



ევროპის უნივერსიტეტი
EUROPEAN UNIVERSITY

Appendix

Surgery 2

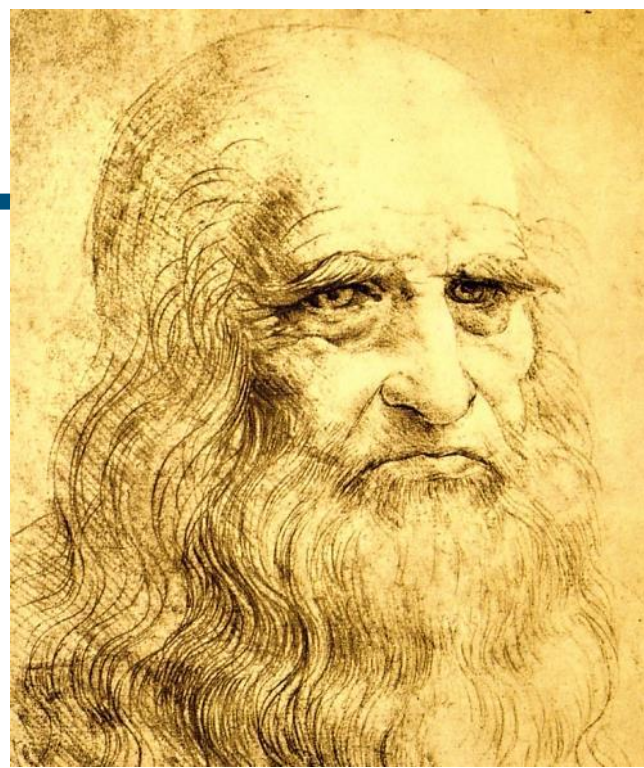
Dr. Badri Kobalava

badri.kobalava@eu.edu.ge

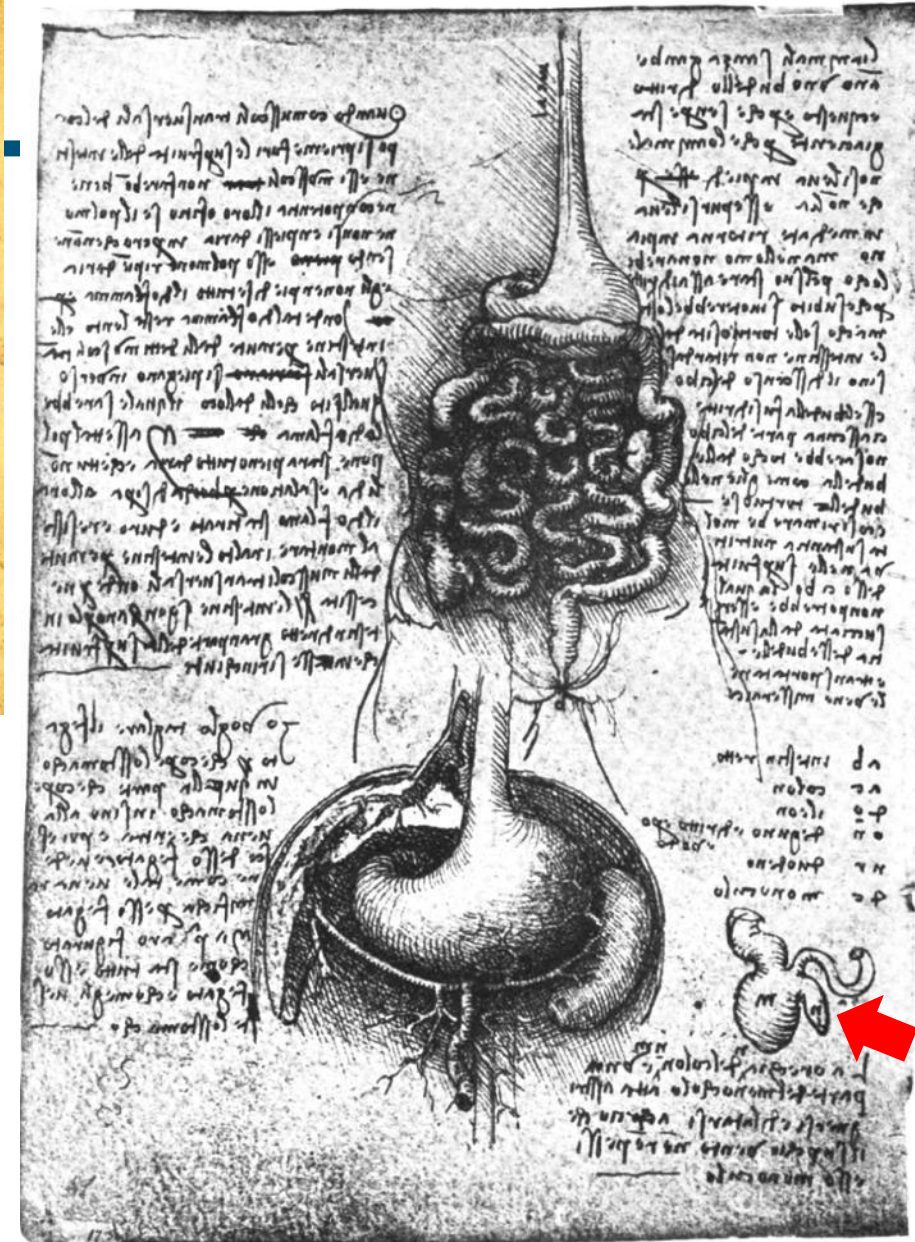
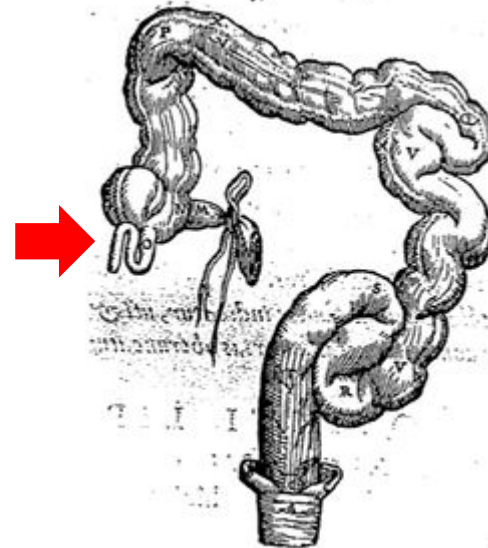
<https://sites.google.com/view/dr-badri-kobalava-eu>

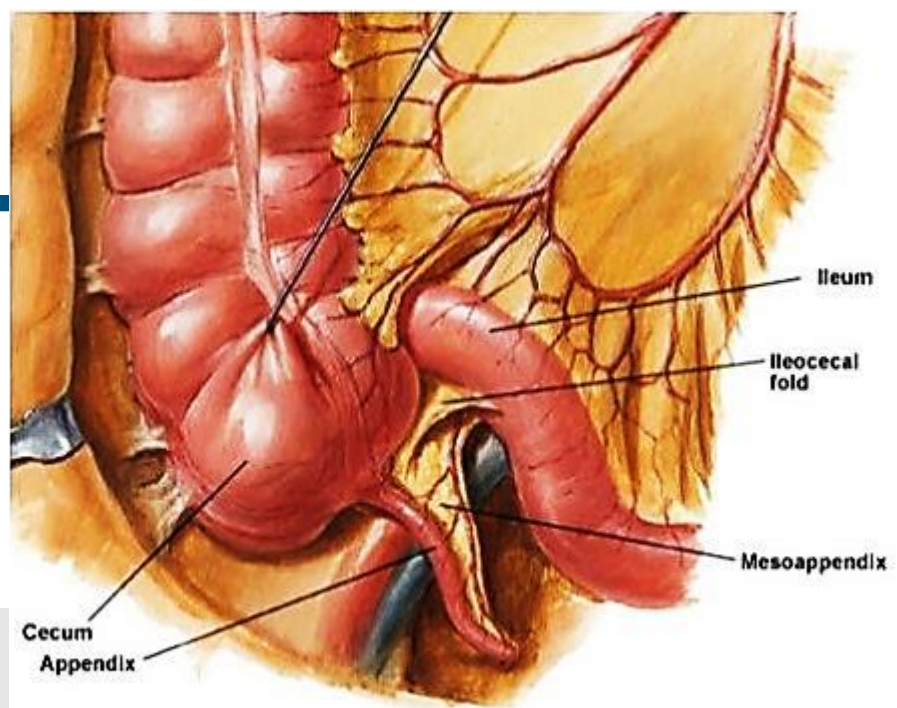


- 1492. Leonardo da Vinci depicted the appendix in his anatomical drawings
- Jean Fernel for first describing appendiceal disease in a paper published in 1544 at autopsy.
- The first known appendectomy was performed in 1736 by Claudius Amyand in London. He operated on an 11-year-old boy with a scrotal hernia and a fecal fistula
- In 1889, Charles McBurney published his landmark paper in the New York State Medical Journal describing the indications for early laparotomy



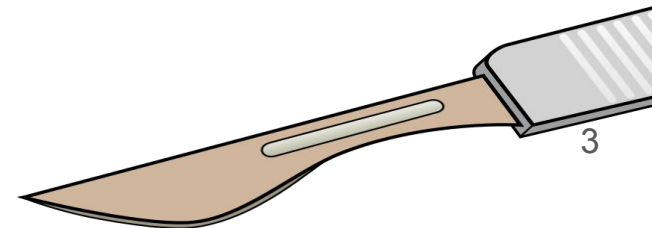
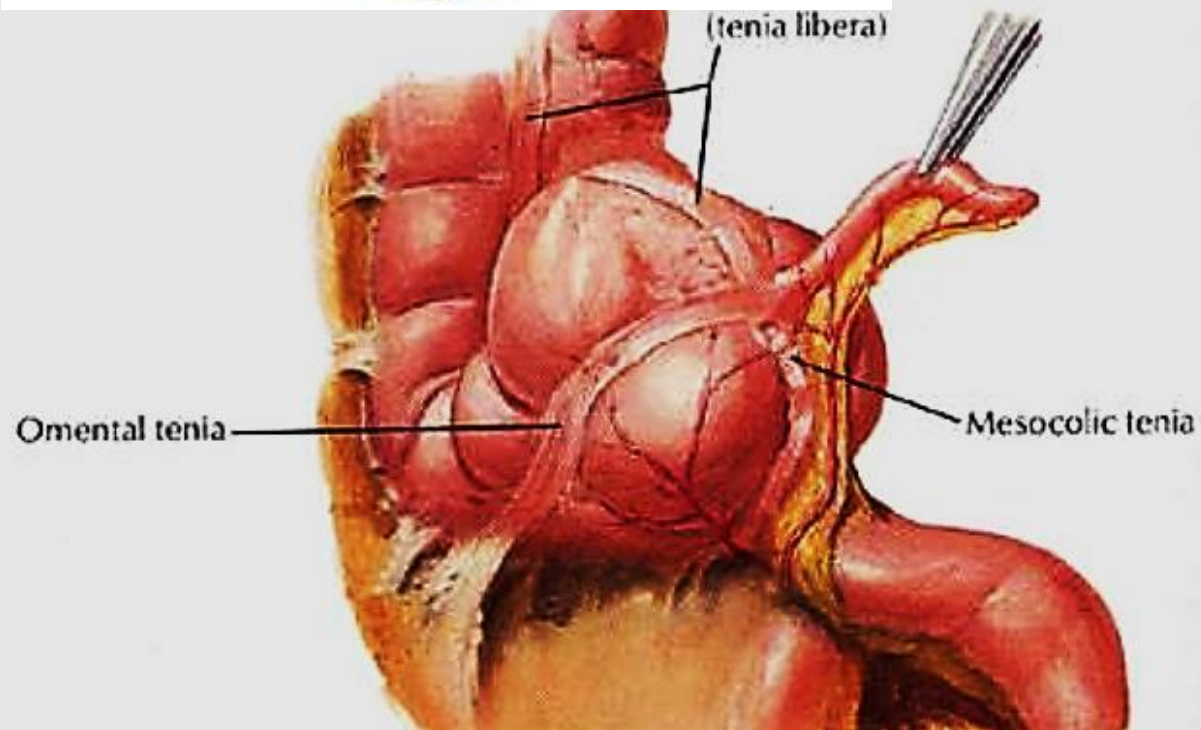
Leonardo Da Vinci
1452-1519





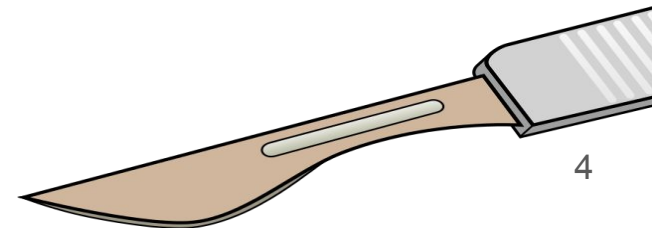
- Immunologic organ, secretion of immunoglobulin A.
- The reservoir to recolonize the colon with healthy bacteria.

- Length from <1 to >30 cm.
- Outer diameter varies $3 \div 8$ mm
- Luminal diameter - $1 \div 3$ mm.
- Lymphoid aggregates occur in the submucosal layer

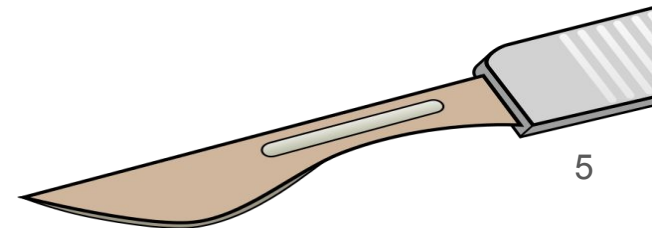
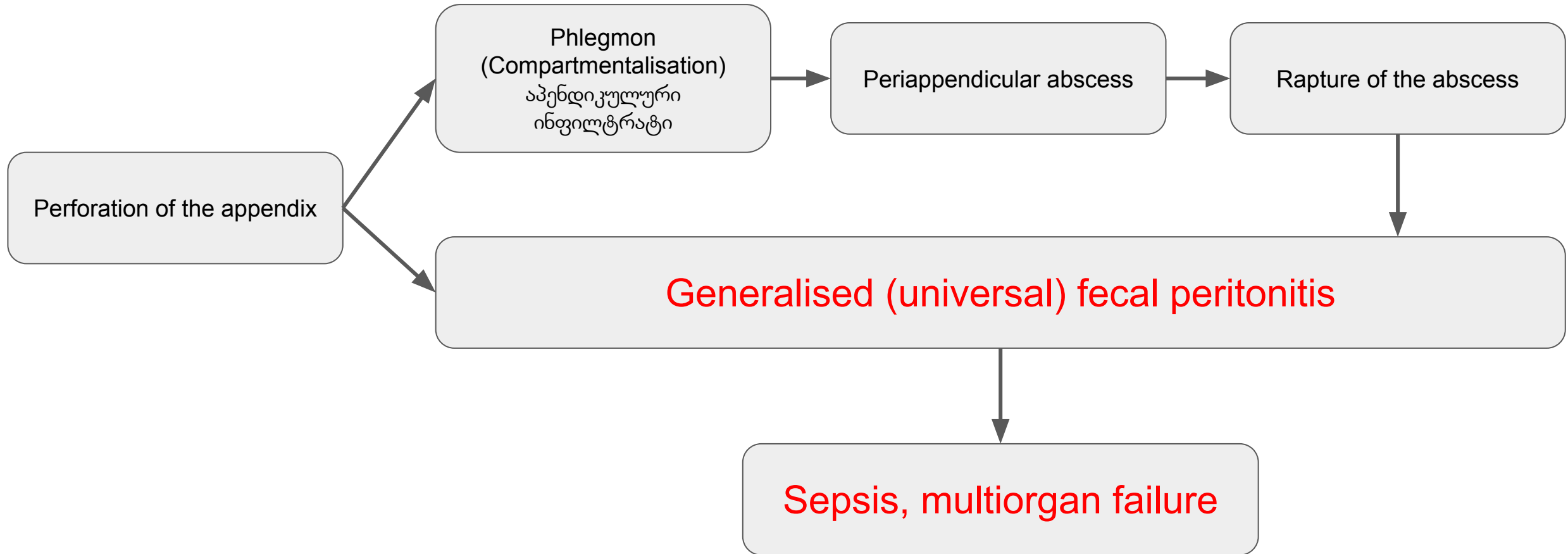


