
- a rigid board-like abdomen
- diffuse tenderness and pain
- Blumberg sign on the whole abdominal wall
- disappearance of liver dullness

Perforated ulcer

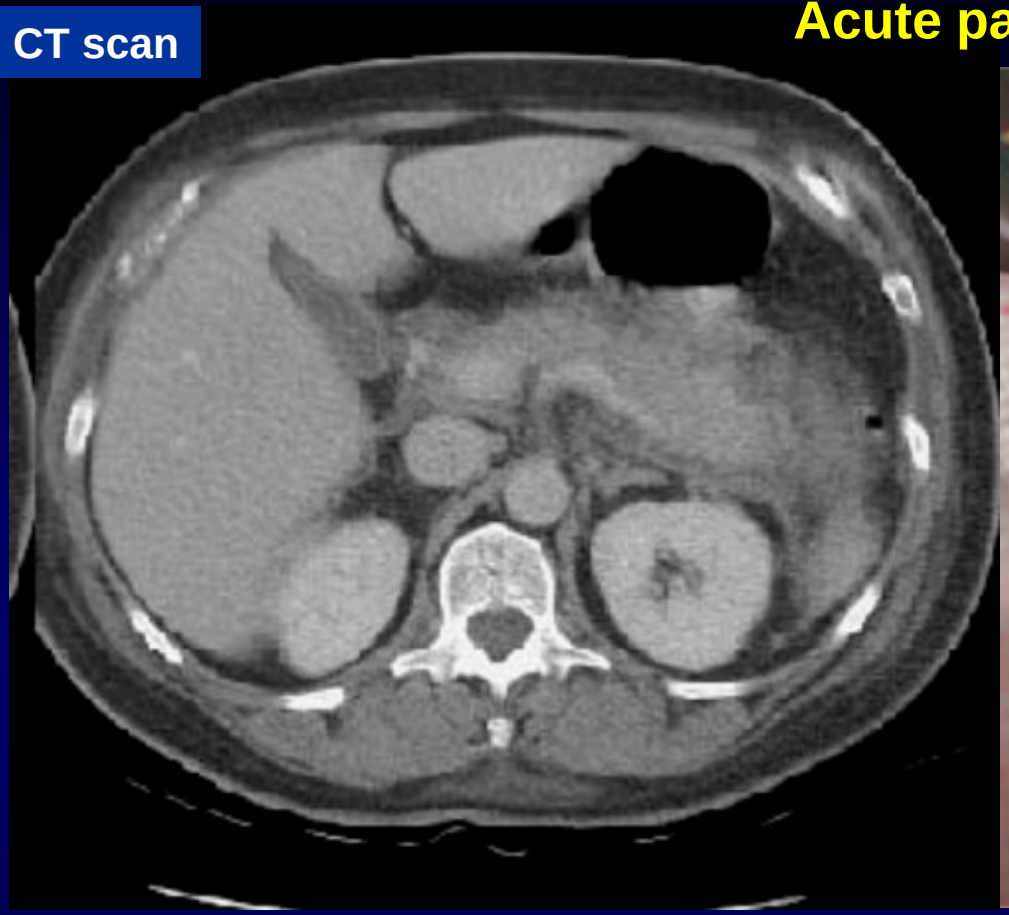


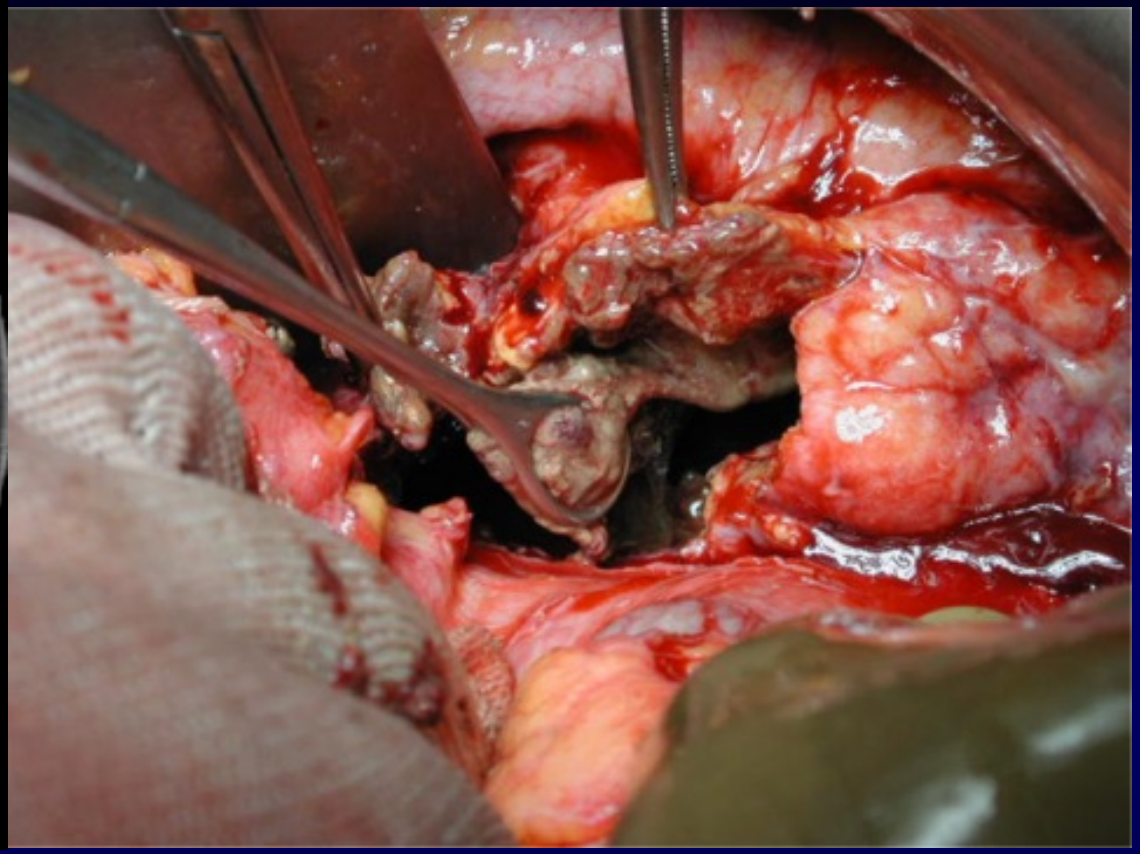


Presence of free air under the diaphragm on abdominal film

Acute pancreatitis

CT scan





- alcohol and gallstone!
- high intensive pain in the epigastric area
- shock
- abdominal distention
- tenderness on the pancreas projection
- tachycardia
- cyanosis

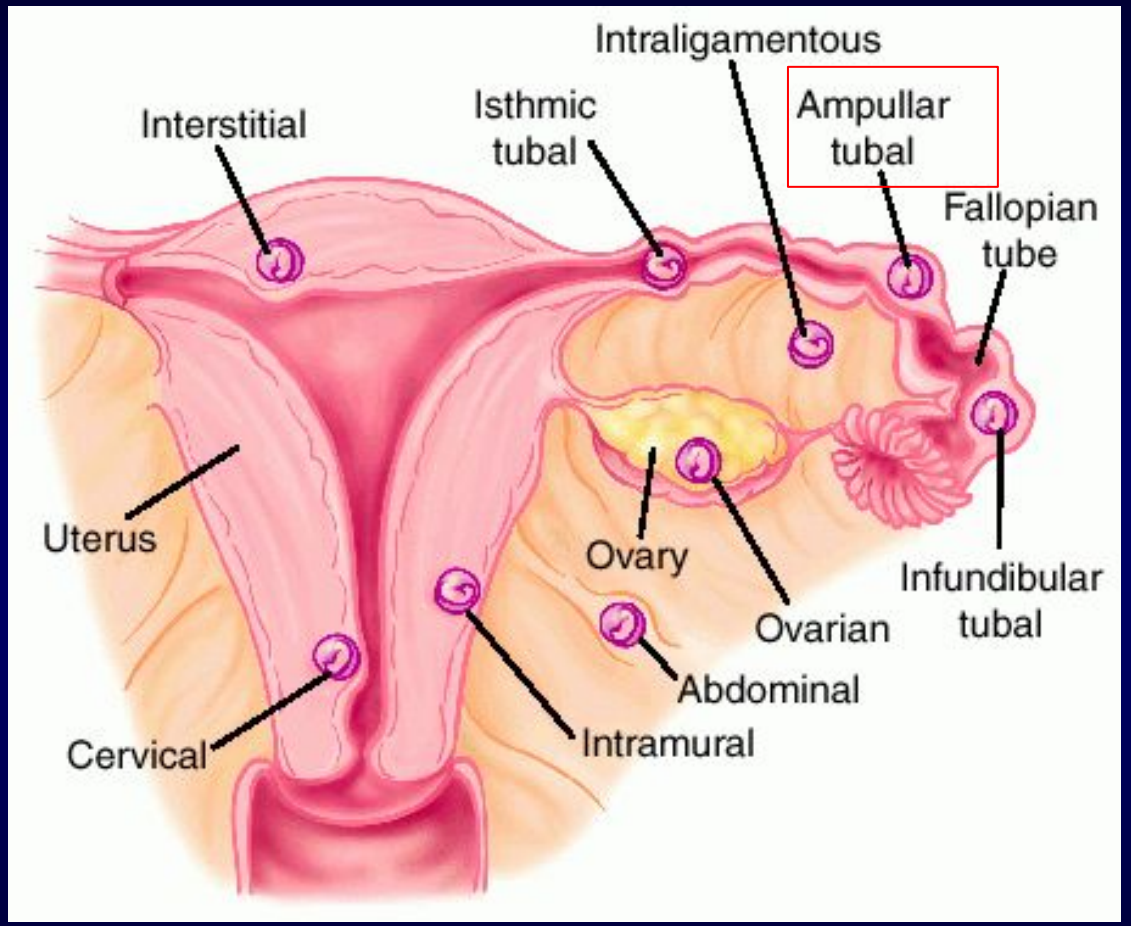
Hyperleucocytosis

Elevated amylase levels in blood and urine

Acute Cholecystitis

- Pain usually beginning after eating fried food, alcohol
- pain is situated in right upper abdominal quadrant and radiated to the right subscapular region
- nausea
- multiple vomiting
- fever
- Grekov-Orthner sign
- Murphy sign
- frenicus sign
- tenderness in RUQ
- mass in RUQ
- jaundice

Ectopic Pregnancy



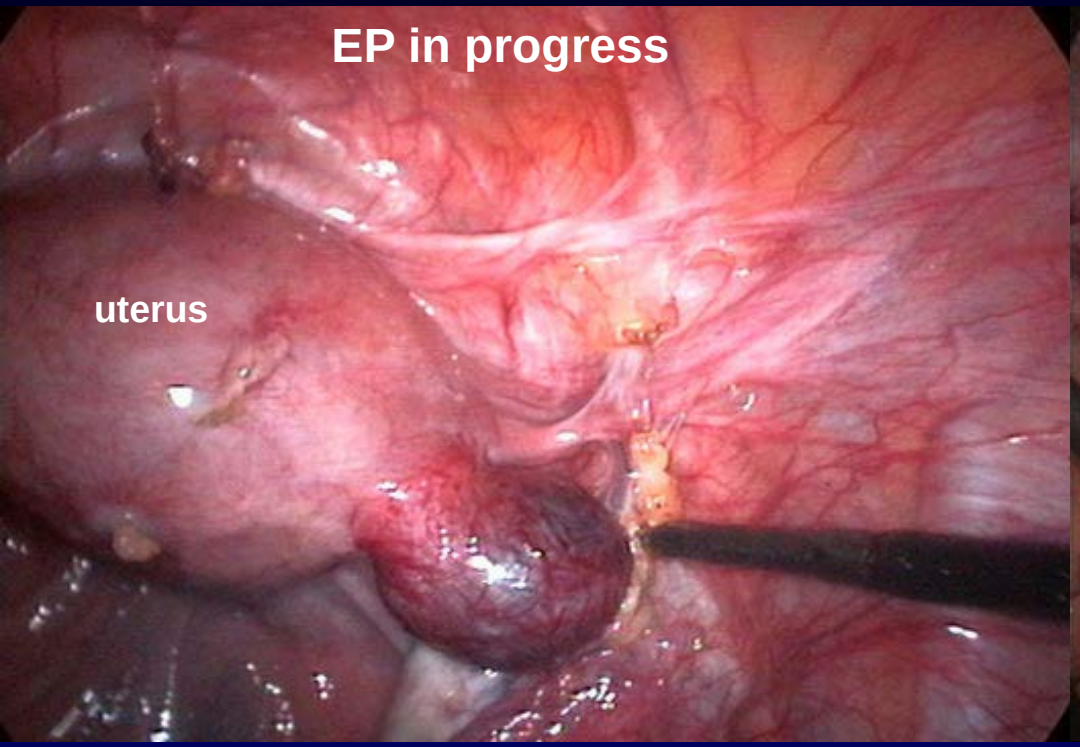
The vast majority of ectopic pregnancies implant in the Fallopian tube.

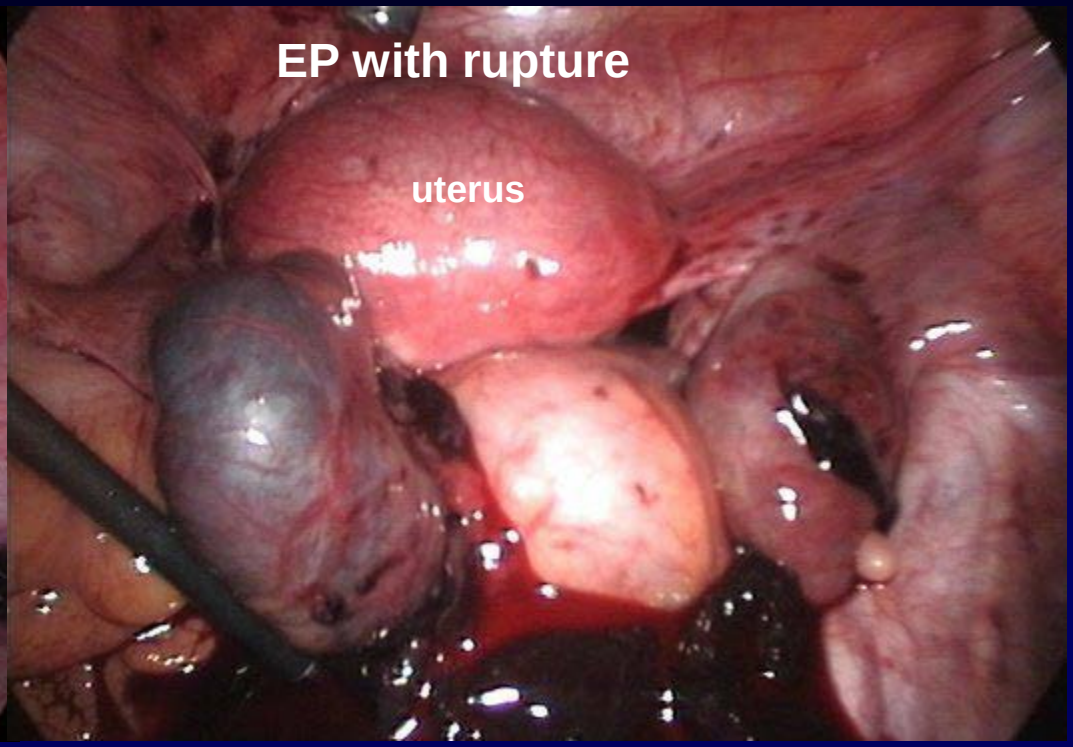
Pregnancies can grow in:

- the fimbrial end (5% of all ectopics)
- the ampullary section (80%)
- the isthmus (12%)
- the cornual and interstitial part of the tube (2%)

Clinical presentation of ectopic pregnancy occurs at a mean of 7.2 weeks after the last normal menstrual period, with a range of 5 to 8 weeks.