Causes of the Appendicitis

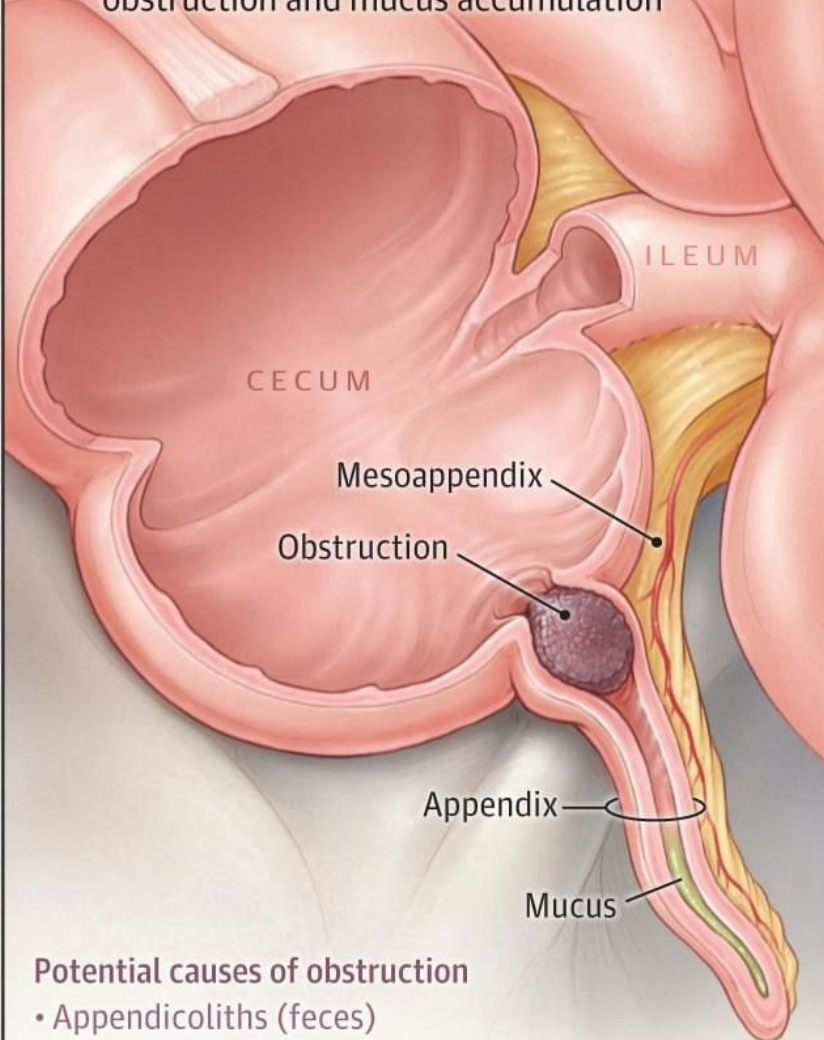
1. Occlusion of the appendiceal lumen ⇒ Distension ⇒ ischemia
⇒ Bacterial invasion ⇒ Necrosis.
2. Cessation of the blood supply ⇒ Necrosis (Primarily gangrenous form).



Complications



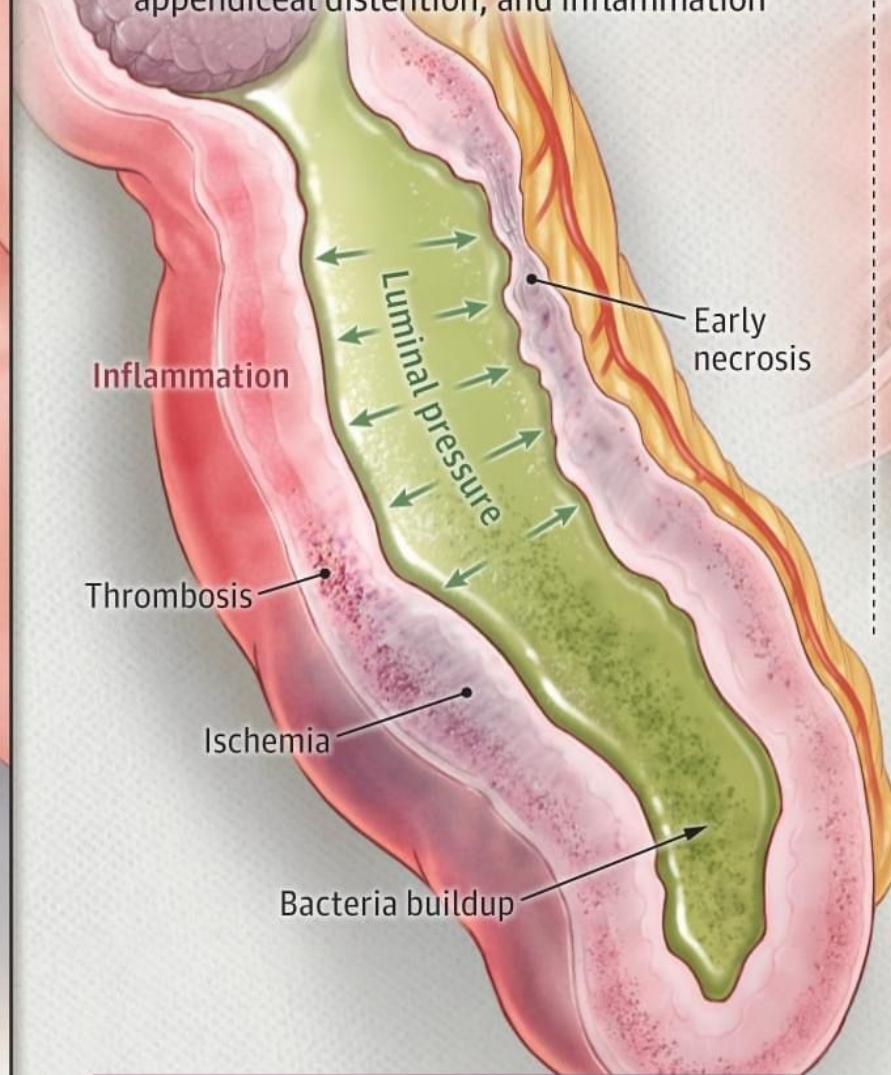
1 Initiation of acute appendicitis with lumen obstruction and mucus accumulation



Potential causes of obstruction

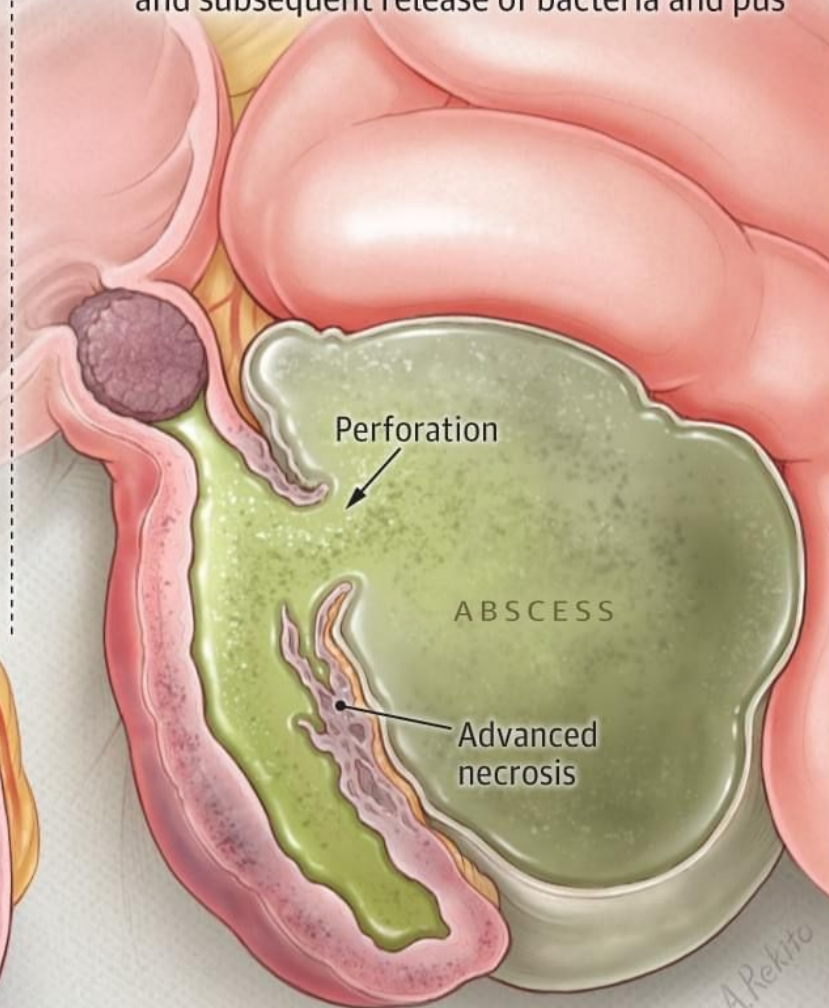
- Appendicoliths (feces)
- Calculi
- Lymphoid hyperplasia
- Infection
- Benign or malignant tumors

2 Progression with increased luminal pressure, appendiceal distention, and inflammation



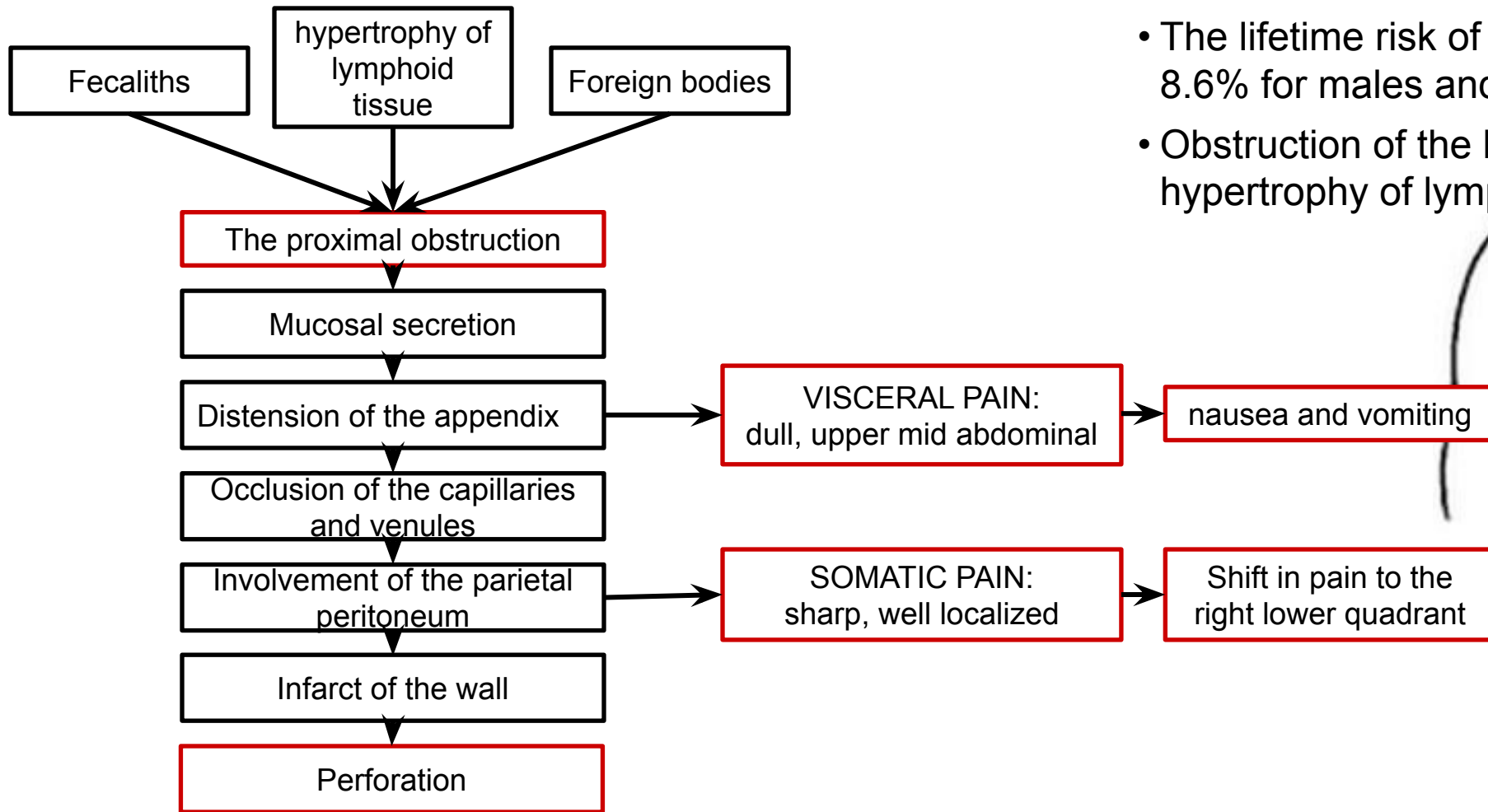
Increasing luminal pressure causes small vessel thrombosis and lymphatic flow stasis, resulting in tissue ischemia and bacteria buildup.

3 Rupture of the necrotic appendiceal wall and subsequent release of bacteria and pus

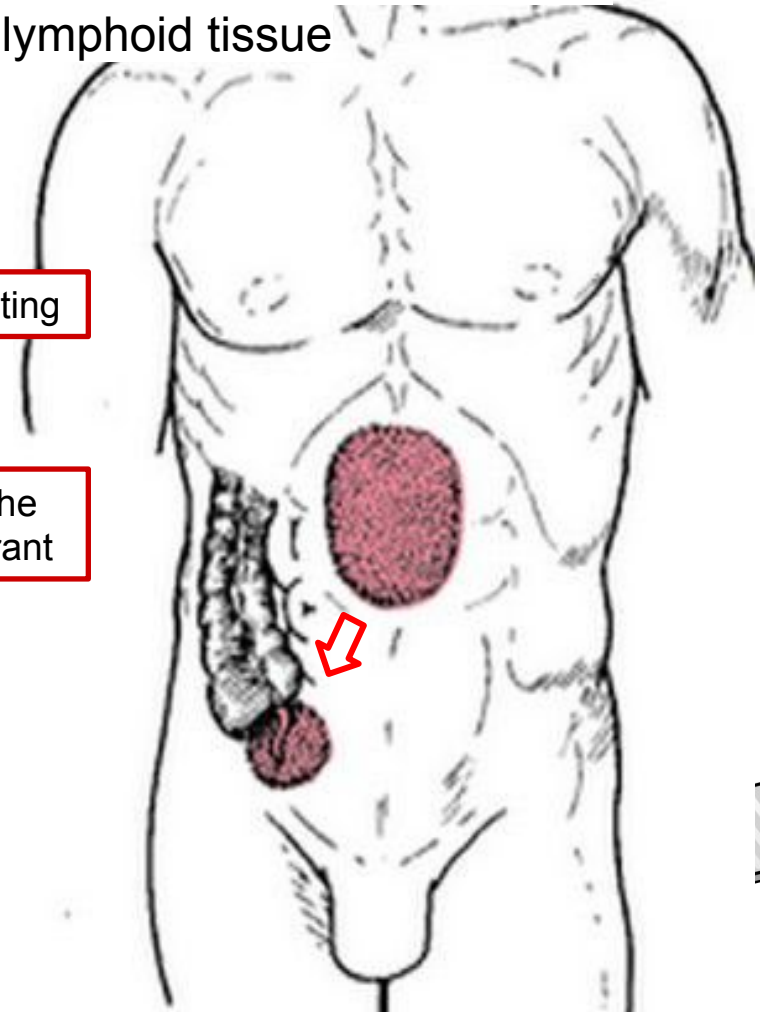


Perforation of the appendix and bacteria in the peritoneal space lead to the formation of abscess, phlegmon, or generalized peritonitis.