Ectopic Pregnancy





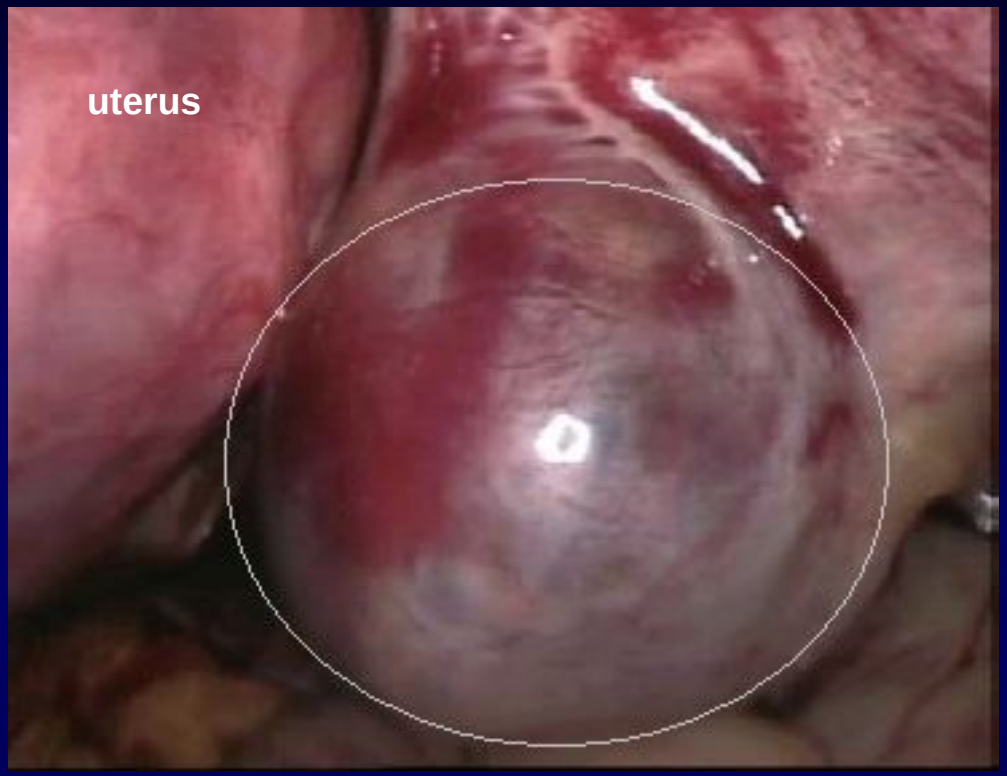
The classic signs and symptoms :

- abdominal pain
- the absence of menstrual periods (amenorrhea)
- vaginal bleeding or intermittent bleeding (spotting)

Diagnosis:

- US and transvaginal ultrasound
- blood β-human chorionic gonadotropin (β-hCG)
- Culdocentesis (fluid is retrieved from the space separating the vagina and rectum) – blood!
- Laparoscopy

Ectopic **Pregnancy**



Surgical treatment:

- incise the affected Fallopian and remove only the pregnancy (salpingostomy)
- remove the affected tube with the pregnancy (salpingectomy).

Laparoscopic Treatment of Tubal Pregnancy

Ovarian Torsion (adnexal torsion)

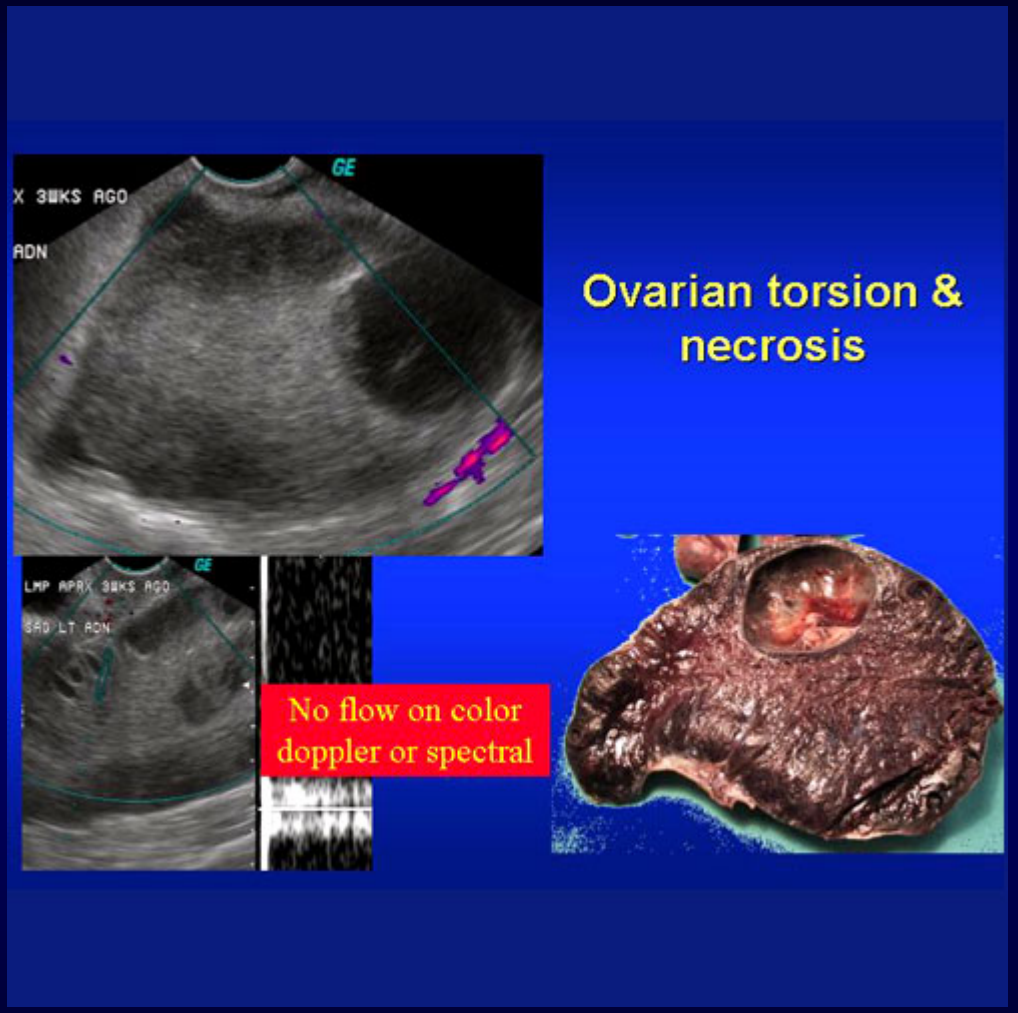
Ovarian torsion is the twisting of the ovary due to the influence of another condition or disease.

This results in extreme lower abdominal pain.

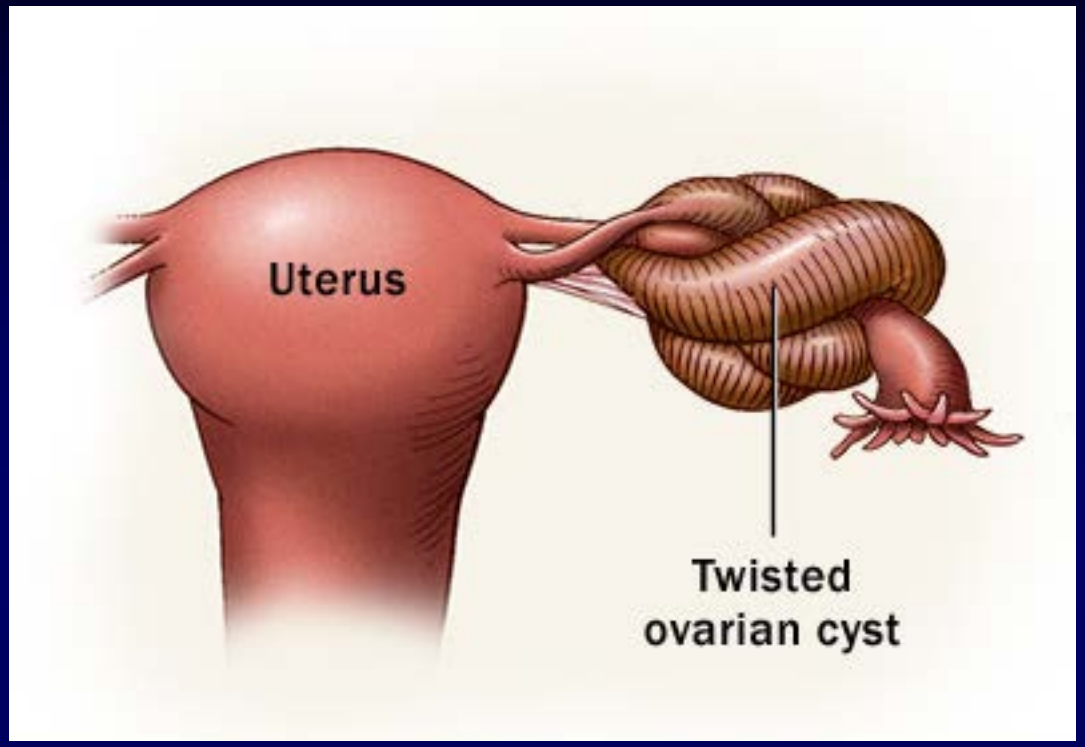
Approximately 70-75% of cases occur in women under 30 years old. Approximately 60% of cases of torsion occur on the right side.

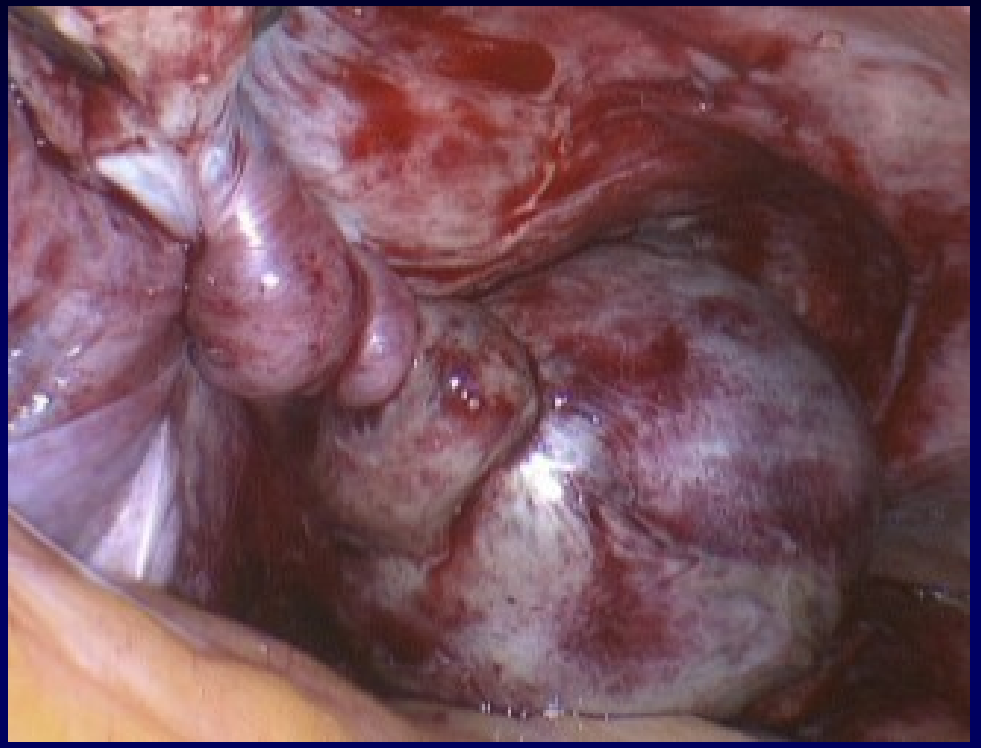
- **abnormalities of the fallopian tube such as extremely longer-than-normal tubes or a missing mesosalpinx**

- **ovarian cysts or fibromas, tumor of the ovary or tubes**



Ovarian Torsion (adnexal torsion)





- Salpingo-oophorectomy

Case presentation

A 25 year-old female patient was admitted to the ED after 6 hours after onset, complaining:

Right iliac fossa pain, nausea.

History of the disease: sudden pain onset in the right iliac fossa, later nausea appeared. Uterine pregnancy 22-23 weeks.

Upon physical examination:

Tongue moist, Abdomen – symmetrically enlarged (pregnancy), participates in respiration.

Abdominal palpation reveals right lower quadrant tenderness, RLQ rebound tenderness. Measured fever in the ED 37.5C

Case presentation

What is the diagnosis?

How do you confirm it?

Case presentation

ECG: sinus rhythm, heart rate 100 b.p.m.

Blood test: Hb 126 g/L; Er $4.0X10^{12}$/L; WBC $13.4X10^{9}$/L

USG: Uterine pregnancy 22-23 weeks. Appendix not visible. Free fluid in the RLQ absent.