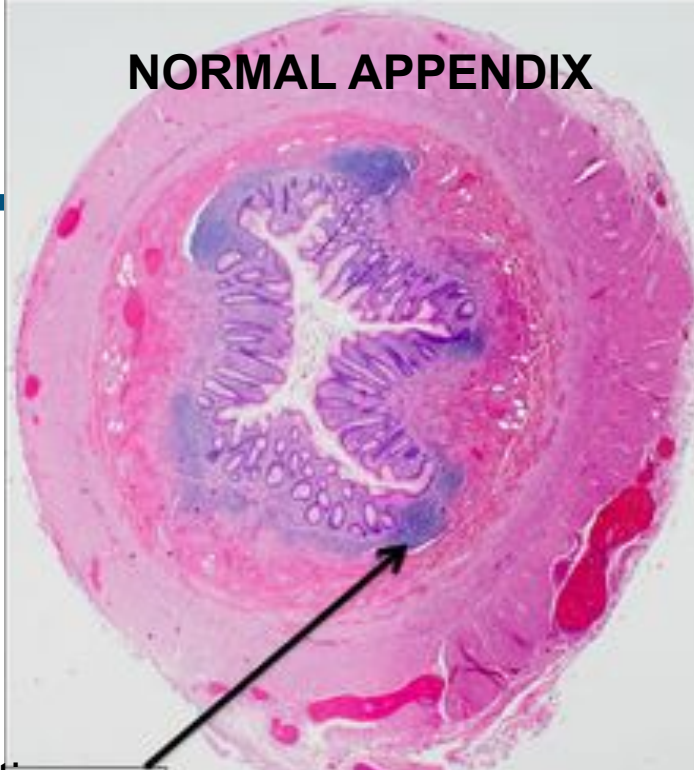
Pathogenesis of the appendicitis



- The lifetime risk of developing appendicitis is 8.6% for males and 6.7% for females,
- Obstruction of the lumen due to Fecaliths or hypertrophy of lymphoid tissue

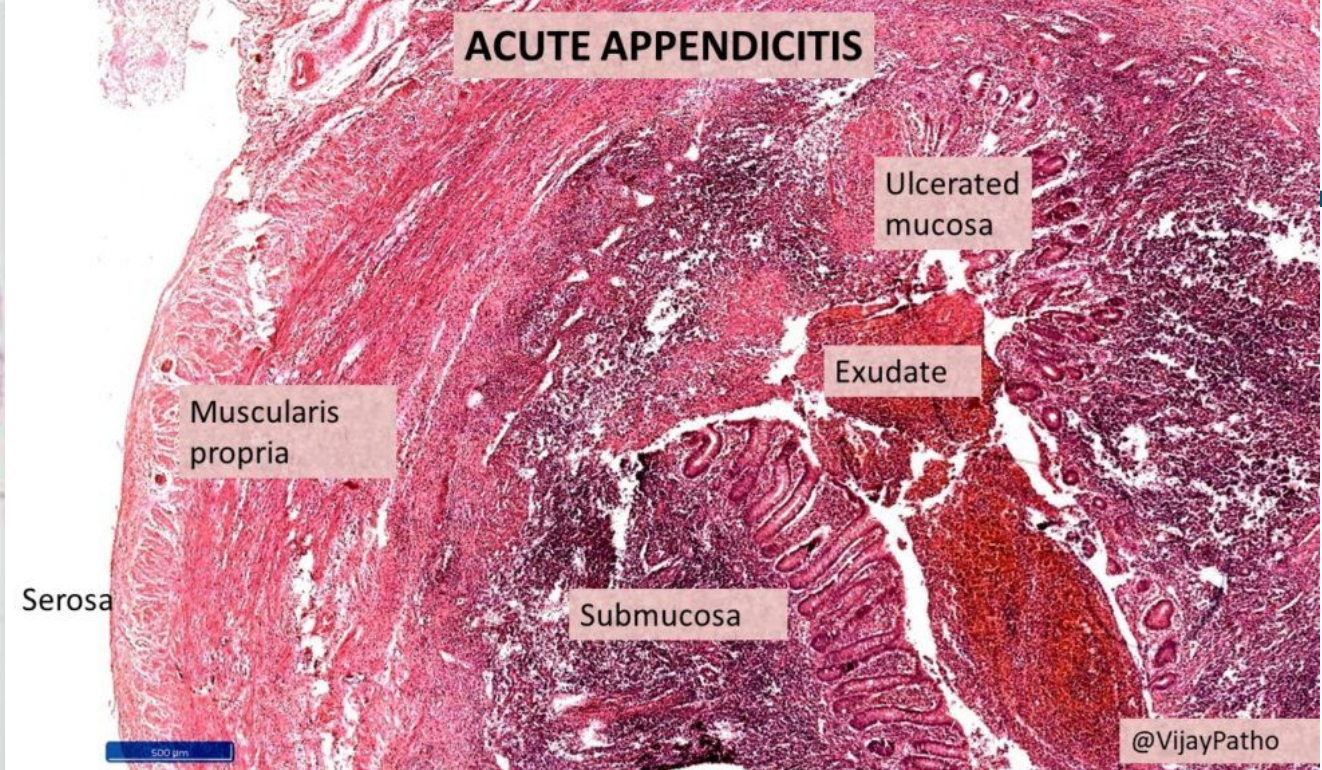


NORMAL APPENDIX



Lymphoid tissue

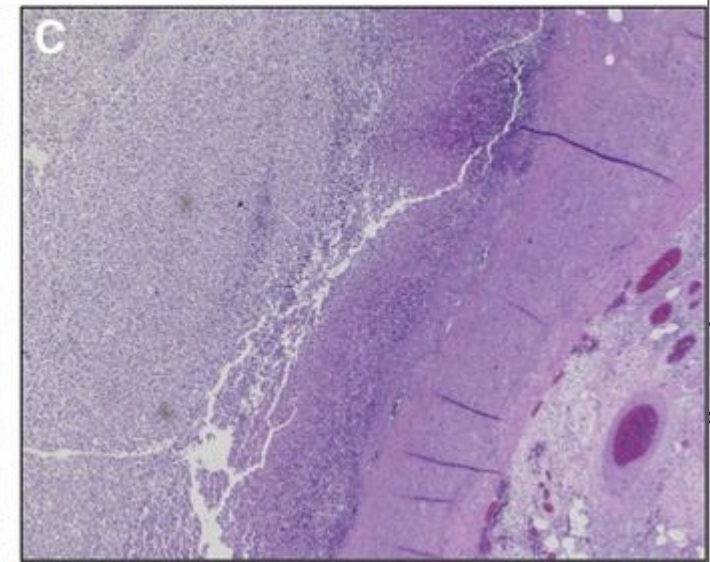
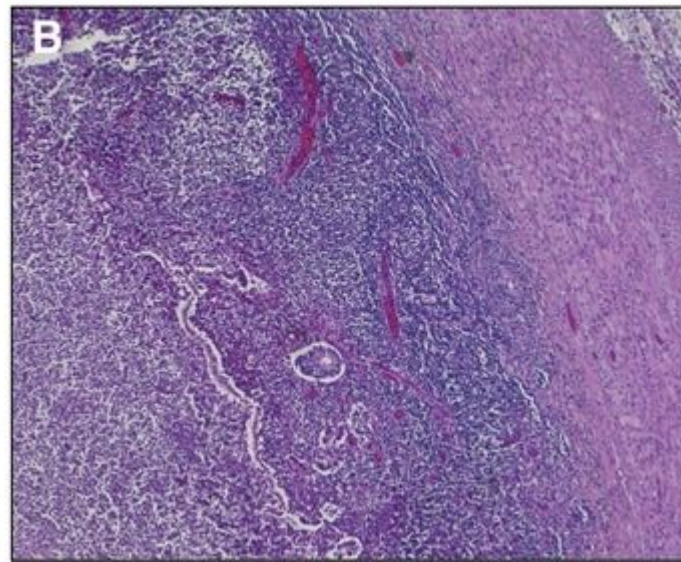
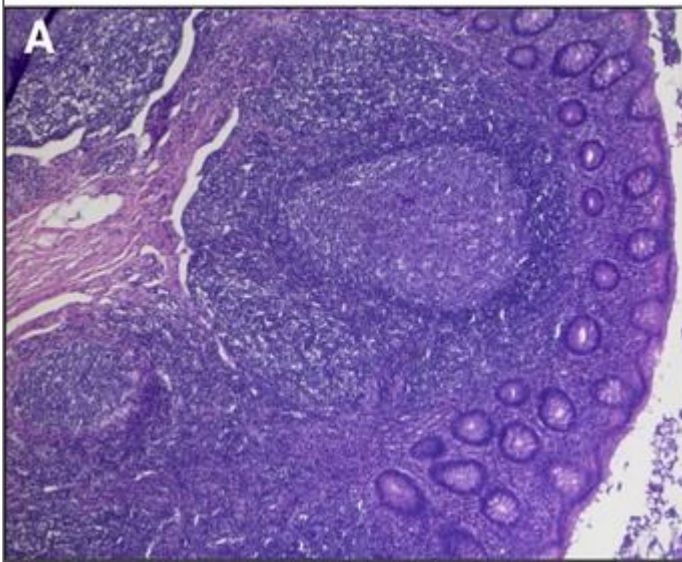
ACUTE APPENDICITIS



normal

phlegmonous

gangrenous

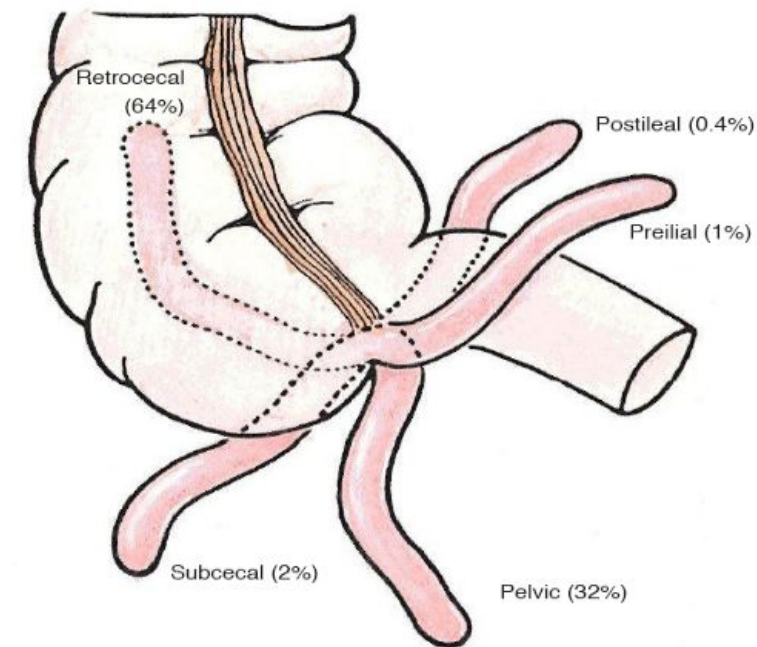


Symptoms

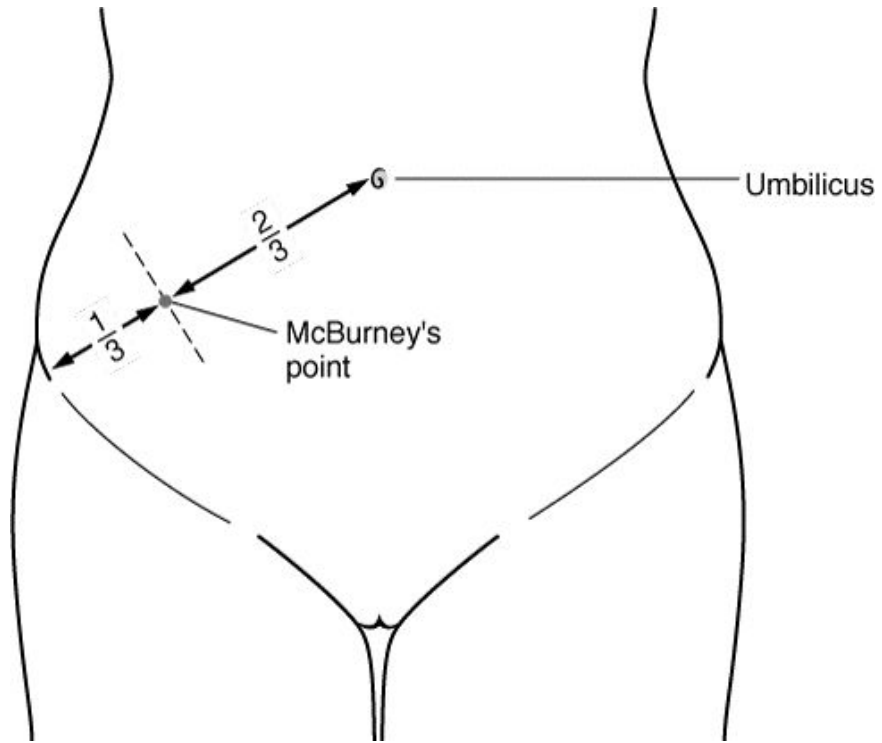
- Not all patients with appendicitis will progress to perforation. Resolution may be a common event.
- Starts with periumbilical and diffuse pain ⇨ localizes to the right lower quadrant.
- Right lower quadrant pain is one of the most sensitive signs of appendicitis.
- Nausea, vomiting, anorexia
- Obstipation / Diarrhea
- Move slowly and prefer to lie supine.
- Tenderness near McBurney's point
- Muscular resistance (guarding) in the right iliac fossa
- Rebound tenderness.
- Indirect tenderness (Rovsing's sign)
- Retrocecal appendix

- Psoas sign - pain with extension of the right leg.
- Obturator sign - stretching of the obturator internus through internal rotation of a flexed thigh

Figure 1. Frequency Of Appendix Locations



McBurney's point



Rebound tenderness



Rovsing's sign (Indirect tenderness)