The Alvarado Scoring System

Features	Score	Present case
• Migratory right lower quadrant pain	1	-
• Anorexia	1	1
• Nausea and vomiting	1	1
• Right lower quadrant tenderness	2	2
• Right lower quadrant rebound tenderness	1	1
• Elevated temperature ≥ 37.3°C	1	1
• Leukocytosis ≥ $10.0X10^{9}$/L	2	2
• Neutrophilic shift to left N 75%	1	-
Total	**10**	**8**

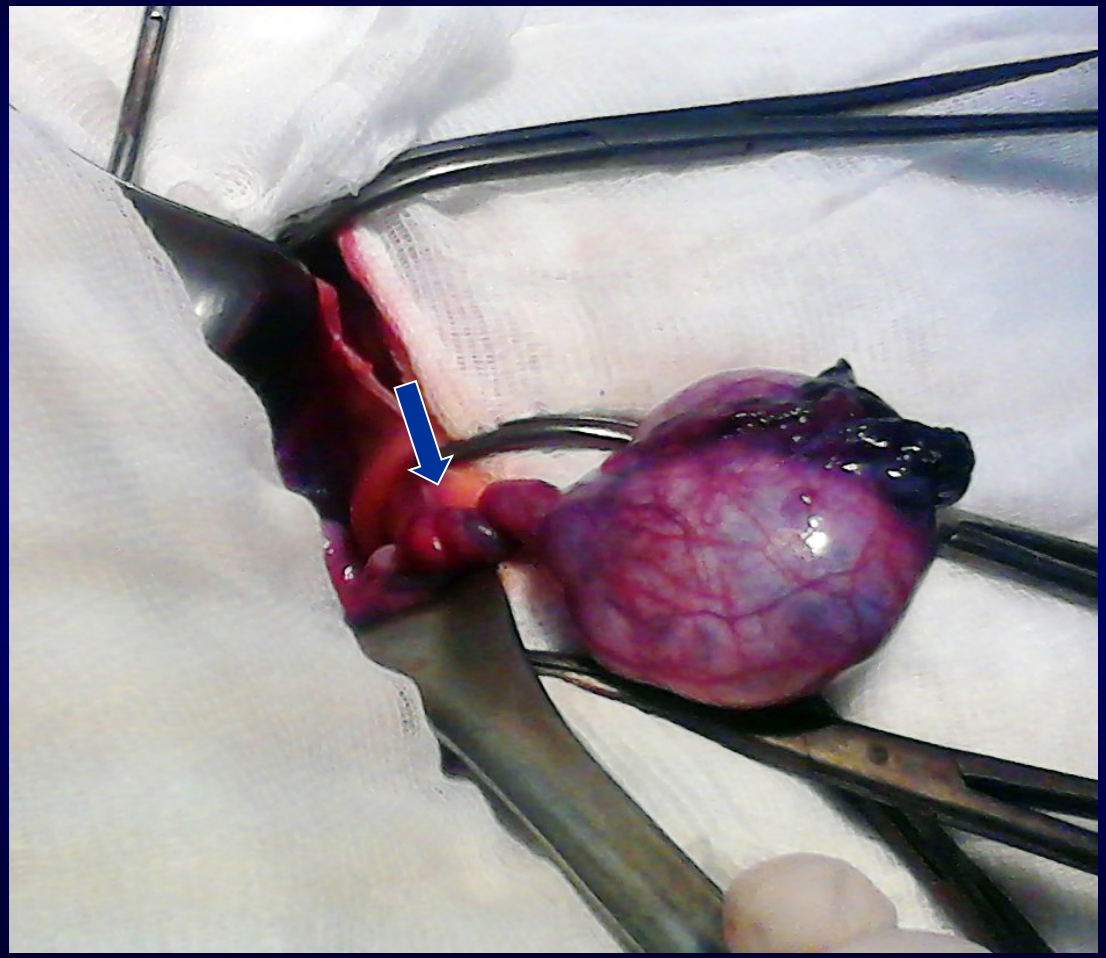
Case presentation

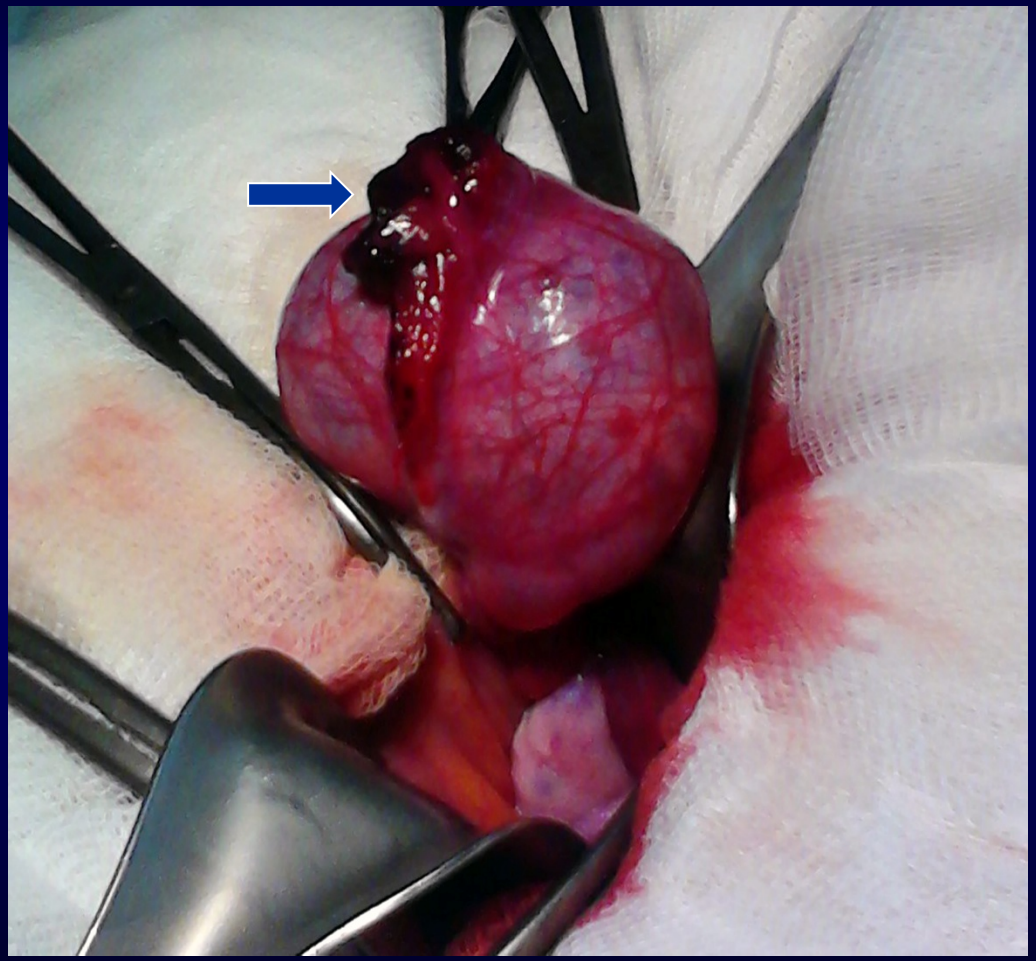
What is the diagnosis?

Any additional investigations?

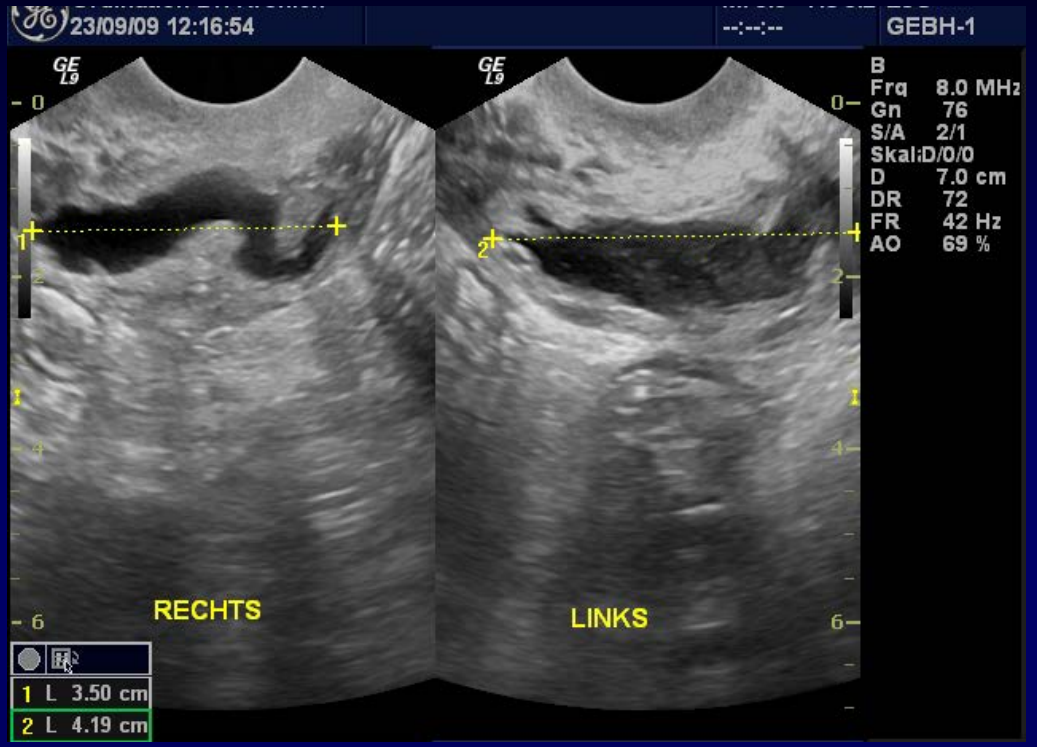
What is the treatment?

Isolated fallopian tube torsion





Acute Salpingitis



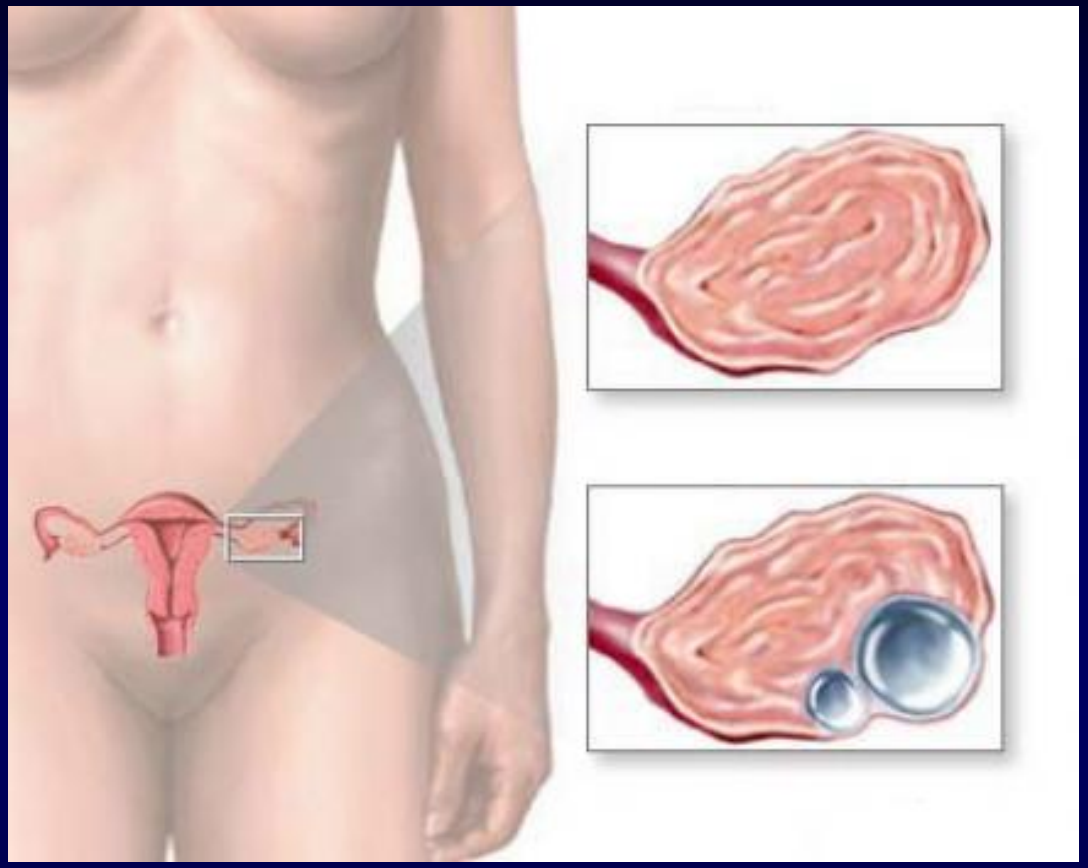
- Abnormal smell and colour of vaginal discharge.
- Pain during ovulation
- Pain during sexual intercourse
- Pain coming and going in periods
- Abdominal pain
- Lower back pain
- Fever (>38°C)
- Nausea
- Vomiting

The bacteria most associated with salpingitis are

- *Neisseria gonorrhoeae*
- *Chlamydia trachomatis*
- *Mycoplasma*

On pelvic examination, motion of the uterus causes pain (Promptov sign)

Ovarian apoplexy



Ovarian apoplexy is a sudden rupture in the ovary:

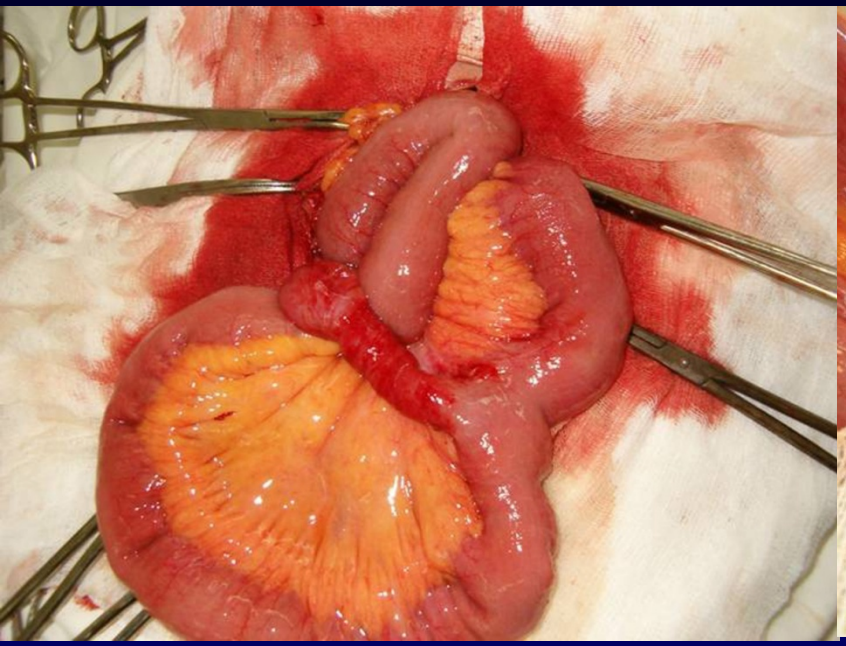
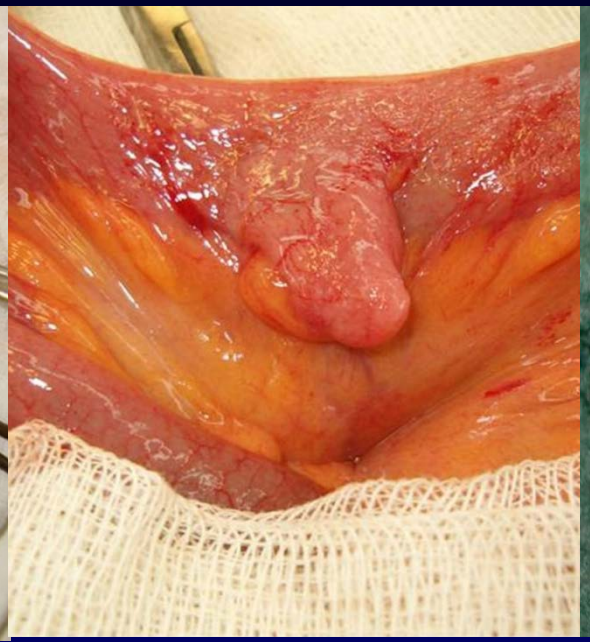
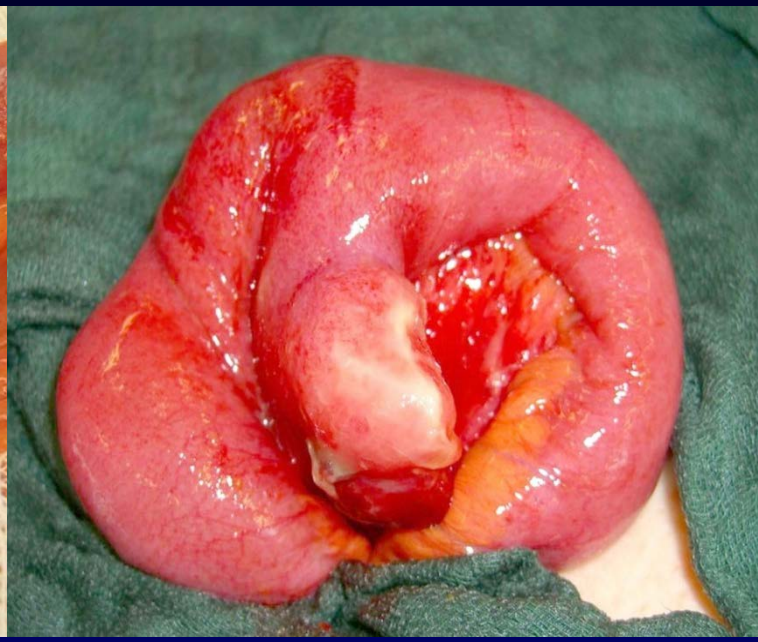
- Ovarian cyst
- Dystrophic and sclerotic changes in ovarian tissue
- Polycystic ovary syndrome

Clinical symptoms:
Pain syndrome, which occurs primarily in the mid-cycle or after a minor delay menstruation Pain is most often localized in the lower abdomen. Sometimes the pain may radiate to the rectum, in the lumbar or the umbilical region.

Hemorrhage in the ovarian tissue and/or intraperitoneal bleeding!

- reduced pressure
- increase heart rate
- syncope

Meckel’s diverticulum

Meckel’s diverticulum (MD) is the most common congenital abnormality of the gastrointestinal tract, occurring in 1% to 2% of the population. It is usually asymptomatic and *becomes evident when complicated*. MD is usually found within 100 cm of the ileocecal valve (>20cm).

- inflammation
- ischemia and infarction
- gastrointestinal bleeding, obstruction

APPENDICEAL MASS

Occasionally in untreated acute appendicitis, the inflammatory process is limited by nearby organs (omentum and small bowel) which adhere around the appendix.

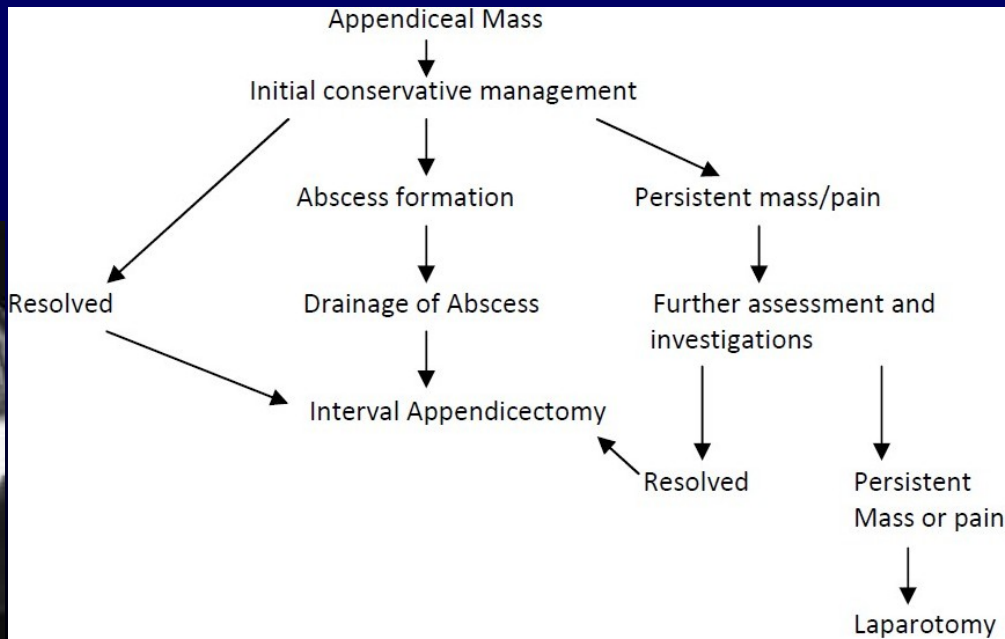
This process is named "*APPENDICEAL MASS*" or *"APPENDICEAL INFILTRATE".*

The appendiceal inflammatory mass appears after 3-5 days from the onset of disease.

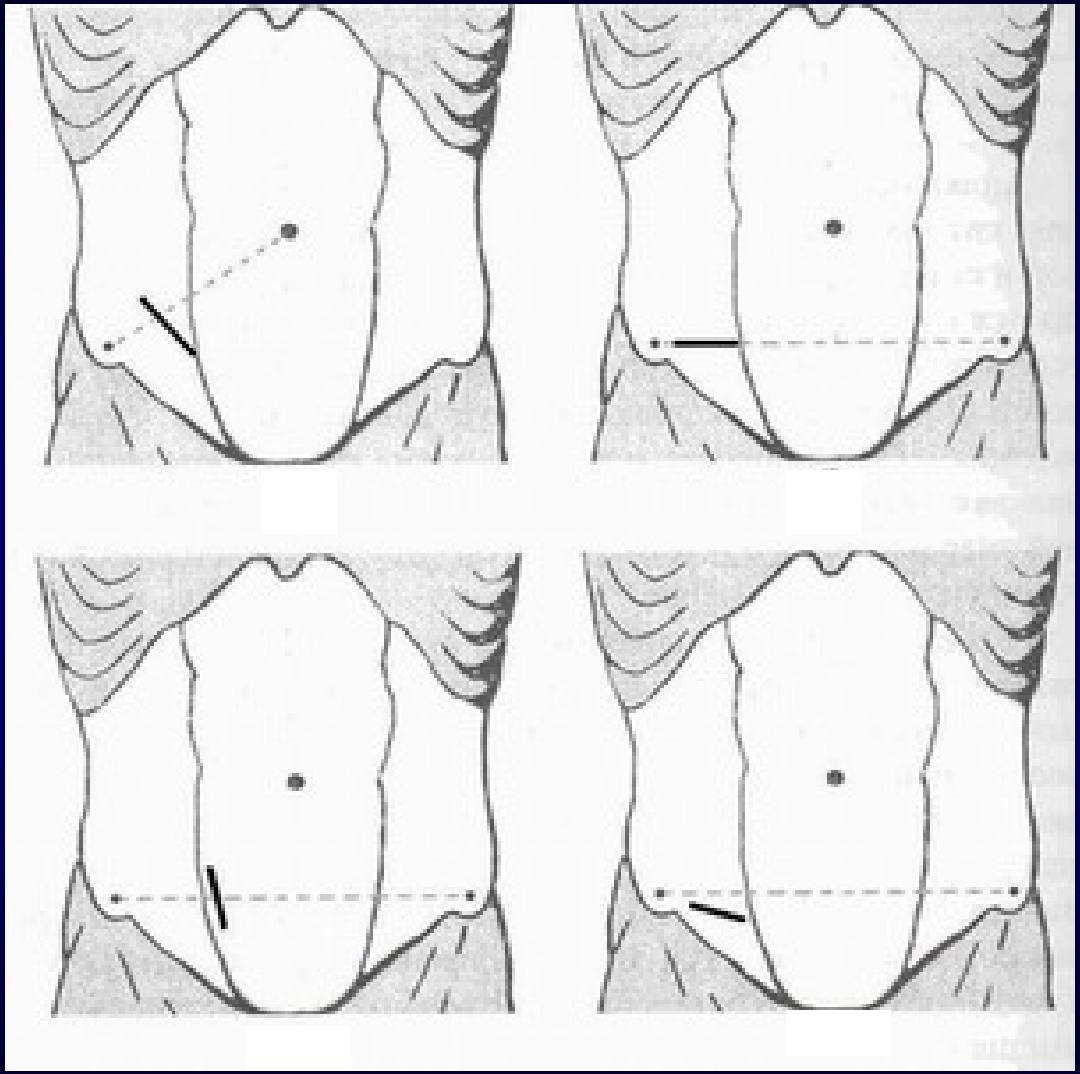
The patients complain dull pain in the right lower abdominal quadrant, subfebrile temperature.

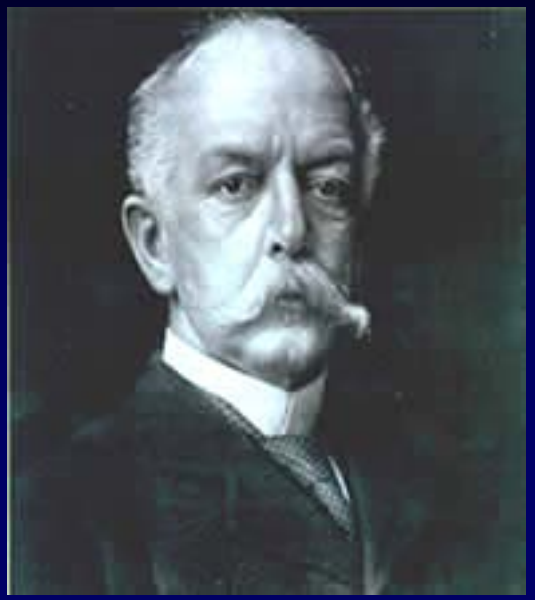
There are **3 stages** of "appendiceal mass" evolution:

- stage of infiltration;
- stage of abscess formation;
- stage of fistula formation.



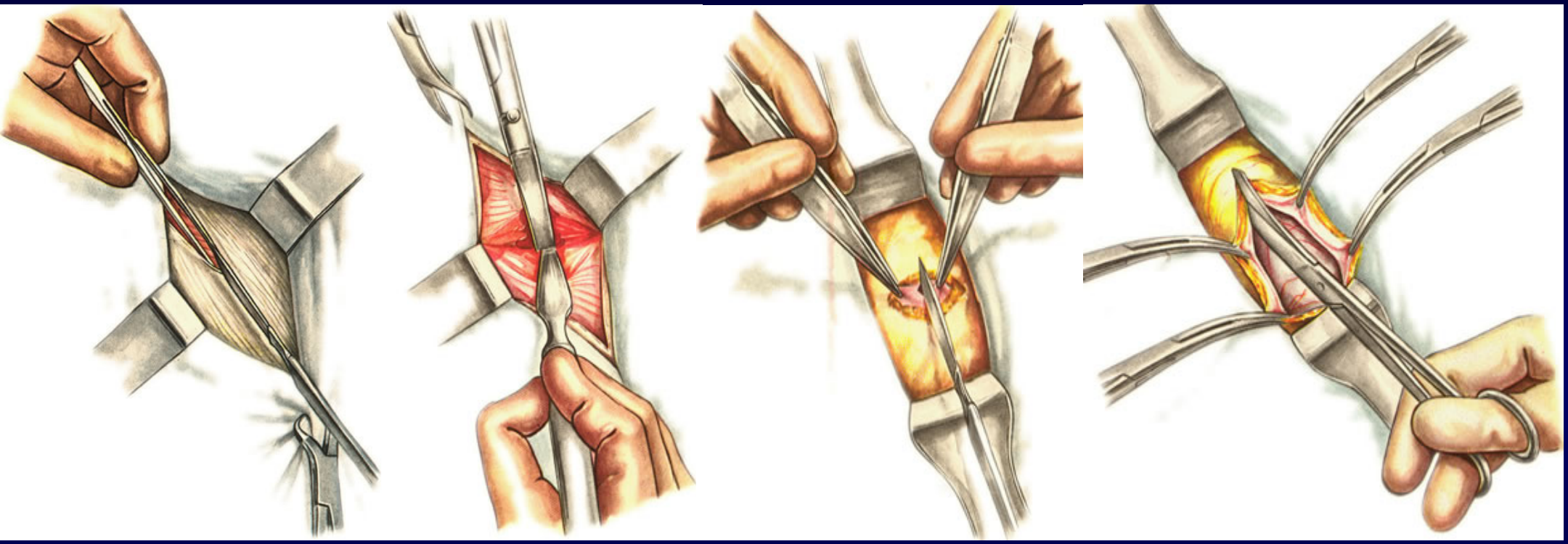
Surgical Treatment (Appendectomy)