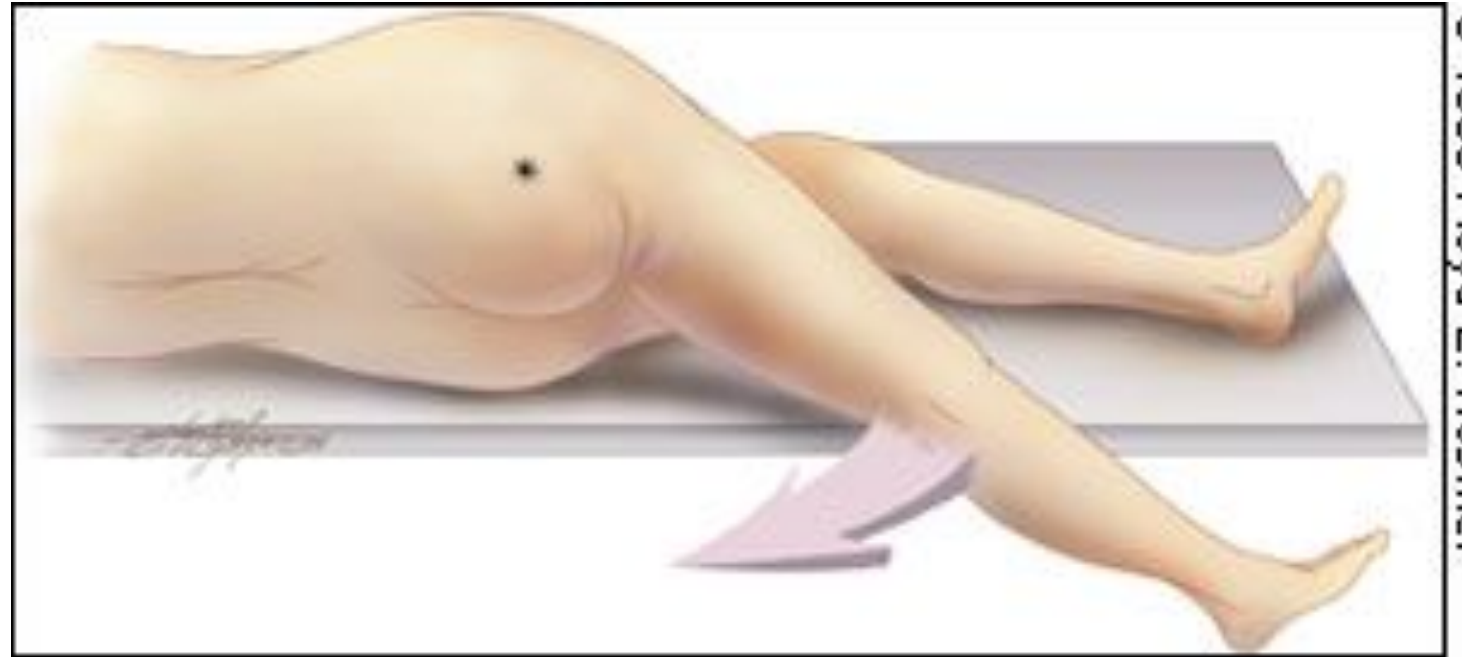
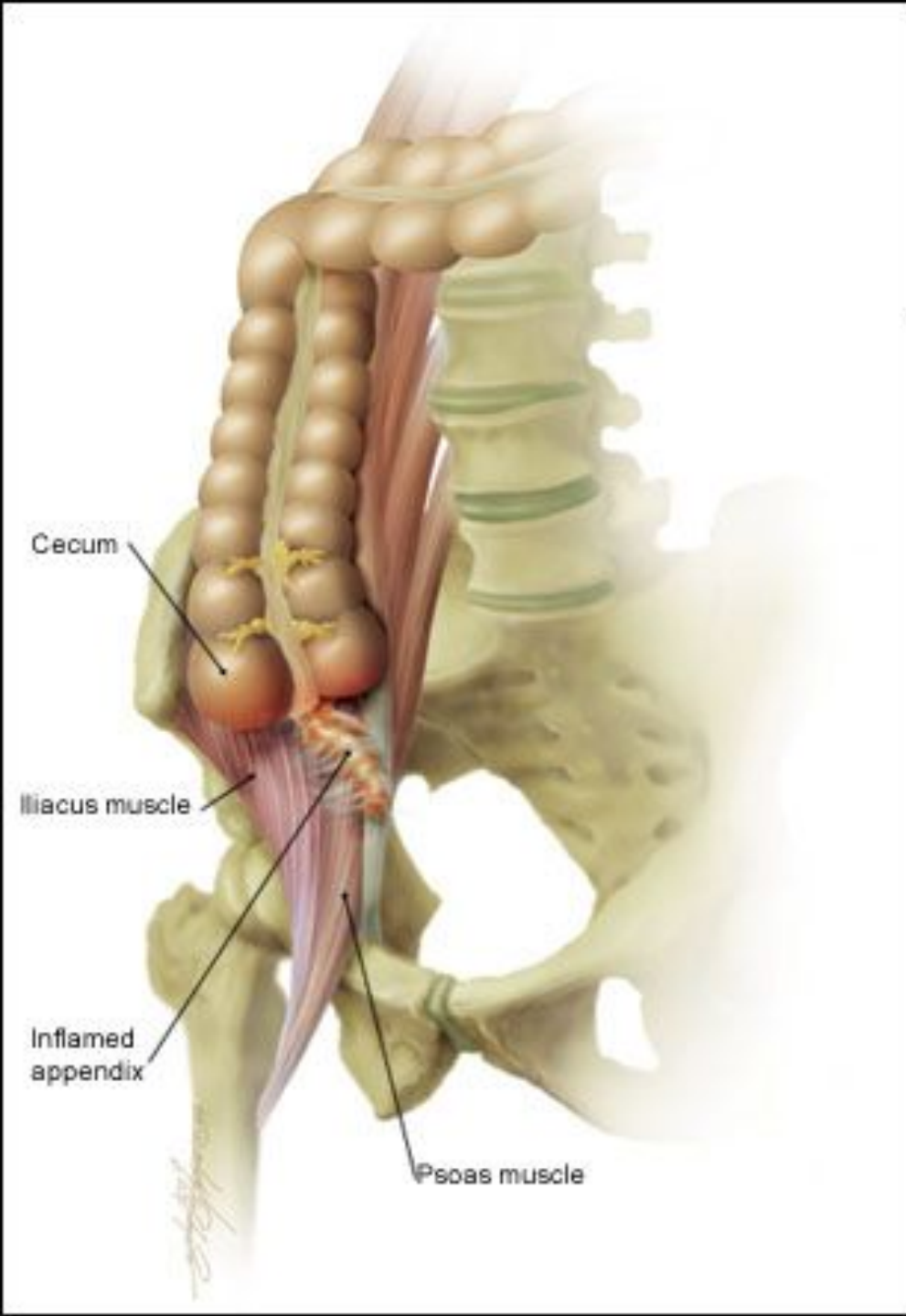
Surgical Teaching

Rovsing's Sign

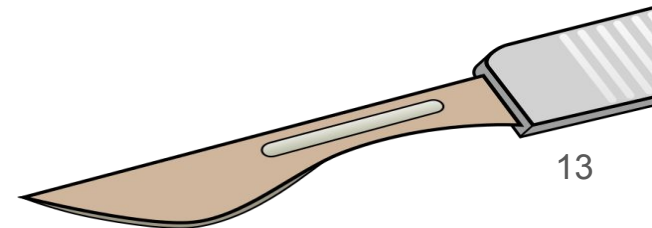


Psoas sign

Illustration © 1999 Floyd E. Hosmer



© 1999 Floyd E. Hosmer



Psoas sign



Obturator sign

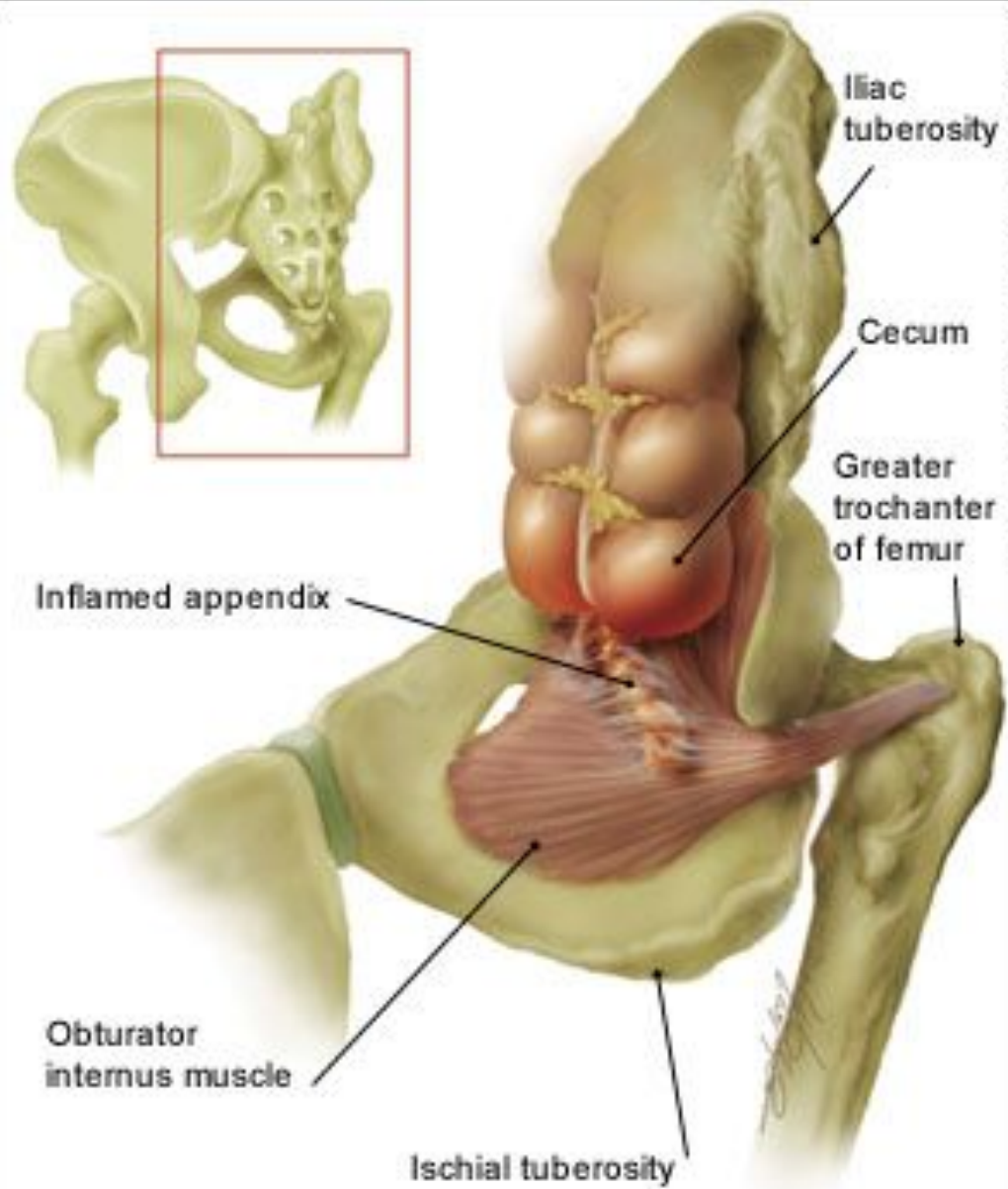
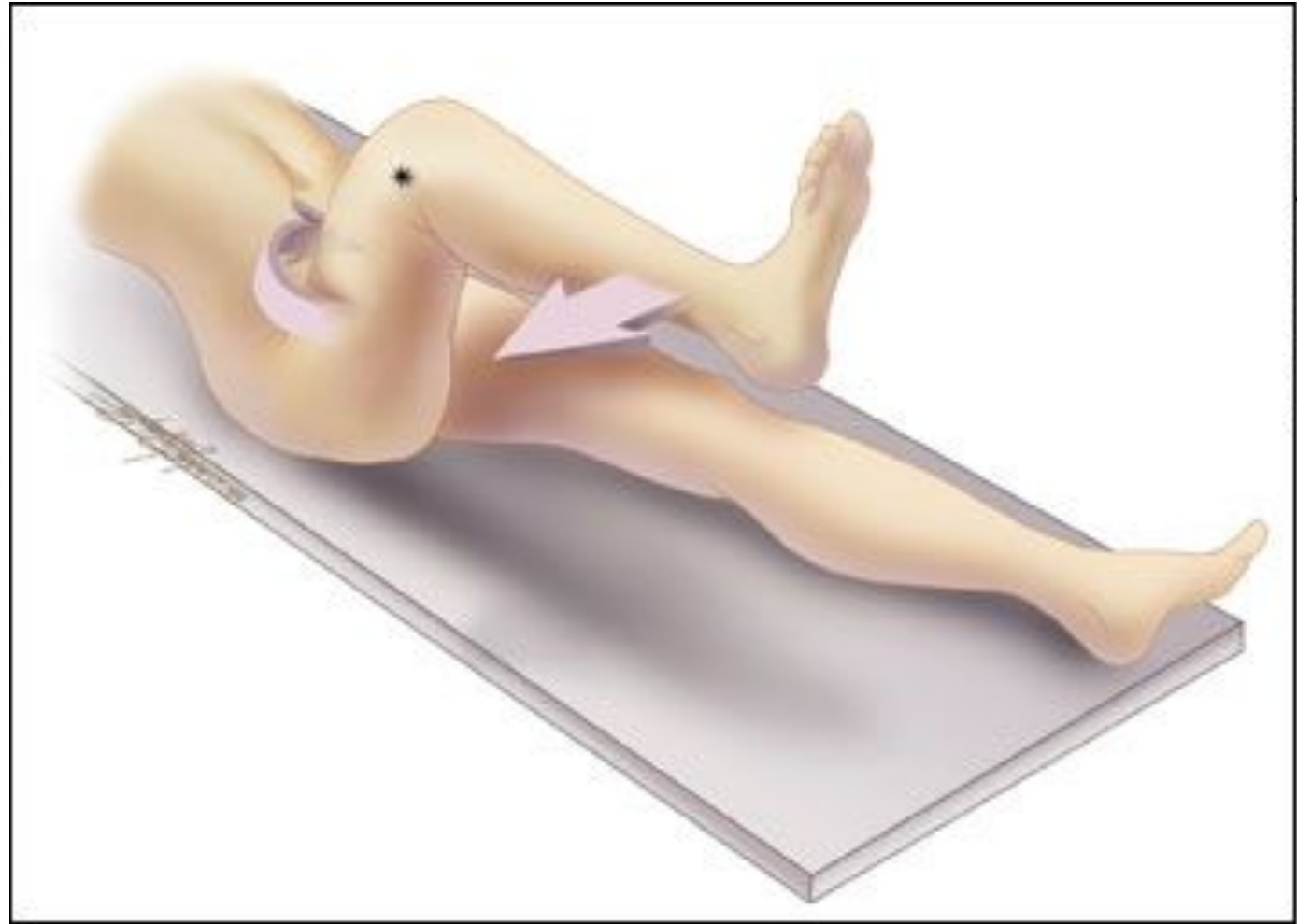
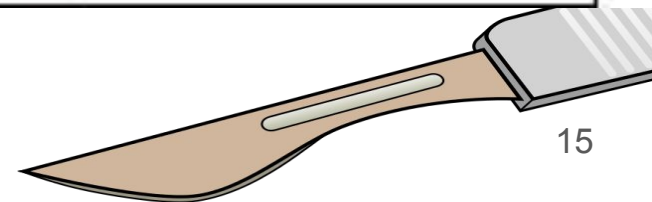


Illustration © 1999 Floyd E. Hosmer



© 1999 Floyd E. Hosmer



Obturator sign

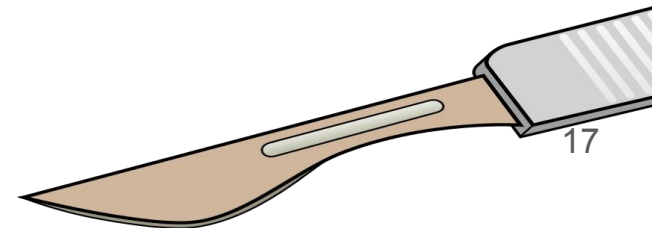


Lab & imaging

- Mild leukocytosis
- Polymorphonuclear prominence
- C-reactive protein
- White blood cell counts can be low
 - Lymphopenia
 - Septic reaction
 - The proportion of neutrophils is usually very high.
- Urinalysis
- A chest radiograph is helpful to rule out referred pain

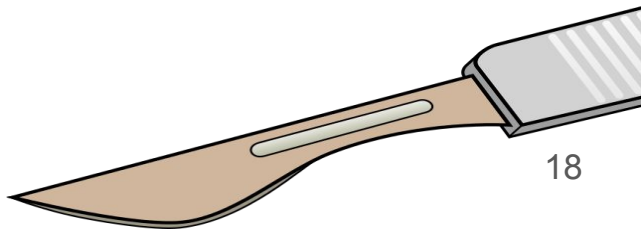
Ultrasound / CT

- Graded compression ultrasonography
- Thickening of the appendiceal wall
- Presence of periappendiceal fluid
- Easily compressible appendix measuring <5 mm in diameter excludes the diagnosis of appendicitis