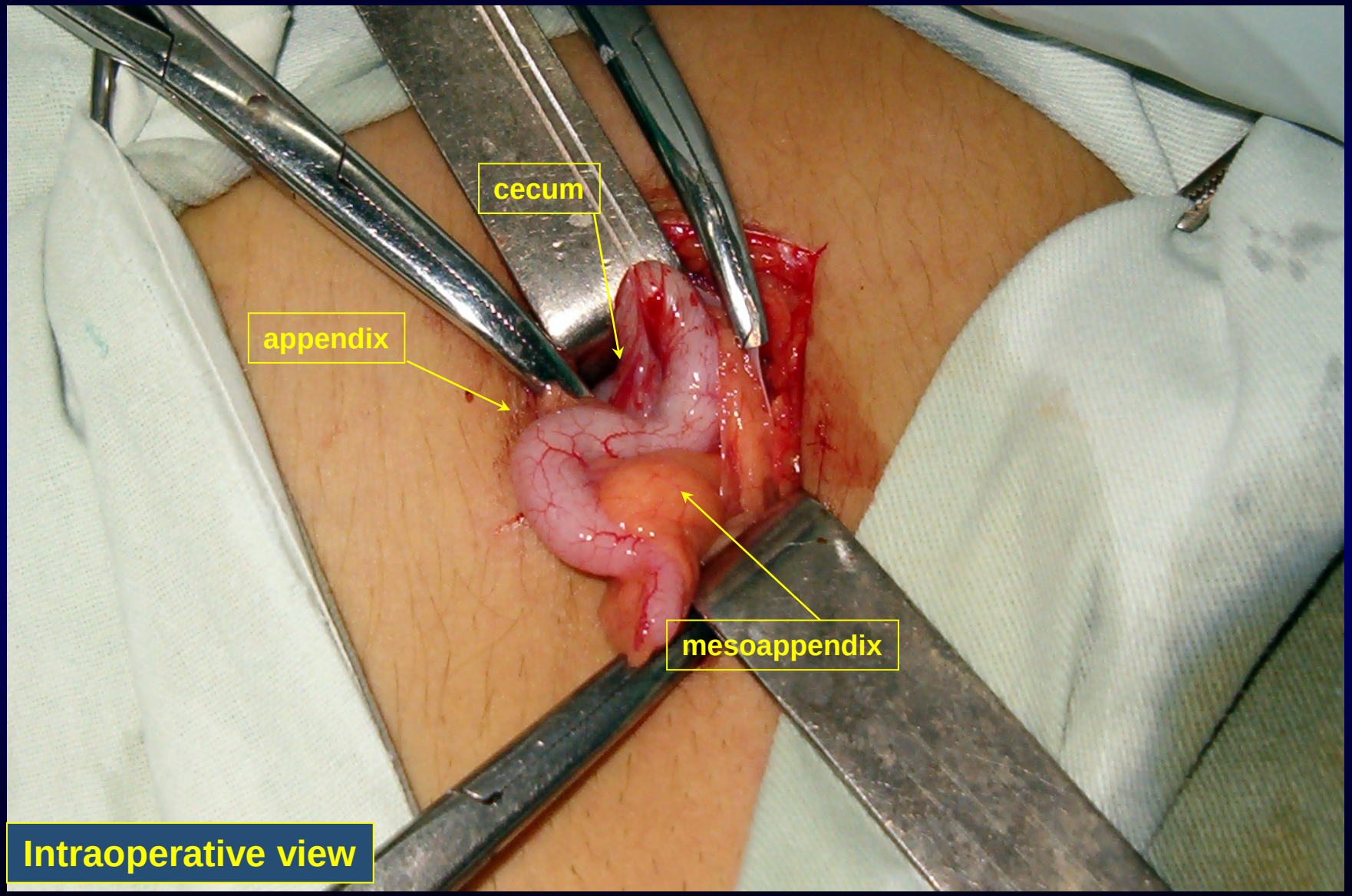


Charles McBurney

Surgical Treatment (Appendectomy)

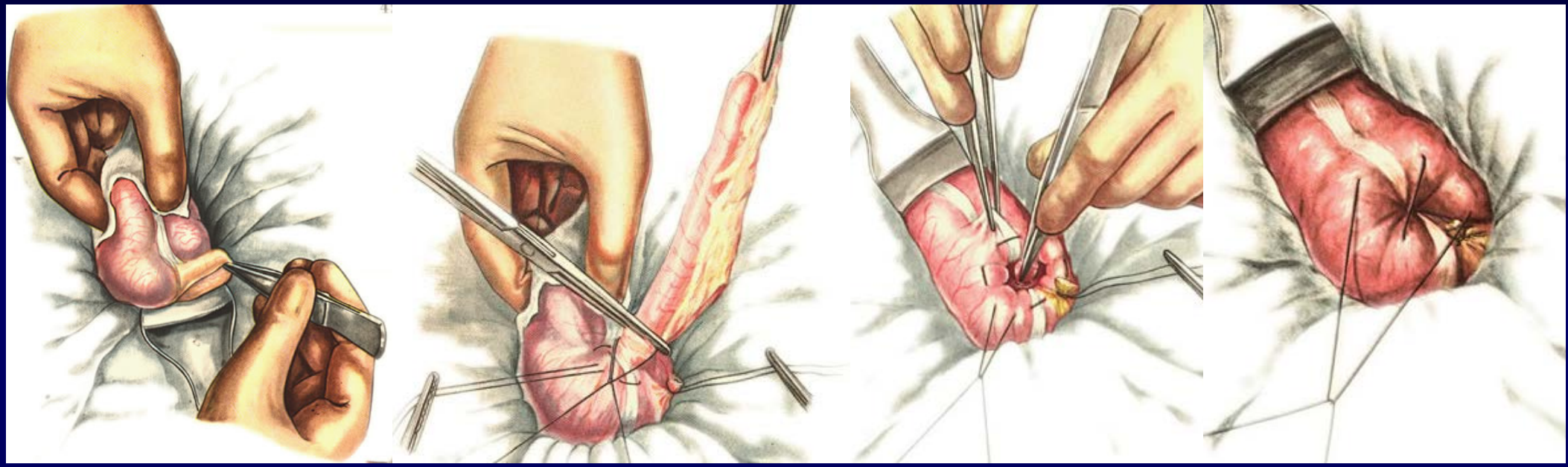


Surgical Treatment



Intraoperative view

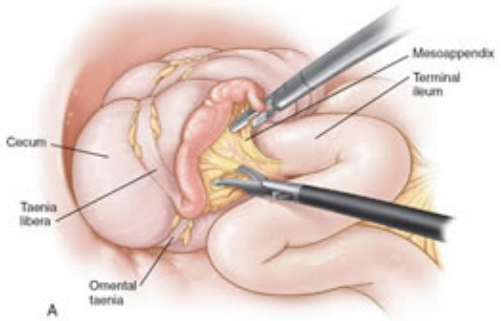
Appendectomy

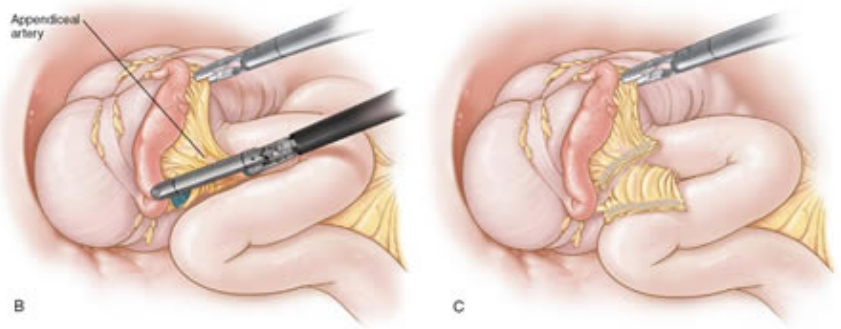


- Mesoappendix is ligated
- Ligation of the appendiceal base with absorbable suture
- Purse-string suture is placed on the cecum around the appendiceal base

Appendectomy

Laparoscopic Appendectomy





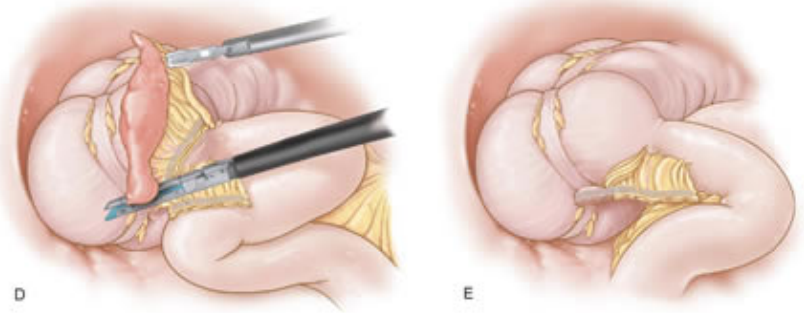
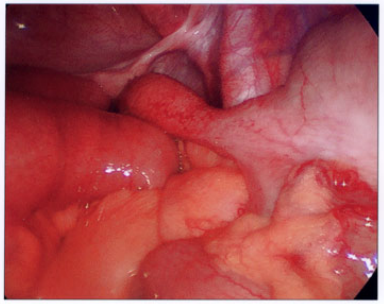
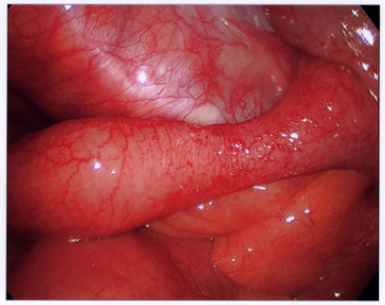


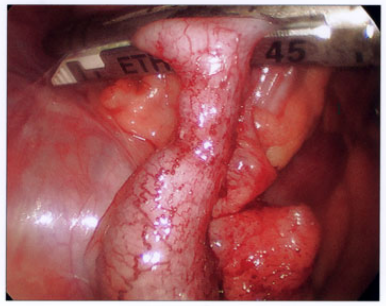
FIGURE 19-4 A, A curved dissector is used to create a window in the mesoappendix and isolate the appendiceal artery. B, A laparoscopic linear stapler (vascular load) is placed across the mesoappendix. C, Successful division of the mesoappendix. D, Laparoscopic linear stapler placed across the base of the appendix. E, Completed appendectomy. Intact staple lines are identified on the base of the cecum and mesoappendix.



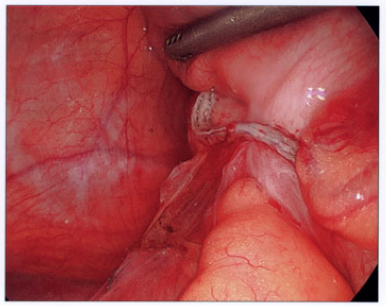
1) Finding the appendix



2) Appendix front and center



3) Clipping off the appendix

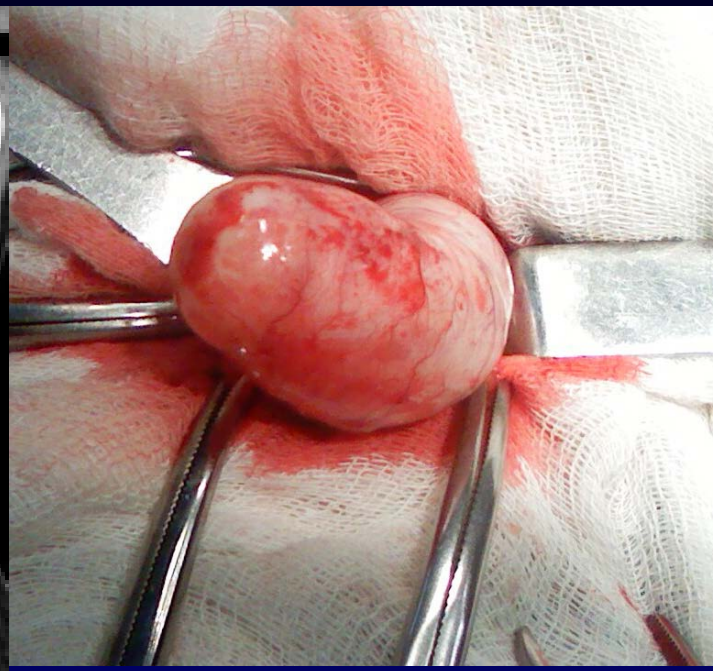


4) Appendix no more - staples in place

5) Tada! Yummy. (bleh)

Laparoscopic Appendectomy

Mucocele of the Appendix



Rokitansky's first report of an appendiceal mucocele in 1842.

Based on data from pathologic specimens, the incidence of AM is approximately 0.07% to 0.3%.

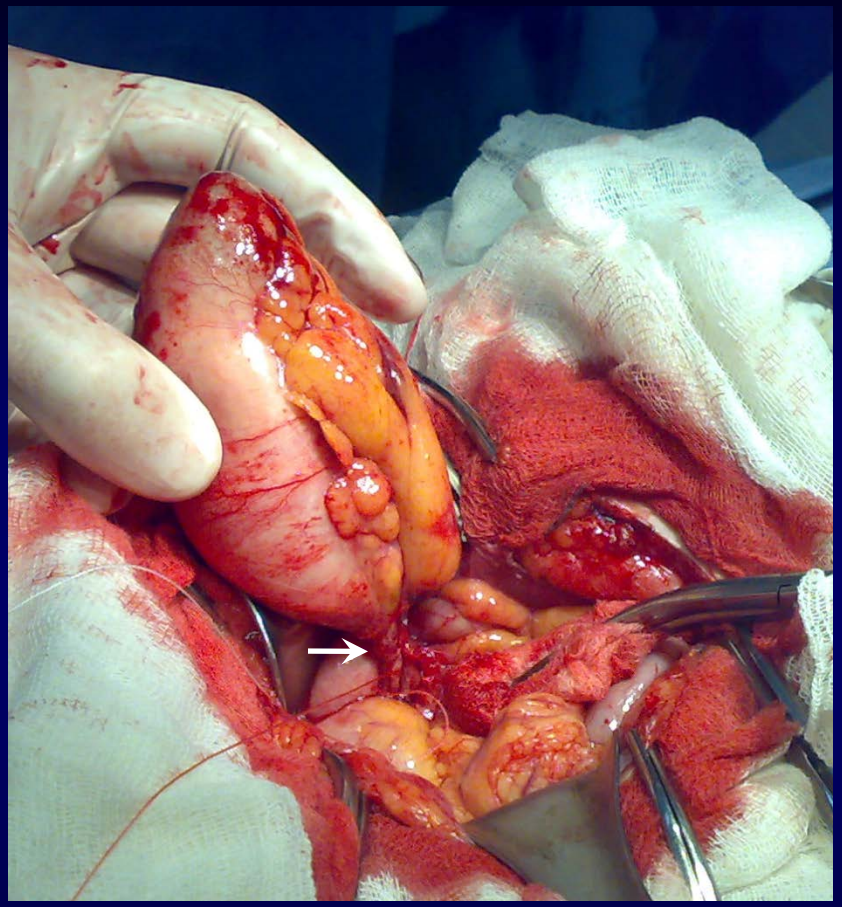
- retention cyst of the appendix (simple mucocele)
- mucosal hyperplasia of the appendix
- cystadenoma of the appendix
- cystadenocarcinomas

— appendectomy

right hemicolectomy

PMP (!)