Ultrasonographic signs of acute appendicitis

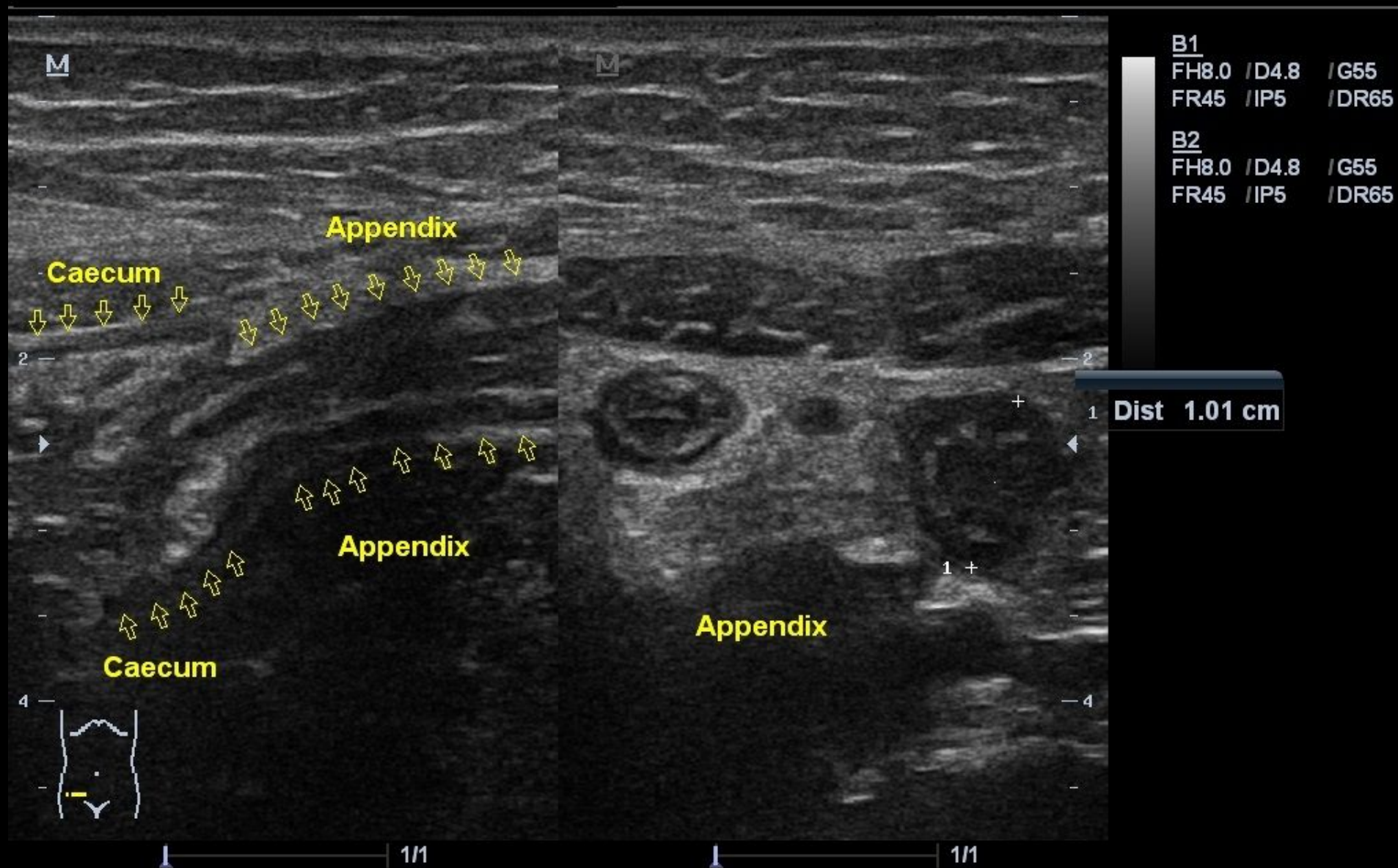
Non-compressible tubular structure in the right lower quadrant	US - Positive: visualization of non-compressible appendix measuring > 6 mm in diameter; other signs include presence of appendicolith, peri-appendiceal fluid, increased flow in the appendiceal wall with color Doppler - Negative: complete visualization of a compressible appendix measuring < 6 mm in diameter - Equivocal: Non-visualization of appendix
Wall thickness >2 mm	
Overall diameter >6 mm	
Free fluid in the right lower quadrant	
Thickening of the mesentery	
Localized tenderness with graded compression	
Presence of a calcified appendicolith	
<i>Hyperemic wall by Doppler</i> <i>Hyperechoic, inflamed peri-appendiceal fat (best predictive value)</i> <i>Fecalith alone in the setting of a high clinical suspicion</i> <i>Interloop peritoneal fluid</i>	





7L4A

Ped-ABD



PHILIPS

Philips Healthcare

MI 1.2

29/12/2016

TIS 0.5

08:35:30

Renal
L12-3
62Hz
6cm

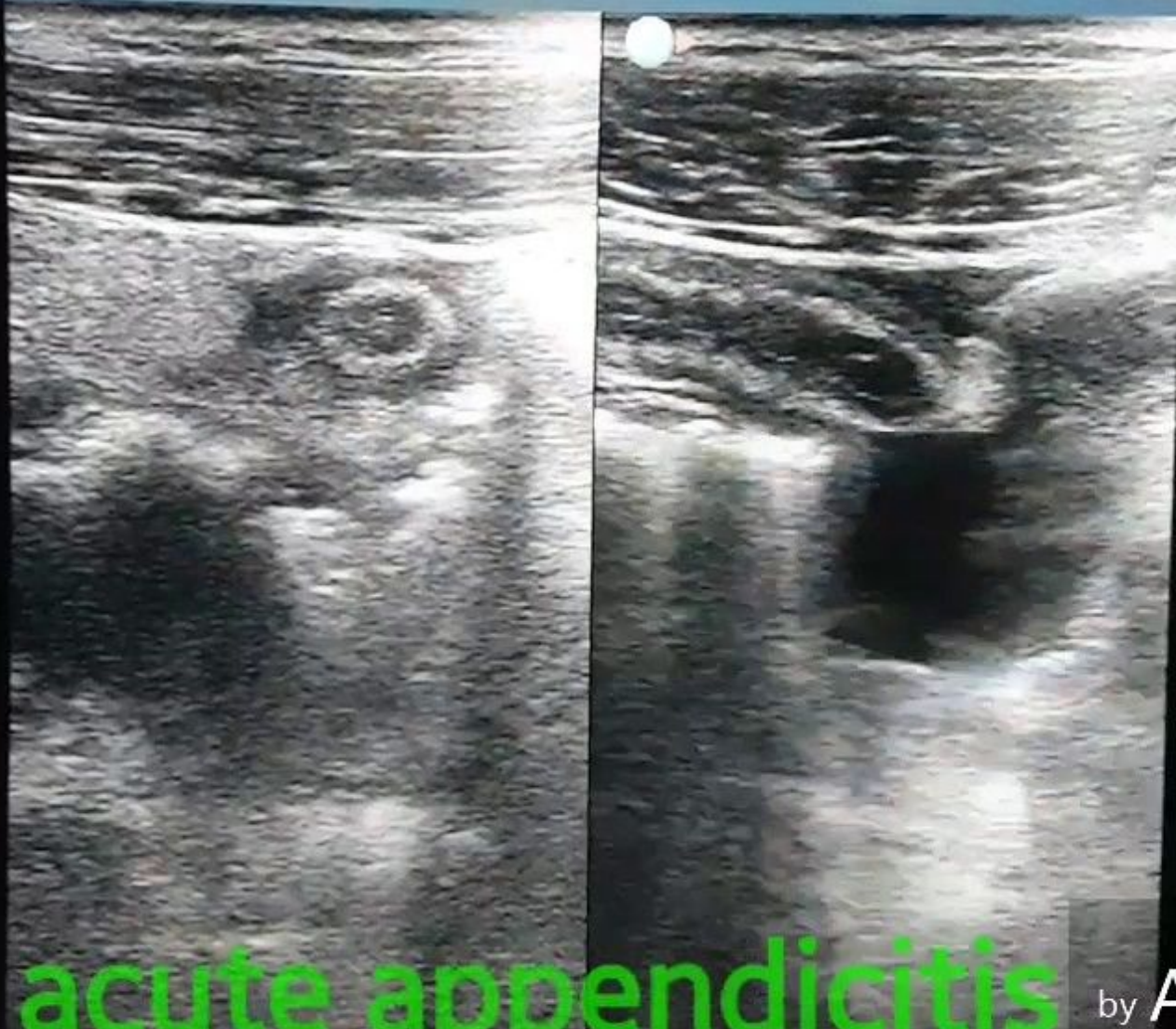
2D

F4

Gn 56

232dB/C6

F/2/3



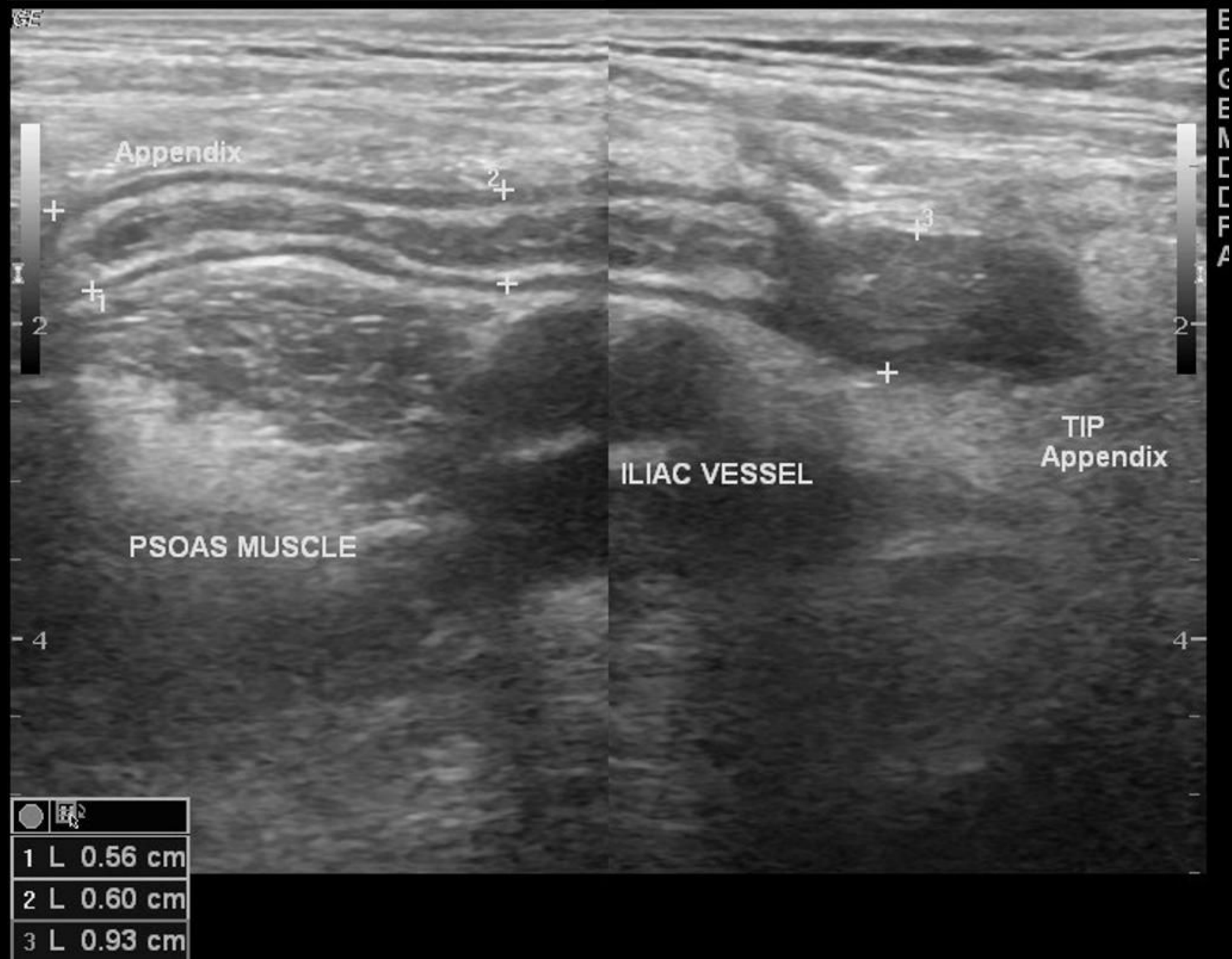
acute appendicitis

CyberLink

by ActionDirector

P G R
3.0 12.0

P R
3.0 12.0



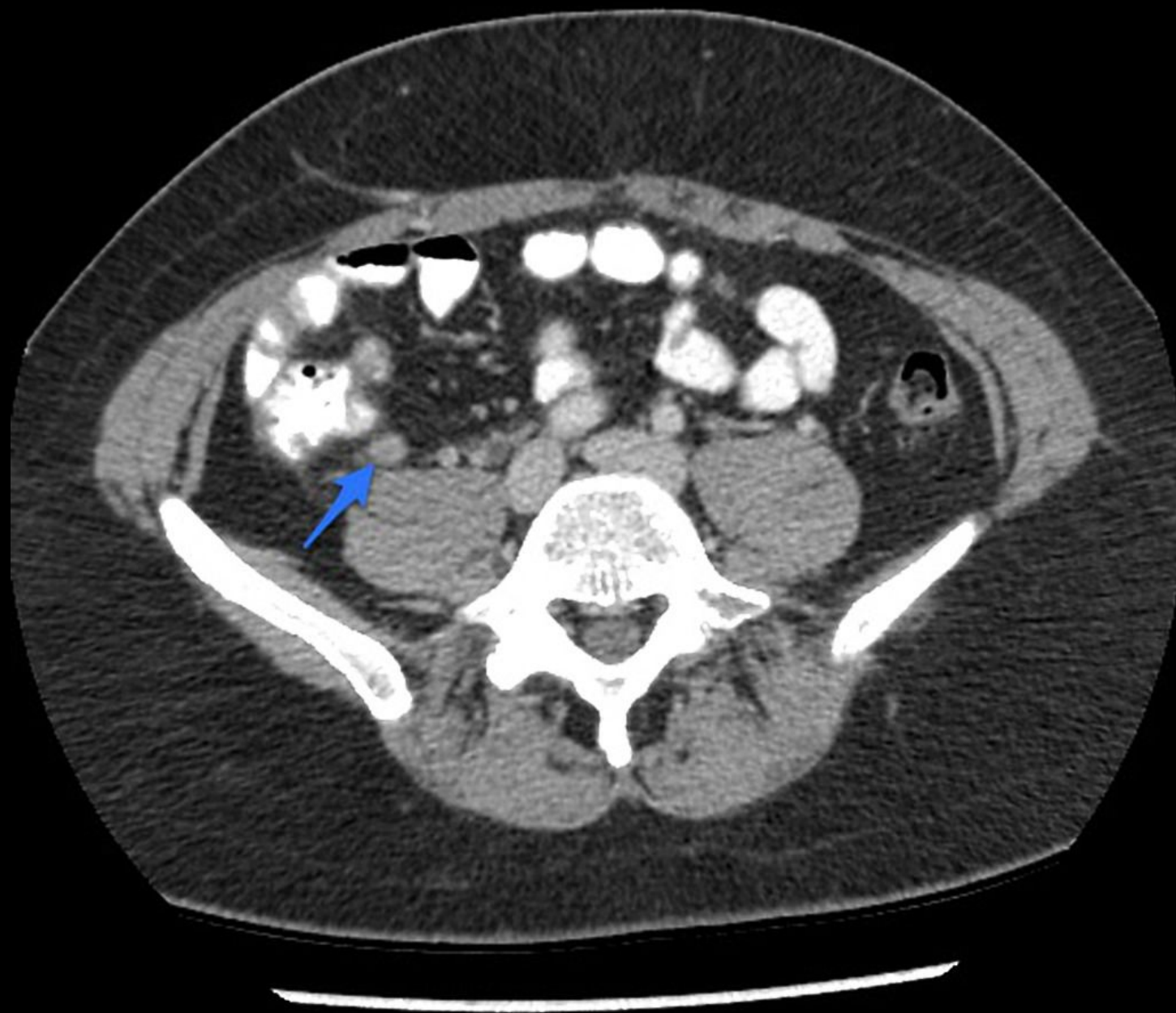
High-resolution helical CT

Acute Appendicitis by CT Scan

Enlarged appendiceal diameter, >6 mm
Appendiceal wall thickening, >2 mm
Appendiceal wall enhancement
Peri-appendiceal fat stranding
Appendicolith (25% of patients)
Does not fill with contrast or air
Cecal thickening
Interloop peritoneal fluid

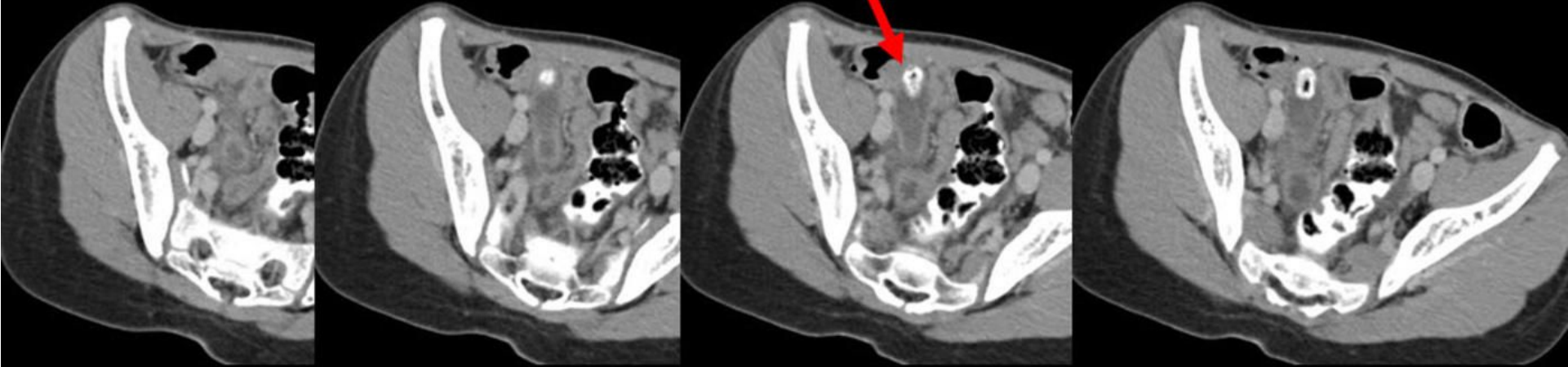
CT

- **Appendicitis:** visualization of an enlarged appendix measuring ≥ 7 mm in diameter in addition to inflammatory signs including hyperemia in the wall, peri-appendiceal fat stranding, or appendicolith
- *Non-perforated* appendicitis: criteria for appendicitis above without any evidence of intra-abdominal abscess, extra-luminal air, extra-luminal appendicolith, or focal defect in enhancing appendiceal wall*
- *Perforated* appendicitis: criteria for appendicitis above with evidence of either intra-abdominal abscess, extra-luminal air, extra-luminal appendicolith, or focal defect in enhancing appendiceal wall*

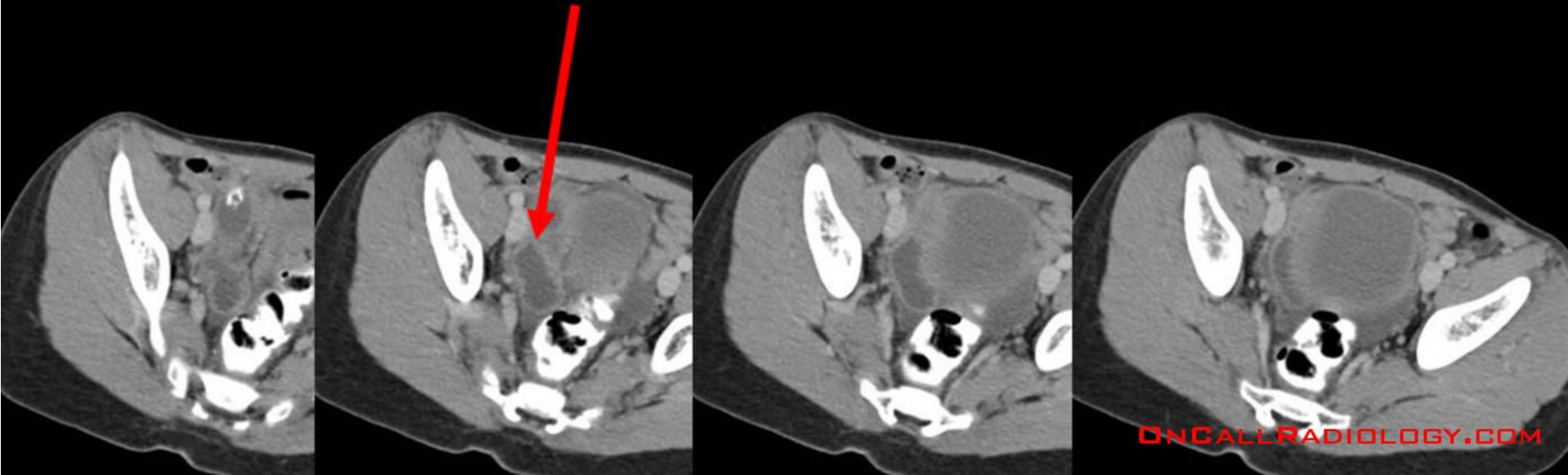




Appendicolith



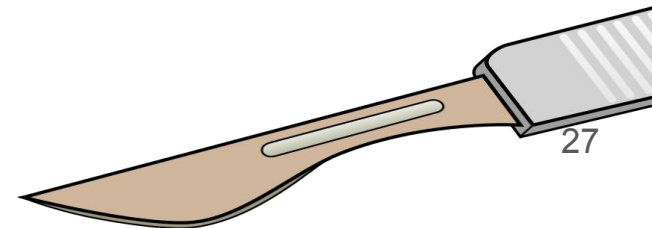
Inflamed, dilated and fluid filled appendix





Not sure about diagnosis?

- If you have doubt about acute appendicitis, but unable to confirm the diagnosis ⇒ perform surgery!
- It's better to remove the innocent appendix than miss real appendicitis ⇒ perforation ⇒ peritonitis ⇒ sepsis.
- The accuracy of preoperative diagnosis should be higher than 85%.



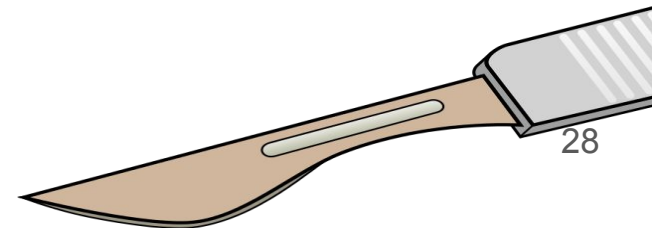
Difficult patient

Pediatric Patient

- Acute mesenteric adenitis
- Generalized lymphadenopathy
- relative lymphocytosis
- Acute gastroenteritis.

Elderly Patient

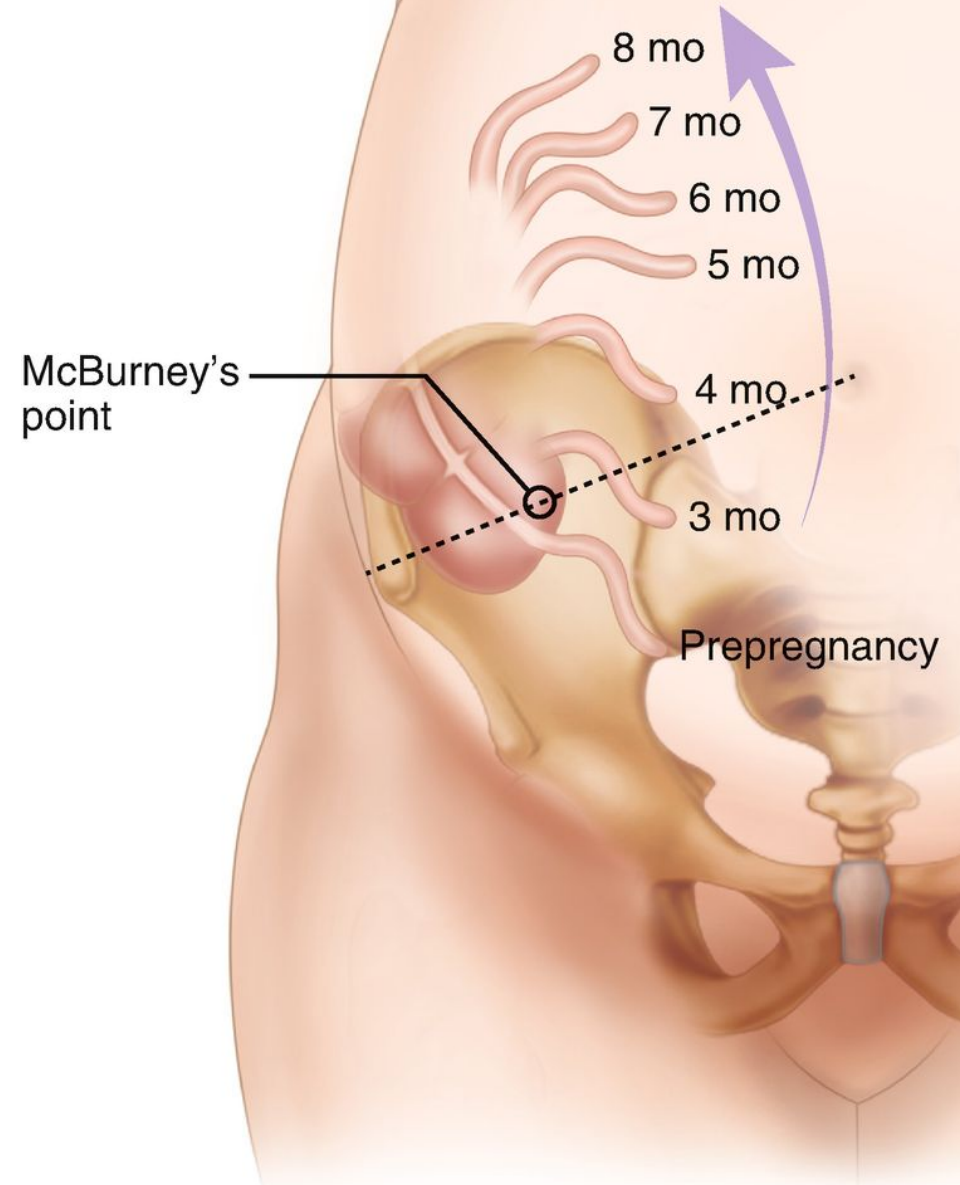
- Diverticulitis
- Carcinoma
- Fecal impaction



Difficult patient

Female Patient

- Right-sided cysts rupture or undergo torsion
- Rupture of right tubal or ovarian pregnancies can mimic appendicitis.
- Pelvic inflammatory disease,
- Endometriosis
- Ruptured graafian follicle - mittelschmerz



Acute Appendicitis during Pregnancy

- Negative appendectomy rate during pregnancy is approximately 25%
- Abdominal pain of new onset in the right side of the abdomen
- Abdominal ultrasound
- Magnetic resonance
- Laparoscopic appendectomy may be associated with an increase in pregnancy-related complications.
- The overall incidence of fetal loss after appendectomy is 4%, and the risk of early delivery is 7%
- Uncomplicated appendectomy
 - can quickly be started on a diet and discharged home the same day or the following day. low, 114
 - Postoperative antibiotic therapy is unnecessary
- Complicated appendectomy,
 - Broad-spectrum antibiotics for 4 to 7 days.
 - Postoperative ileus → diet
- Surgical site infection (superficial or deep) → opening, culture
- Intra-abdominal abscesses
 - Small abscesses → antibiotics
 - Larger abscesses → Percutaneous drainage with CT or ultrasound guidance
 - Laparoscopic abscess drainage

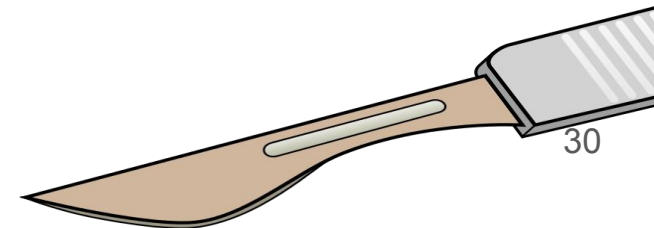


Table 30-2

Scoring systems

ALVARADO SCORE ³⁷		APPENDICITIS INFLAMMATORY RESPONSE SCORE ^{38,39}	
Findings	Points	Findings	Points
Migratory right iliac fossa pain	1	Vomiting	1
Anorexia	1	Pain in the right inferior fossa	1
Nausea or vomiting	1	Rebound tenderness or muscular defense	
Tenderness: right iliac fossa	2		Light 1
Rebound tenderness right iliac fossa	1		Medium 2
Fever $\geq 36.3^{\circ}\text{C}$	1		Strong 3
Leukocytosis $\geq 10 \times 10^9$ cells/L	2	Body temperature $\geq 38.5^{\circ}\text{C}$	1
Shift to the left of neutrophils	1	Polymorphonuclear leukocytes	
			70%–84% 1
			$\geq 85\%$ 2
		White blood cell count	
			$10.0\text{--}14.9 \times 10^9$ cells/L 1
			$\geq 15.0 \times 10^9$ cells/L 2
		C-reactive protein concentration	
			10–49 g/L 1
			≥ 50 g/L 2
Score: <3: Low likelihood of appendicitis		Score: 0–4: Low probability. Outpatient follow-up.	
4–6: Consider further imaging		5–8: Indeterminate group. Active observation or diagnostic laparoscopy.	
≥ 7 : High likelihood of appendicitis		9–12: High probability. Surgical exploration.	

Appendicitis Treatment

Uncomplicated appendicitis

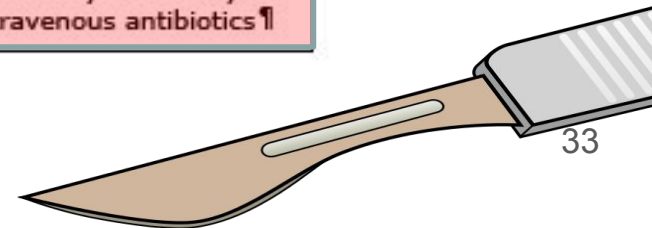
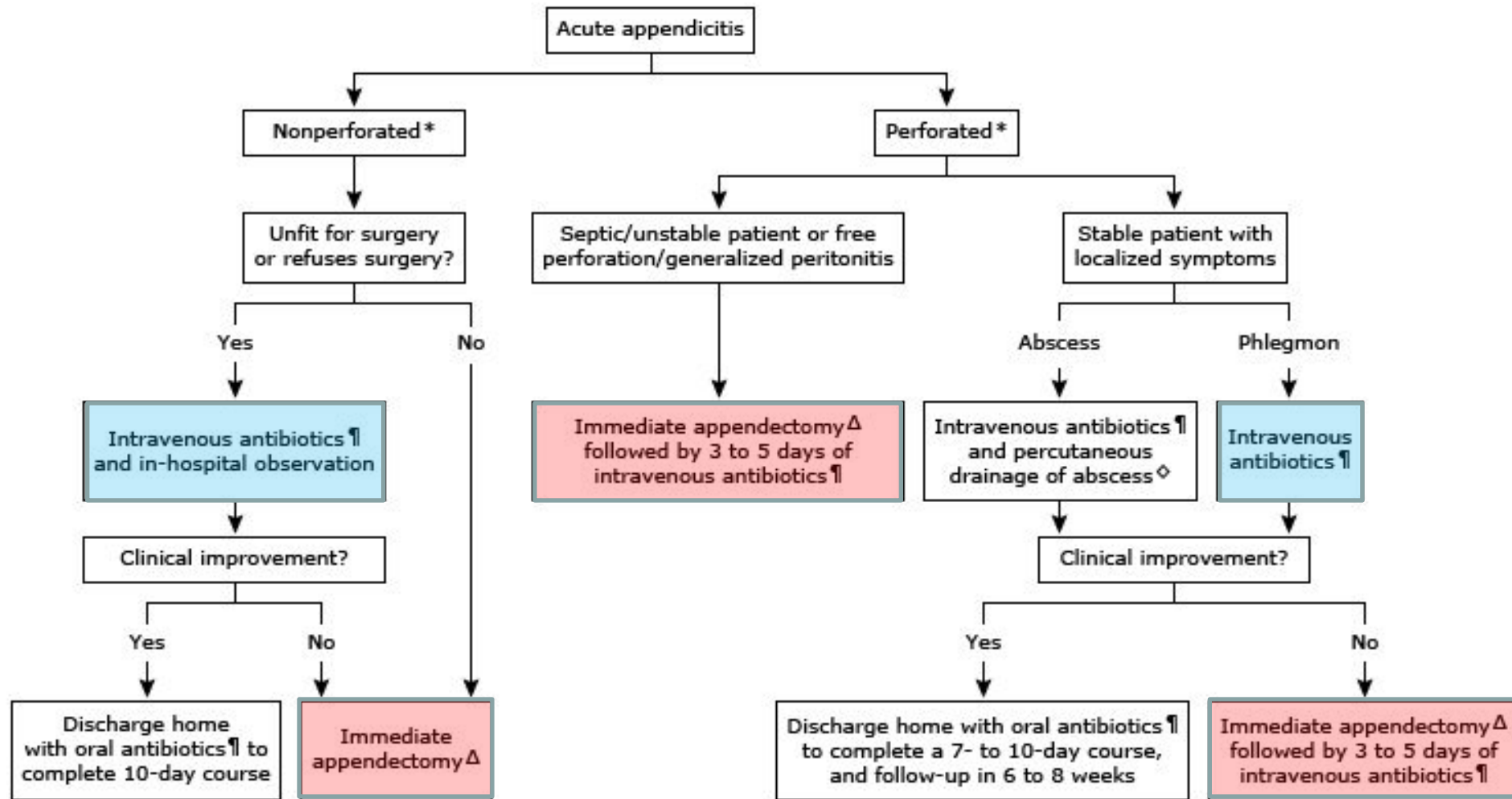
- 9% failure rate with nonoperative management
⇒ half have complicated (perforated or gangrenous) appendicitis.
- Operative treatment of uncomplicated appendicitis still remains the standard of care ⇒
Urgent laparoscopic or open appendectomy