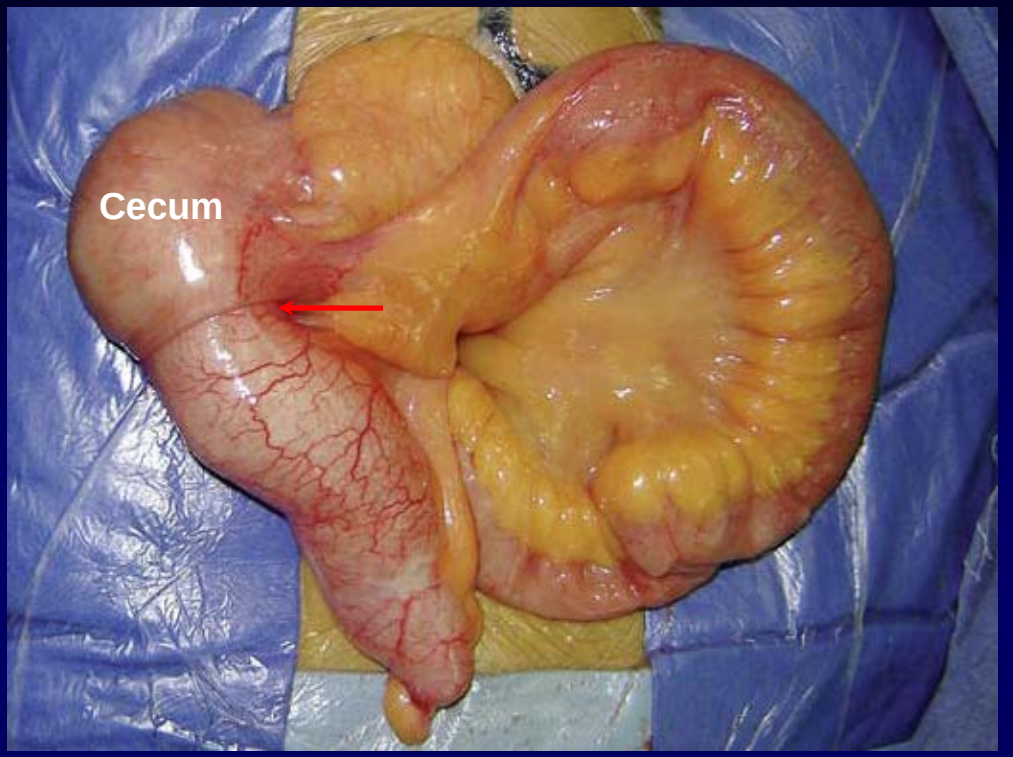
Vermiform Appendix Torsion



Mishin I, Ghidirim G, Zastavnitsky G, Popa C. Torsion of an appendiceal mucinous cystadenoma. Report of a case and review of literature. Ann Ital Chir. 2012;83(1):75-8.

Appendiceal Intussusception

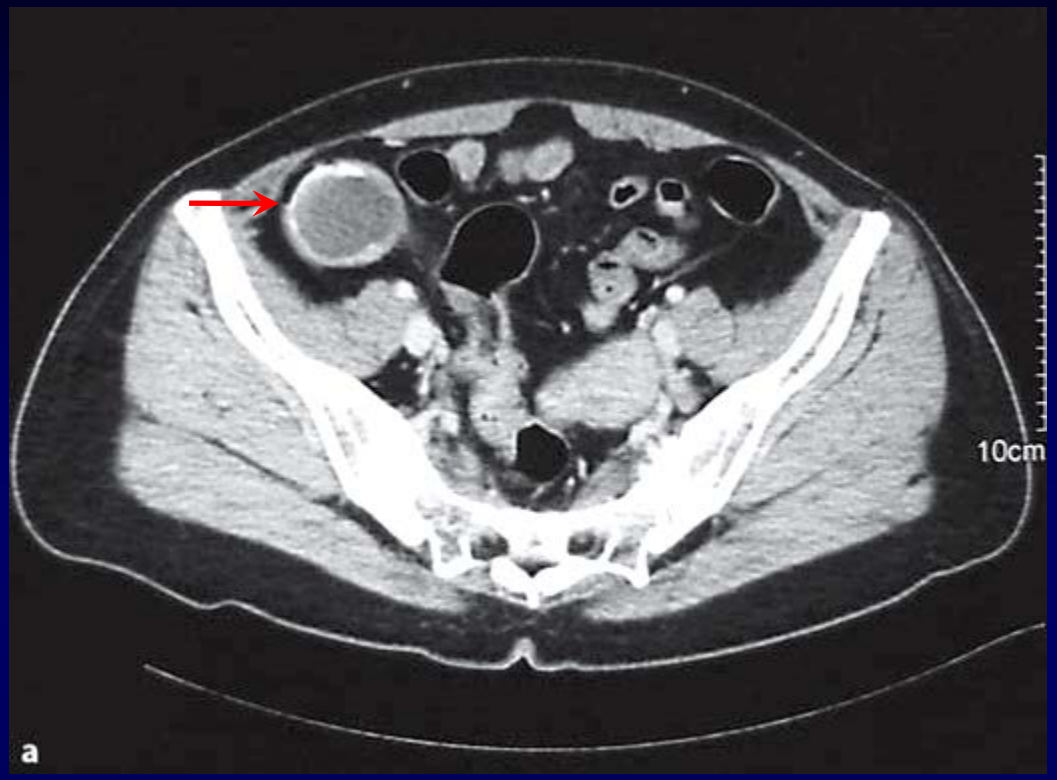
Intra-operative view of an appendico-appendicular intussusception

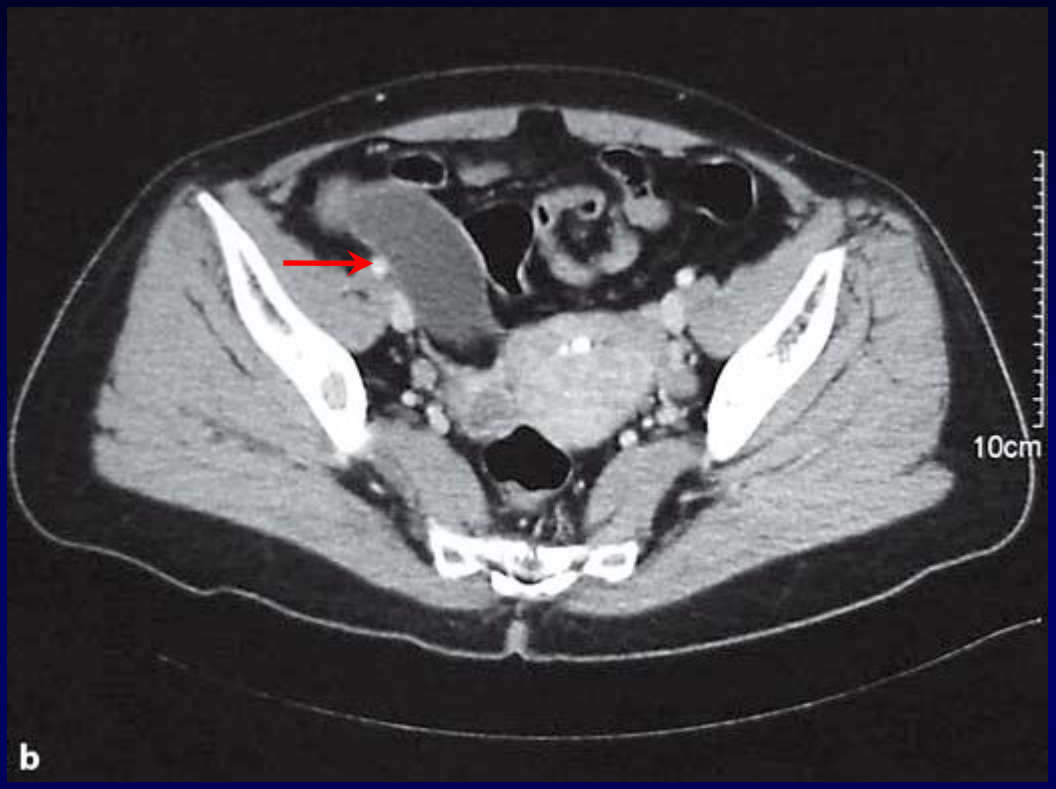


Intraoperative finding of a giant appendiceal mucocele with partial intussusception into the cecum

I	Tip of the appendix invaginates into the proximal lumen
II	Distal appendix invaginates into the lumen of the proximal appendix
III	Proximal appendix invaginates into the distal appendix
IV	Complete intussusception of the appendix within the caecum

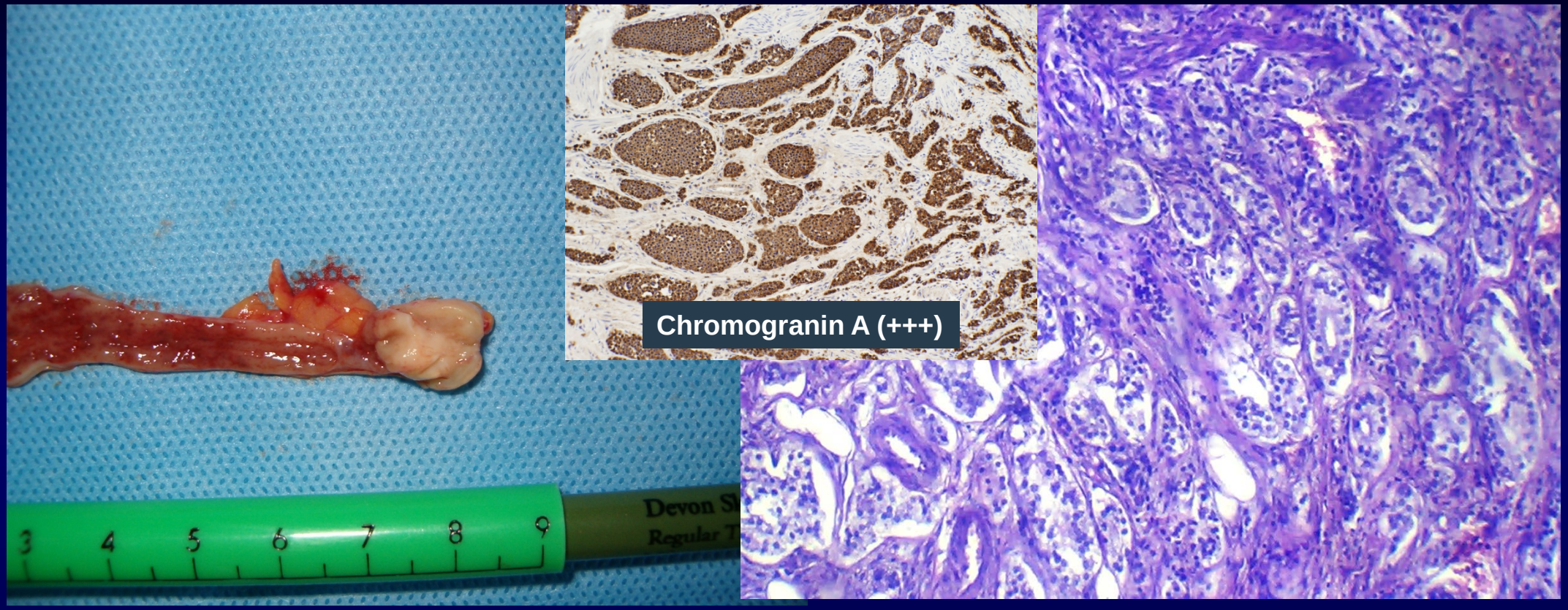
Appendiceal Intussusception





Computed tomography (CT) scan shows a 4-cm diameter, hypodense, well-encapsulated, cystic mass with the presence of wall calcification communicating with the cecum.

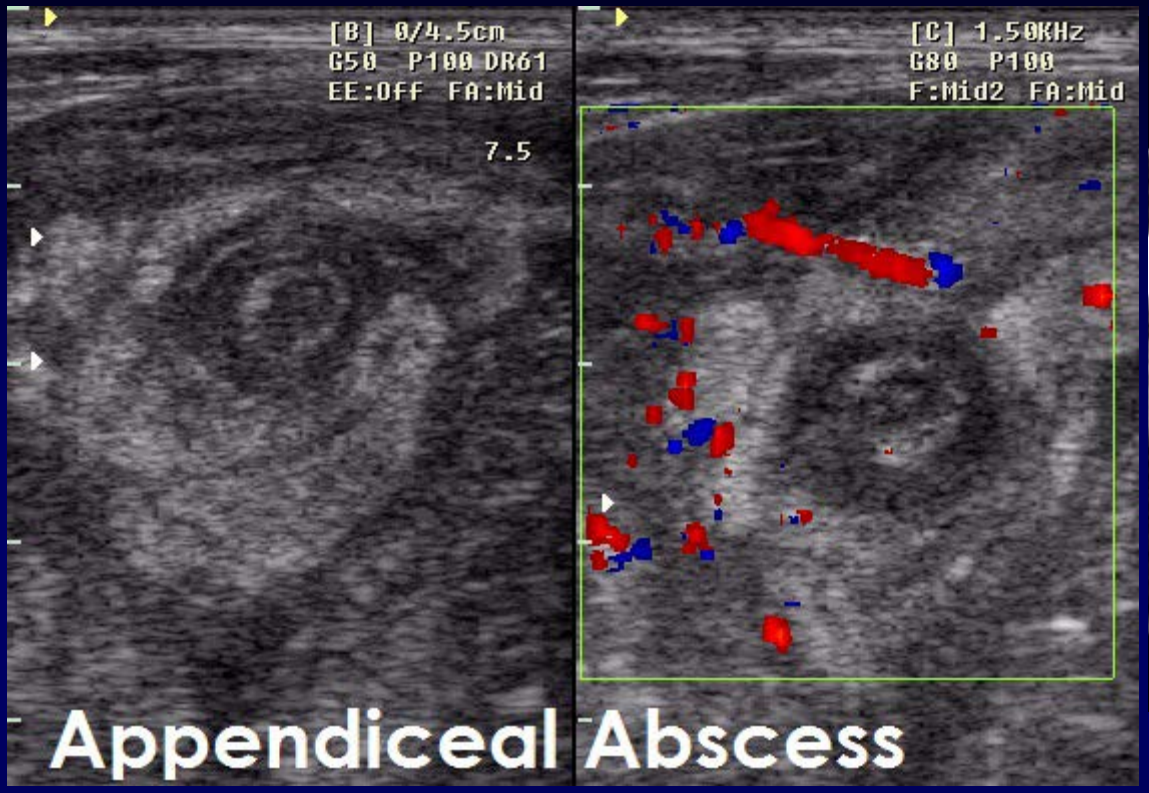
Carcinoid (neuroendocrine) Tumours of the Appendix

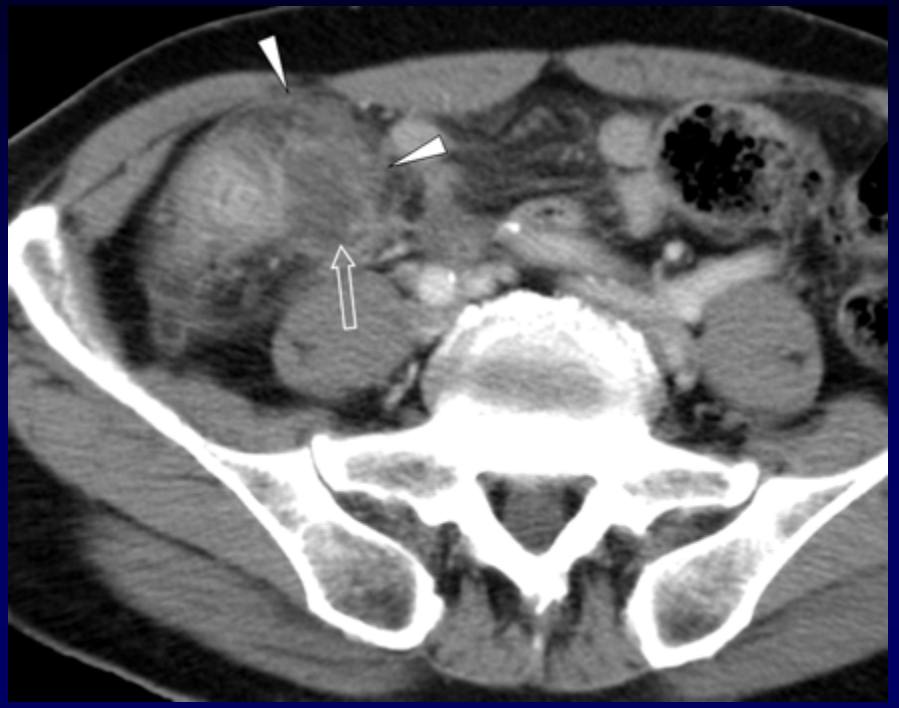


Appendiceal carcinoid tumours are found in 0.3 – 0.9% of appendicectomy

- **< 1 cm, distal part – appendectomy**
- **>2 cm and proximal part (↑metastatic spread) - right hemicolectomy**

Periappendiceal Abscess



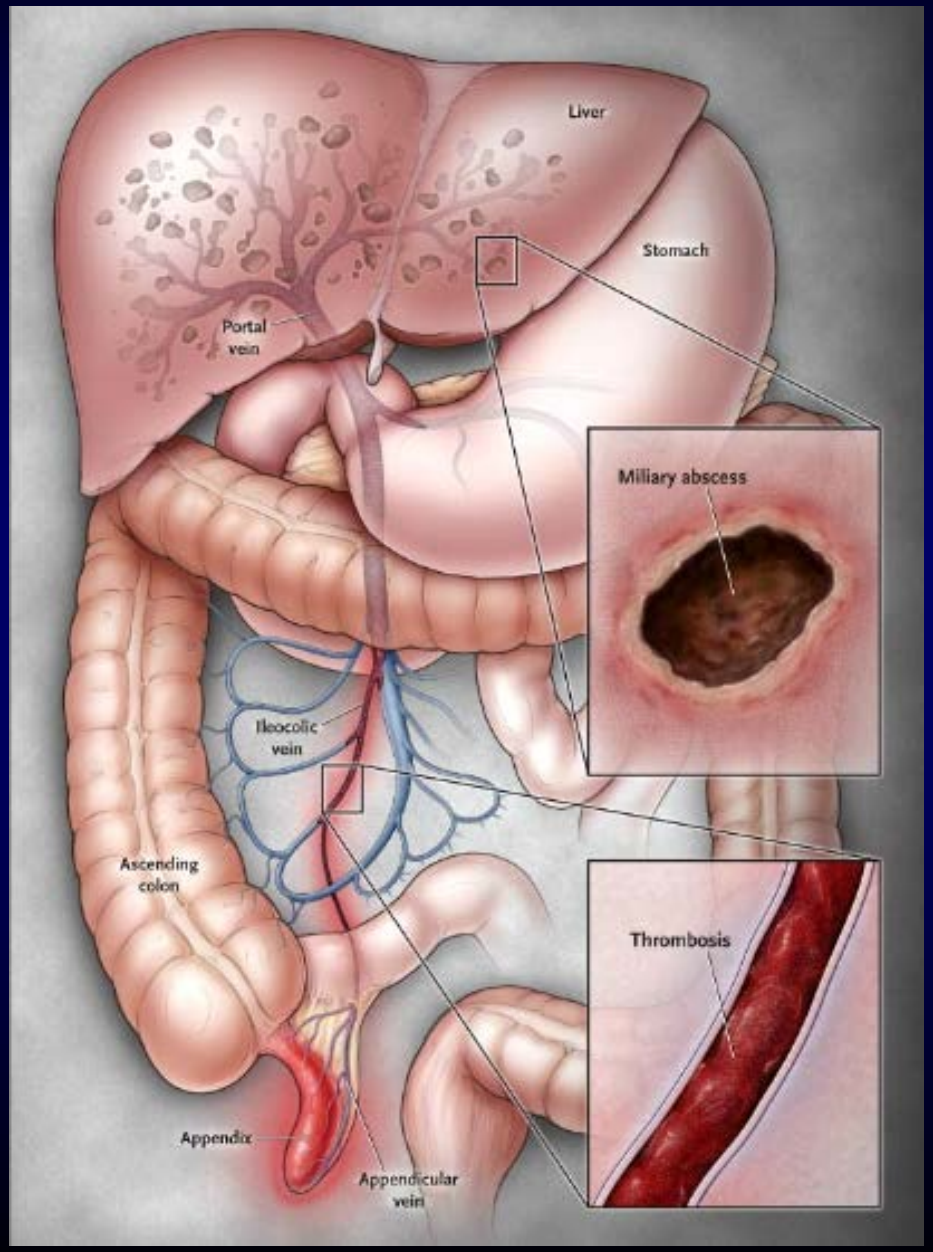


CT: periappendiceal abscess

- Pain increases
- High grade fever
- Hyperleukocytosis
- Severe pain
- Blumberg positive sign

→ Surgery – drainage of abscess *via* Pirogov aproach (extraperitoneal)

Pylephlebitis (septic thrombophlebitis of the portal vein)



The venous drainage from the appendiceal area and terminal ileum flows directly into the portal system.

The organisms most frequently cultured from the blood were *bacteroides* (especially *Bacteroides fragilis*) and *E. coli*.

This disease entity occurred in 0.4% of patients with acute appendicitis before 1950, but it has become very rare due to major advances in antibiotic therapy and surgical treatment.

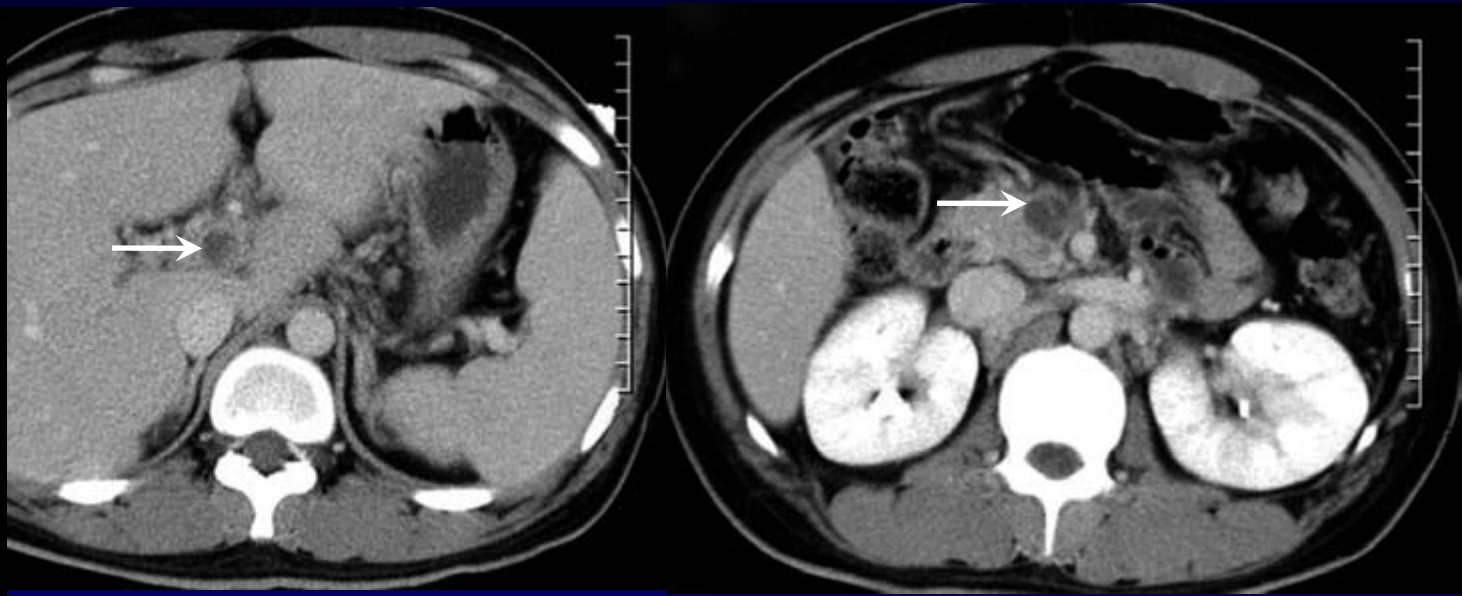
Pylephlebitis is considered a severe condition!

The reported mortality rate of pylephlebitis is 30%-50%, partly due to a delay in diagnosis from its atypical clinical findings and a low index of suspicion.

Diagnosis:

- Ultrasound scan with color flow Doppler
- CT scan

Pylephlebitis (septic thrombophlebitis of the portal vein)



CT scan showing total occlusion of the portal vein with a thrombus (arrow) extending to the superior mesenteric vein.

- air bubbles or thrombi of the portal venous system
- liver abscesses

The principles of treatment for pylephlebitis:

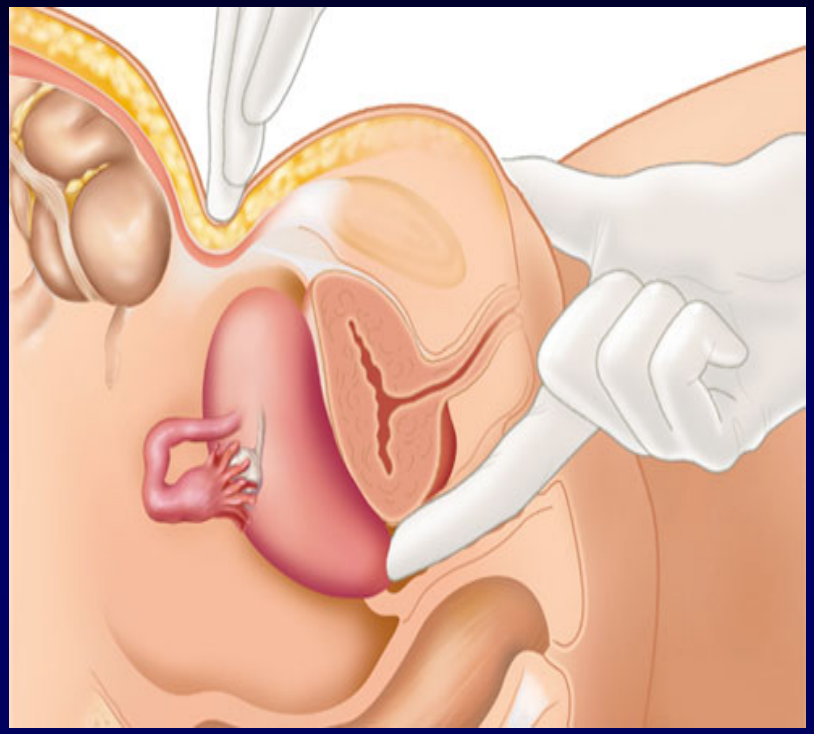
- to remove the source of infection and eradicate the toxic microorganisms using appropriate antibiotics
- systemic Ⅳ antibiotics (4 wk), hepatic abscess (at least 6 wk)
- anticoagulation therapy

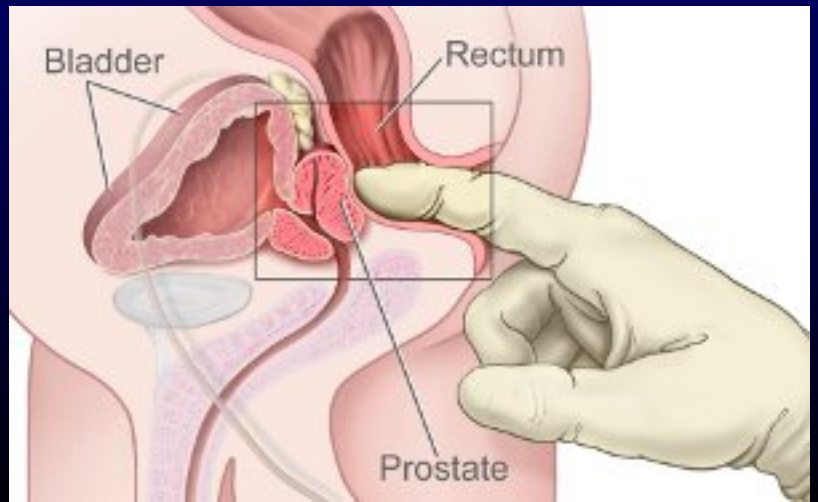
Postoperative Complications

- haematoma in the wound
- wound infection
- bleeding may rarely occur from the mesoappendix (appendicular artery)
- faecal fistula (if the method used to secure the appendix stump is insecure)
- incisional hernia through an appendicectomy incision (is also uncommon and usually occurs after a superficial wound complication)

- Mortality rate due acute appendicitis is 0.1-0.3%

Pelvic Abscess

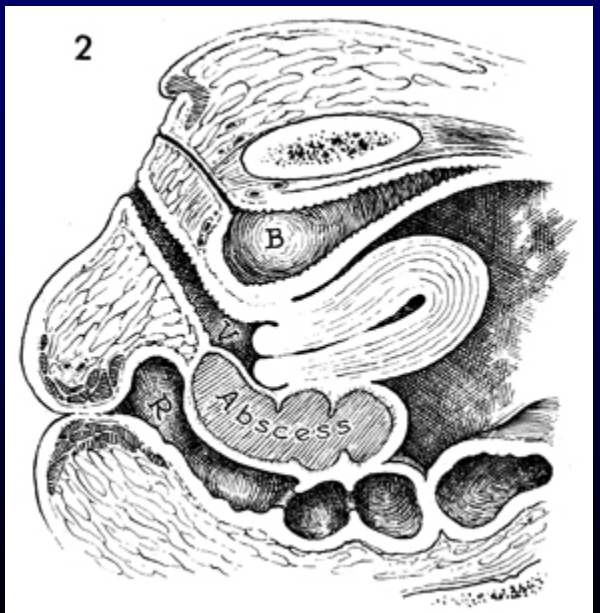




A pelvic abscess is a collection of pus in the pelvis or lower abdomen. An abscess usually appears <u>2-3 weeks</u> after the initial operation.