Complicated Appendicitis = Perforated appendicitis

<5 years and >65 years of age → highest rates of perforation

1. A phlegmon ⇒ **Hospitalisation, antibiotics, fluid therapy**
 - Success ⇒ Discharge from the hospital ⇒ planned appendectomy???
 - Failure ⇒ Abscess ⇒ **percutaneous drainage** ⇒ planned appendectomy???
2. Diffuse (regional or generalized) peritonitis ⇒ **Urgent open appendectomy, peritoneal drainage**

Management of acute appendicitis in adults



SAGES Guideline for the Diagnosis and Treatment of Appendicitis

Preoperative planning



CT > US
But US
ok 1st
study

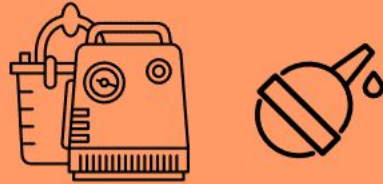


OR for both complicated
or uncomplicated



Uncomplicated OK
for immediate <12h
or delayed >12h OR

Operative decisions for complicated appendicitis



Suction/lavage
=
suction alone



No routine
drain placement

Complicated appendicitis perioperative decision making



Postop short-term
>
long-term Abx



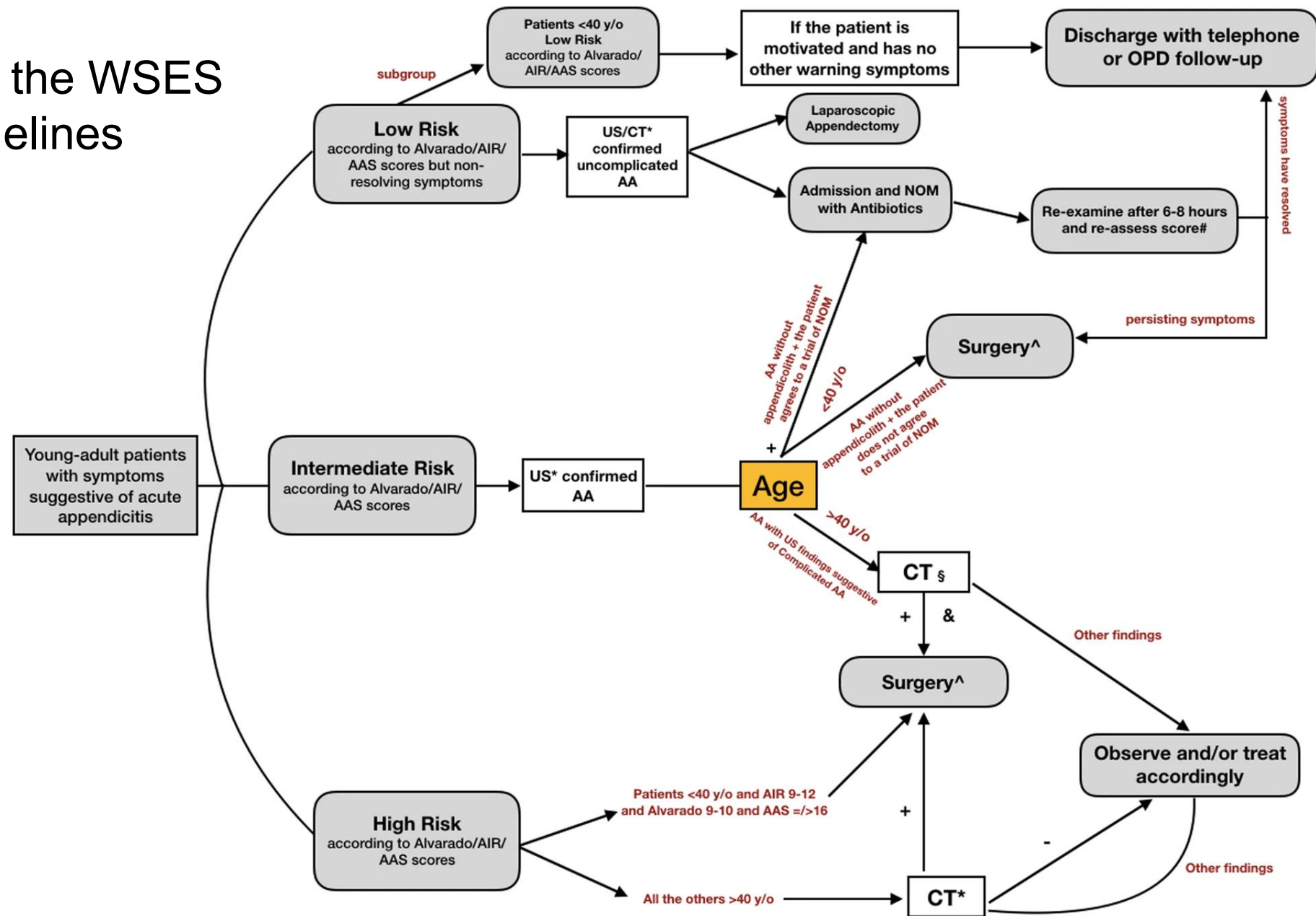
if treated nonop, proceed
with interval appendectomy



SAGES Guidelines Committee

Sunjay S. Kumar, et al.
Surgical Endoscopy 2024
Visual Abstract by Athanasiadis DI

2020 update of the WSES Jerusalem guidelines

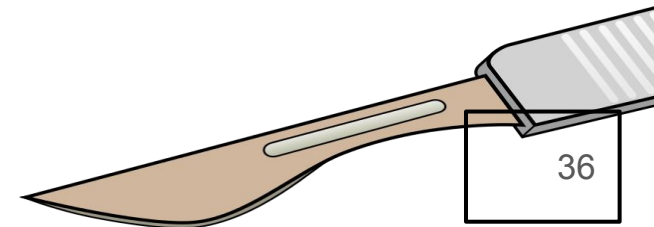
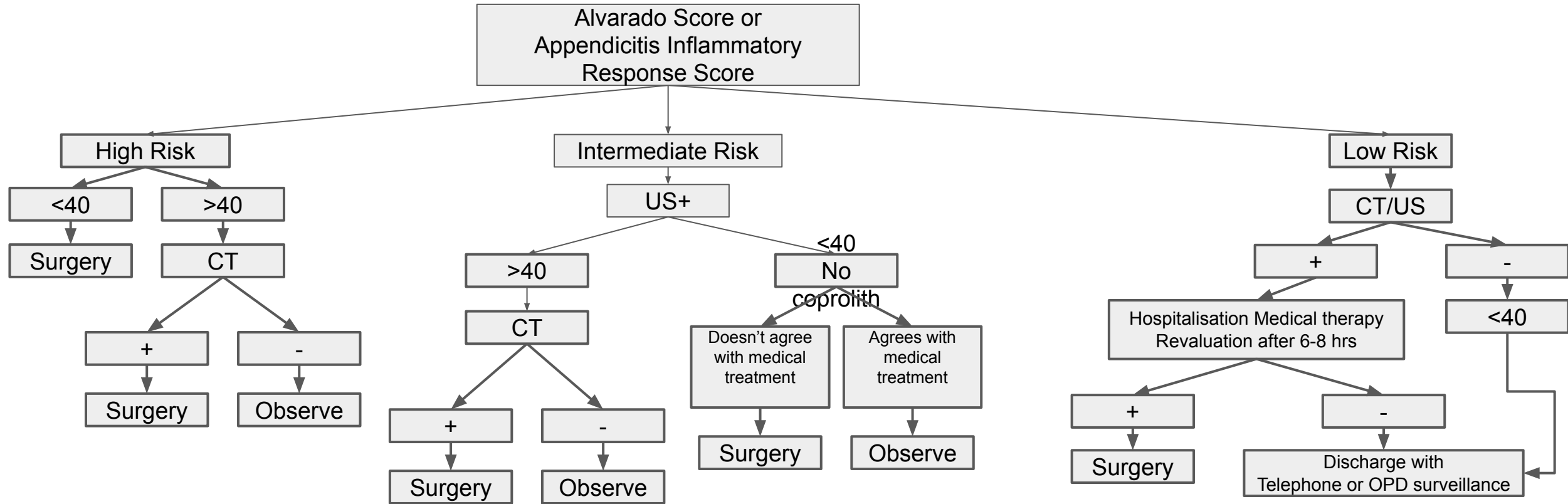


*We recommend the routine use of a combination of clinical scores and US (POCUS); consider use of CT scan (low-dose protocols for young adults) if US inconclusive.

#If no improvements after observation and re-assessment, consider US or CT based on age and probability of other disease. ^ Surgery is meant as Lap Appendectomy. In case of abscess or phlegmon on US/CT, consider also antibiotics + percutaneous drainage.

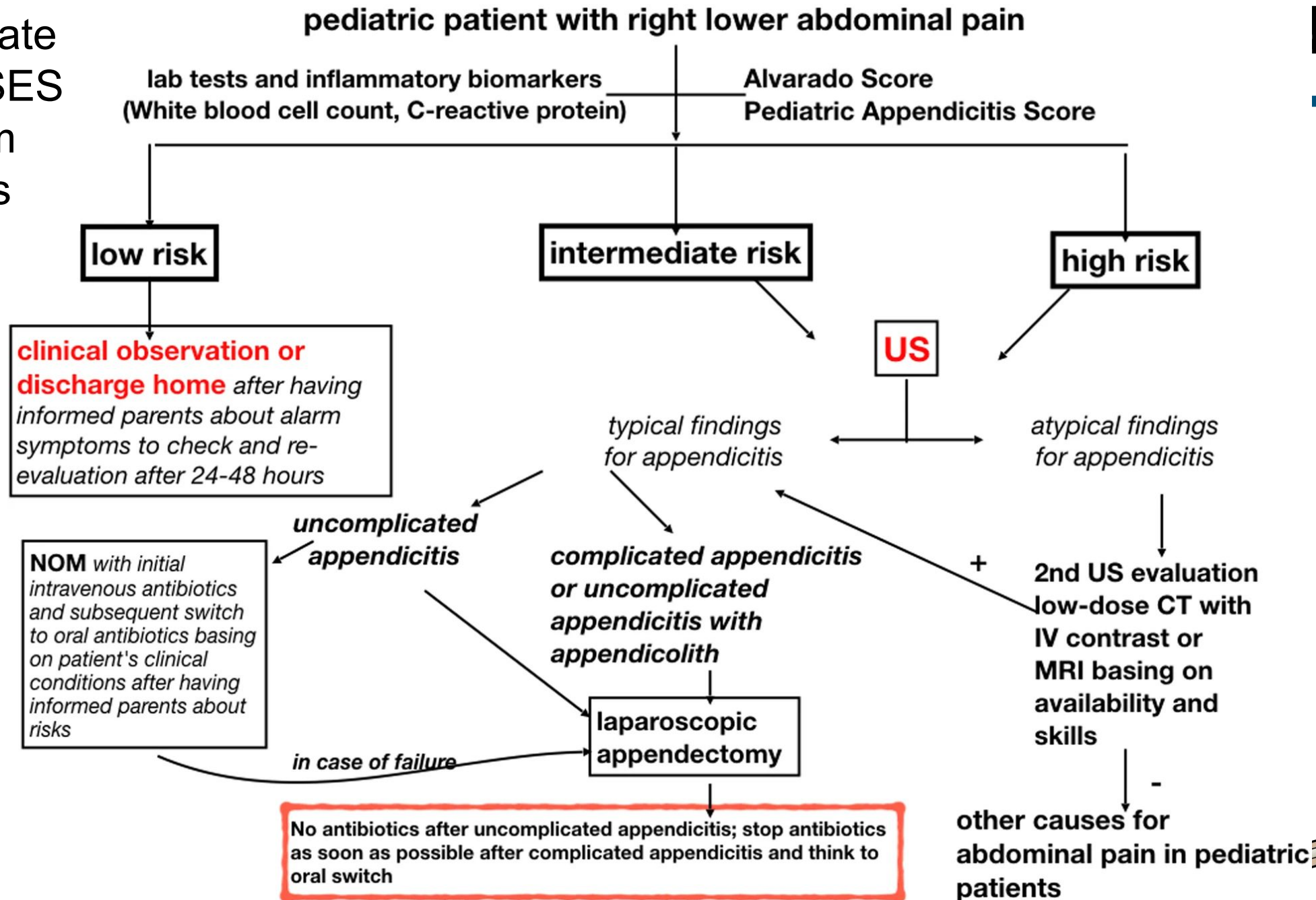
& Patients >40 y/o with complicated appendicitis treated non-operatively should undergo colonic screening and interval full-dose contrast-enhanced CT scan. § Consider CT in patients >40 y/o with clinical/US signs of complicated AA.

2020 update of the WSES Jerusalem guidelines



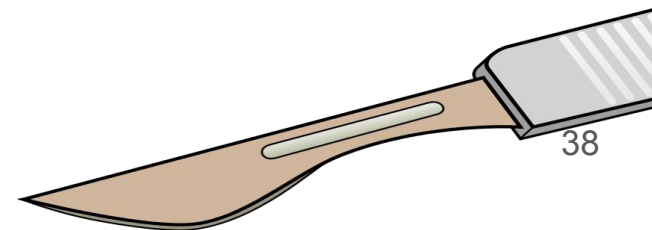
2020 update of the WSES Jerusalem guidelines

ults



Open Appendectomy

- Trendelenburg position with rotation of the bed to the patient's left.
- Tracing the taenia libera.
- Dividing the mesoappendix.
- The appendiceal stump → simple ligation or by ligation and inversion
- Obliteration of the mucosa → prevention of a mucocoele development
- Pus in the abdomen should be aspirated, but irrigation in complicated appendicitis is not recommended.
- Placement of surgical drains for both uncomplicated and complicated
- Inspection:
 - The cecum and mesentery should be inspected.
 - Crohn's disease or Meckel's diverticulum
 - In female patients, the reproductive organs
 - Valentino's appendicitis = a perforated duodenal ulcer presenting as appendicitis,
- A medial extension of the incision (Fowler-Weir) or superior extension
- Selective laparoscopy through a right lower quadrant incision



Open Appendectomy

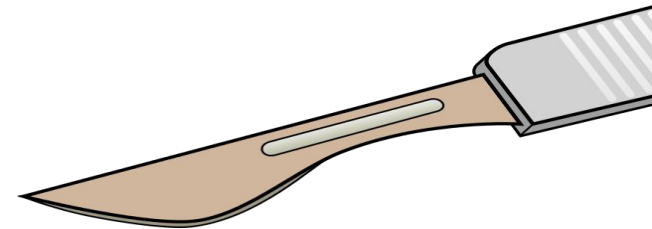
Modified McBurney
(aka Lanz or
Langer's line
incision)