In males the abscess is located between the bladder and the rectum.

In females the abscess lies between the uterus and the posterior fornix of the vagina, and the rectum posteriorly.



Pelvic Abscess

Presentation

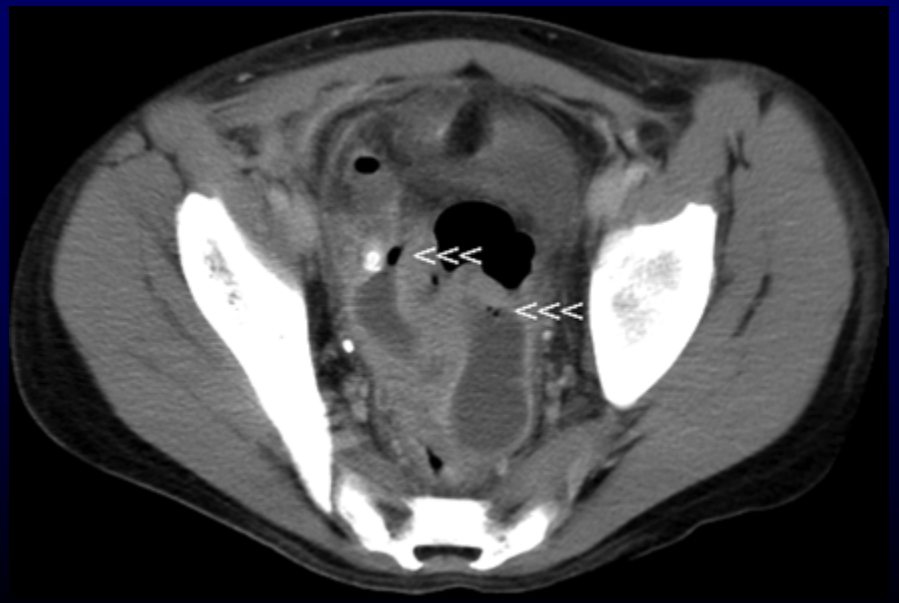
Systemic features of toxicity: fever, malaise, anorexia, nausea, vomiting.

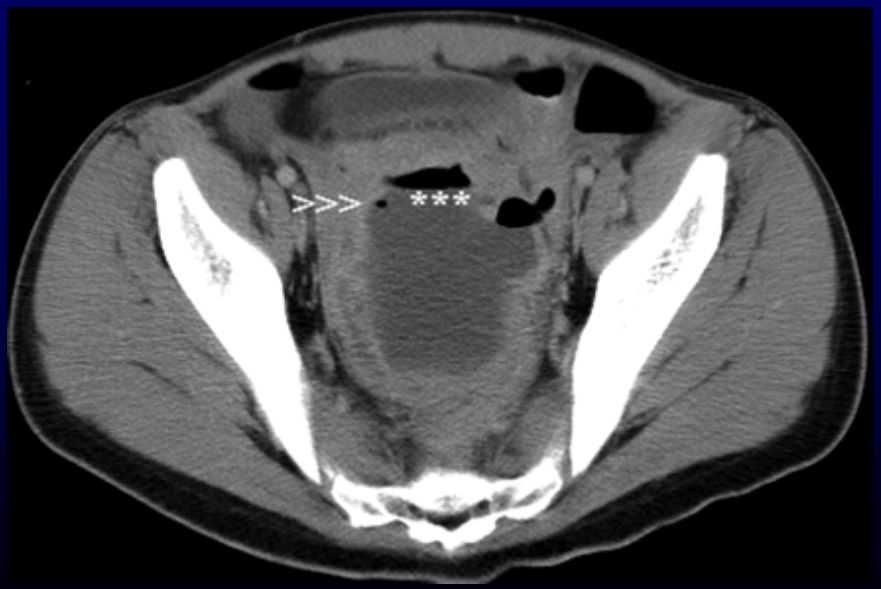
Local effects, e.g. pain, deep tenderness in one or both lower quadrants, diarrhoea, mucous discharge per rectum, urinary frequency, dysuria.

Rectal or vaginal examination: may reveal tenderness of the pelvic peritoneum and bulging of the anterior rectal wall.

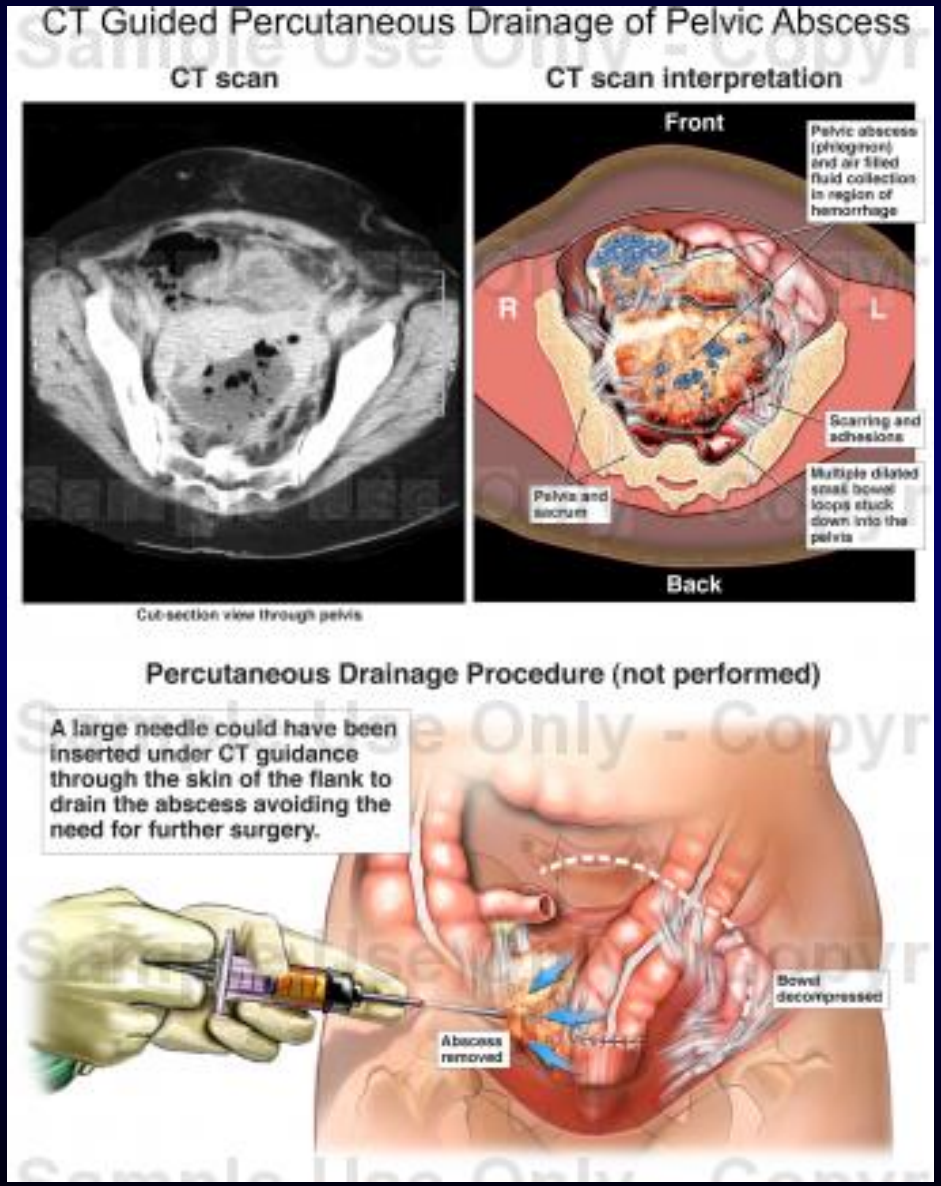
Leukocytosis.

CT/MRI scanning may be more effective at identifying the origin of the abscess



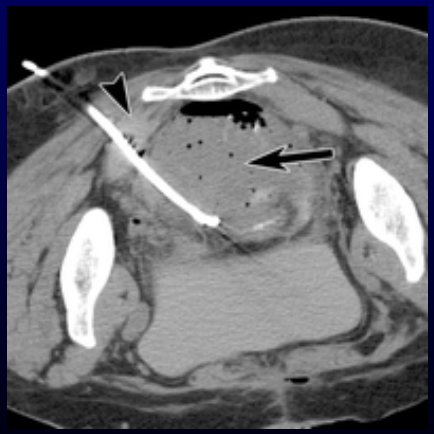


Pelvic Abscess

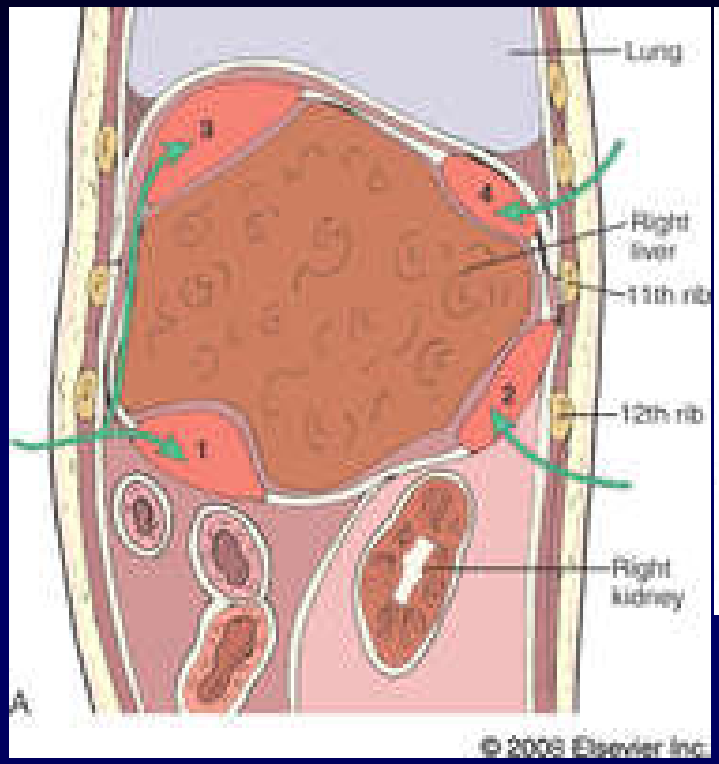


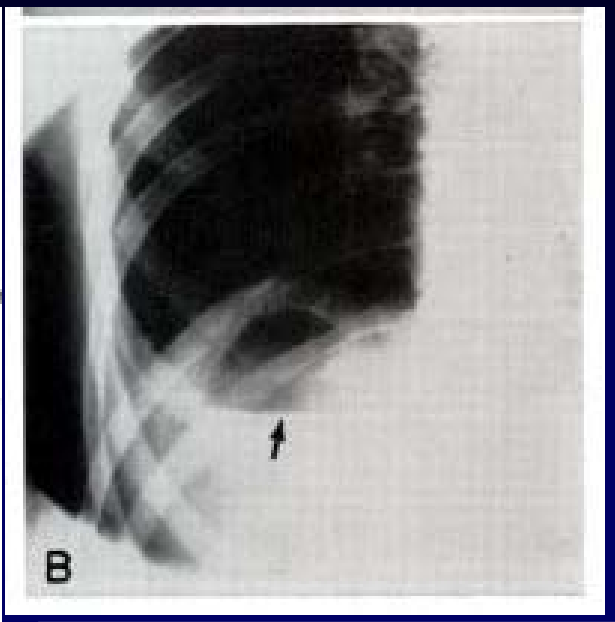
The abscess should be drained transrectally in men, and transvaginally in females

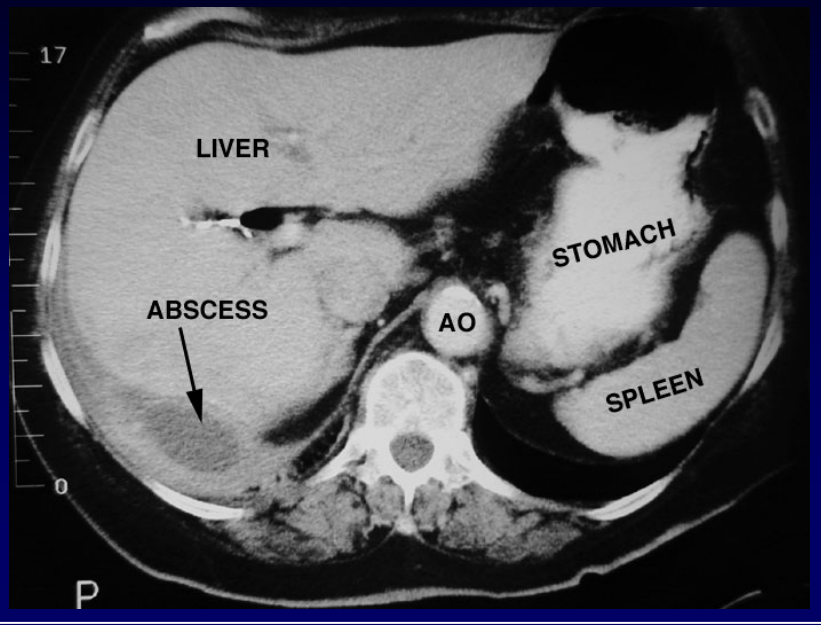
- Traditional approach
- Ultrasound-guided aspiration and drainage
- Percutaneous abscess drainage is performed using CT or sonographic guidance



Subdiaphragmatic absces







A subdiaphragmatic abscess is a localized accumulation of pus in the abdominal cavity just beneath the diaphragm.

Operative treatment for subdiaphragmatic abscess includes drainage using a needle and syringe (percutaneous drainage), or one of four different types of open surgical approaches (transpleural, extrapleural, extraperitoneal, transperitoneal)