McBurney

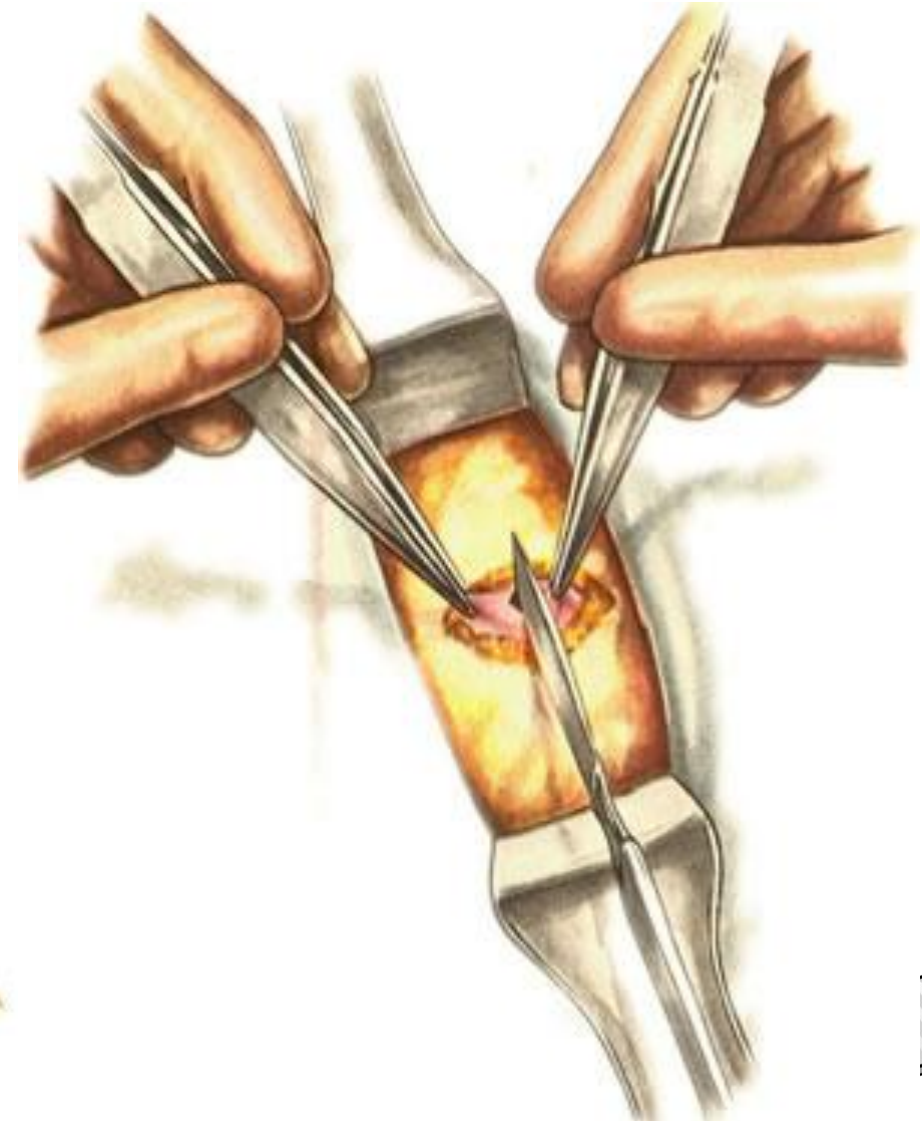
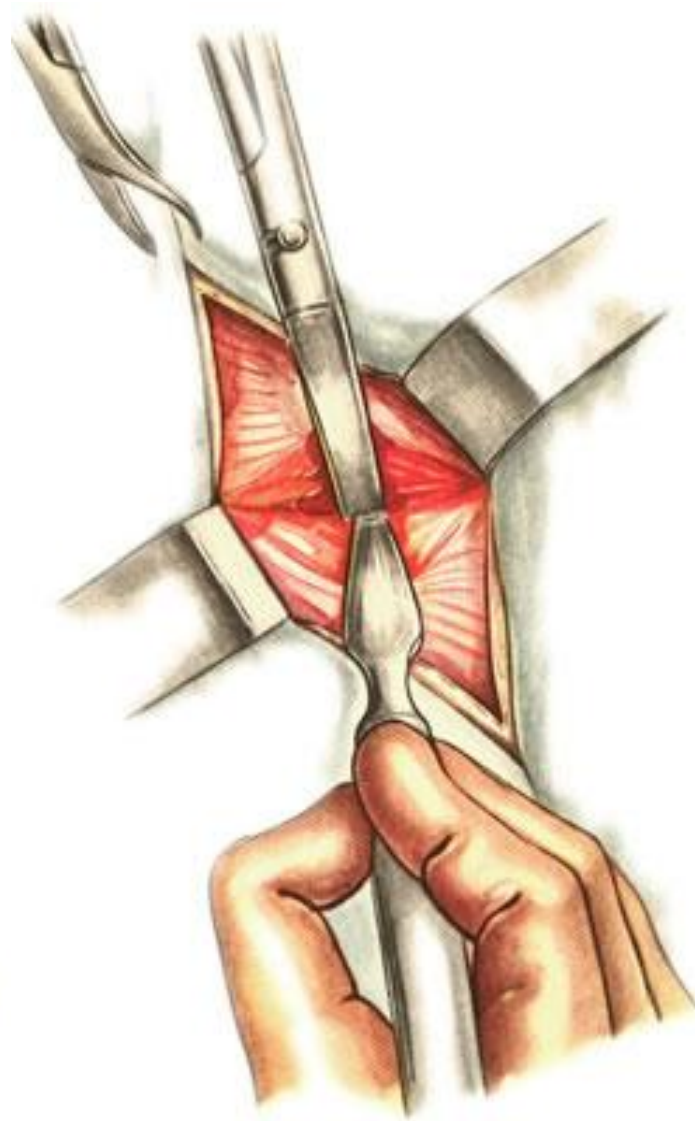
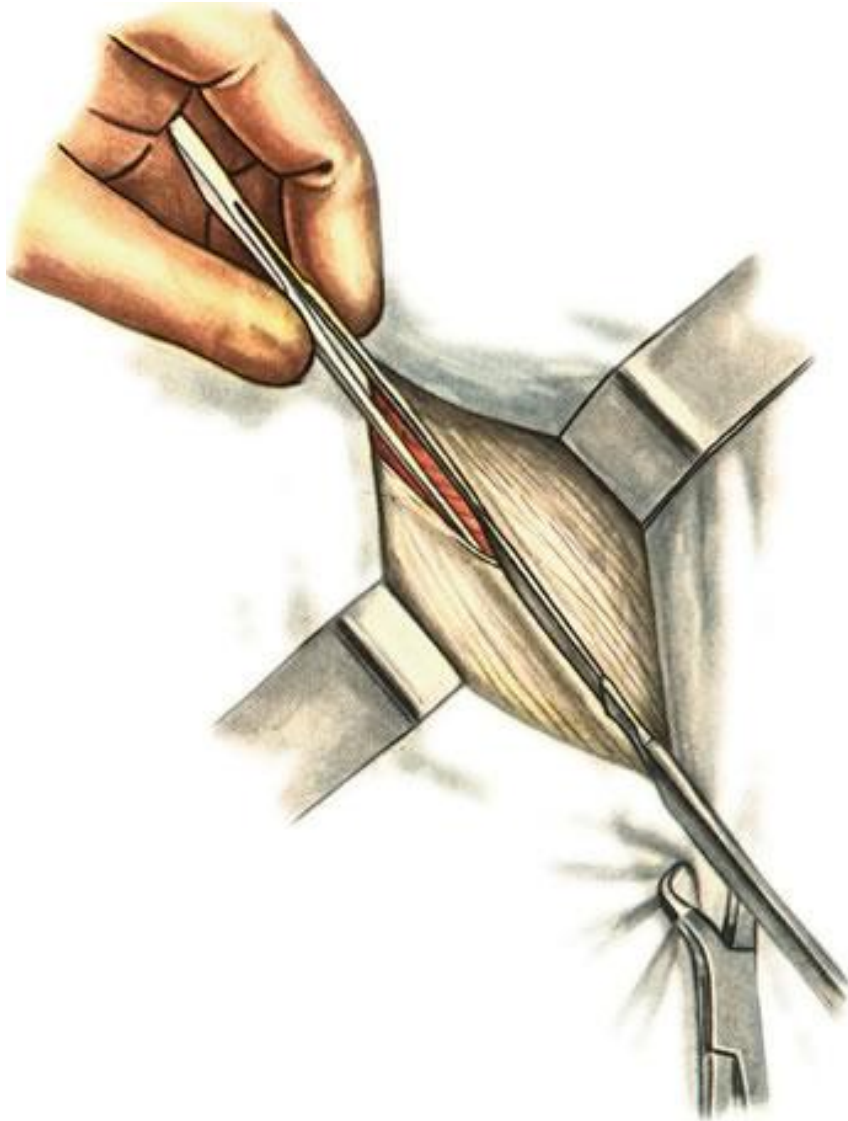
Rutherford
Morrison
extension

Rockey-Davis

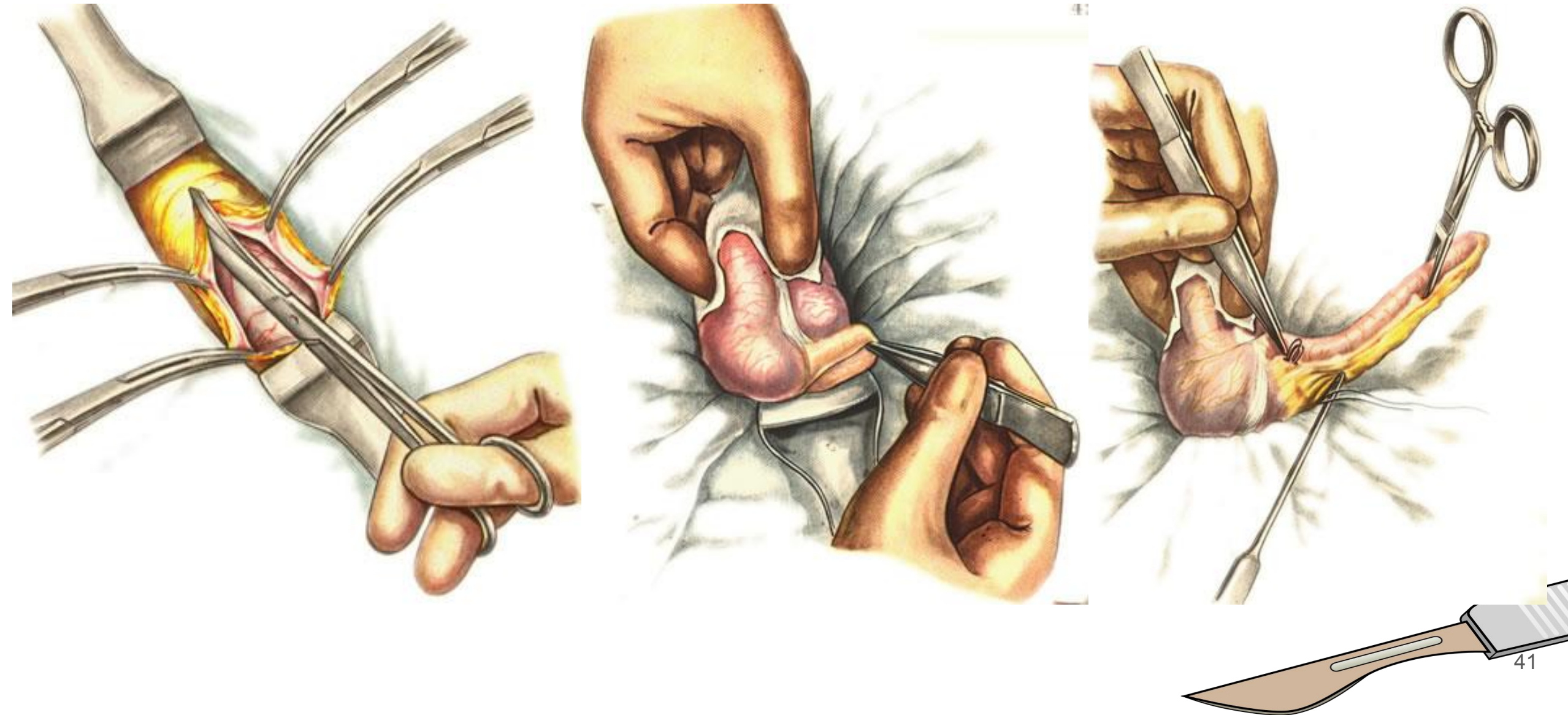
Fowler-Weir
extension



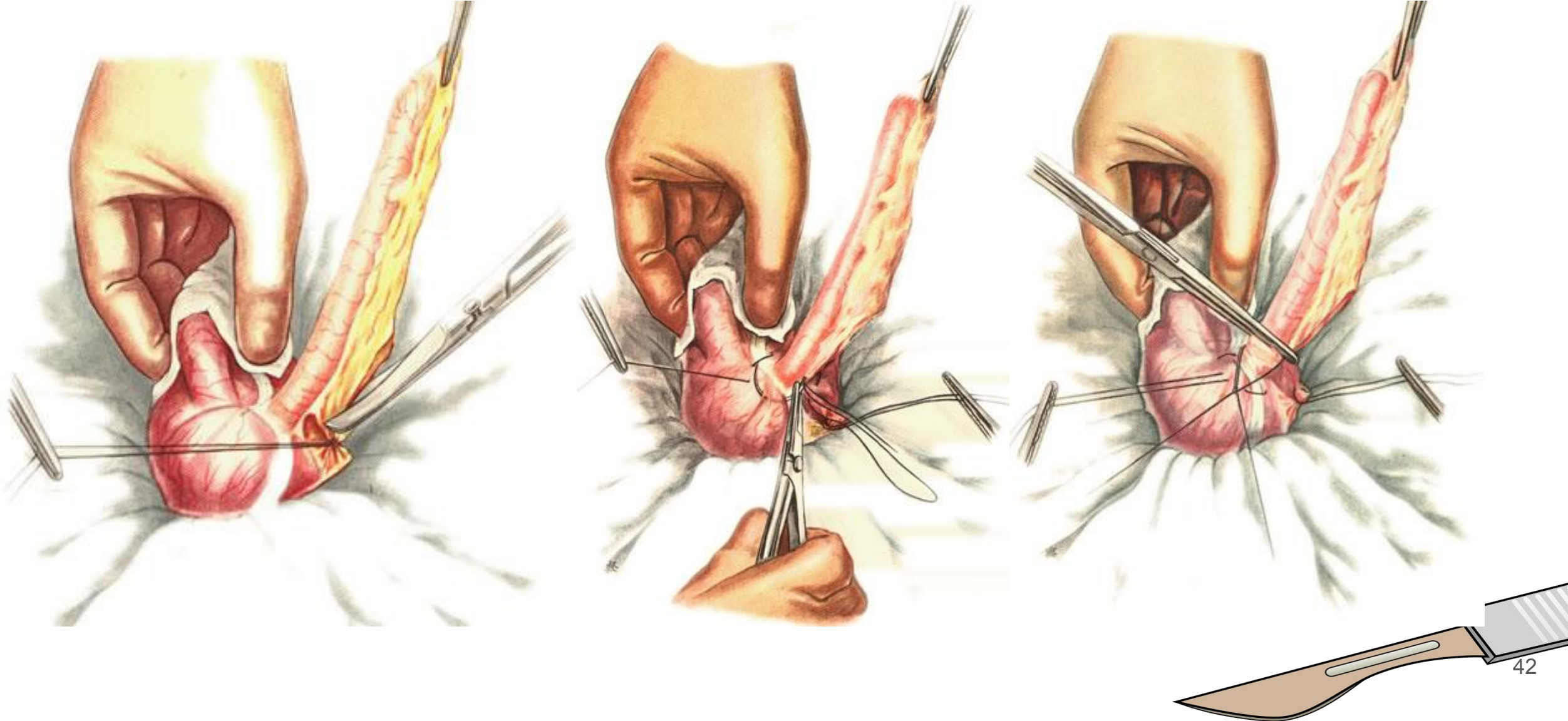
Open Appendectomy



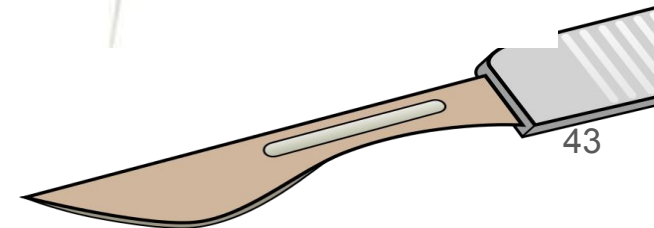
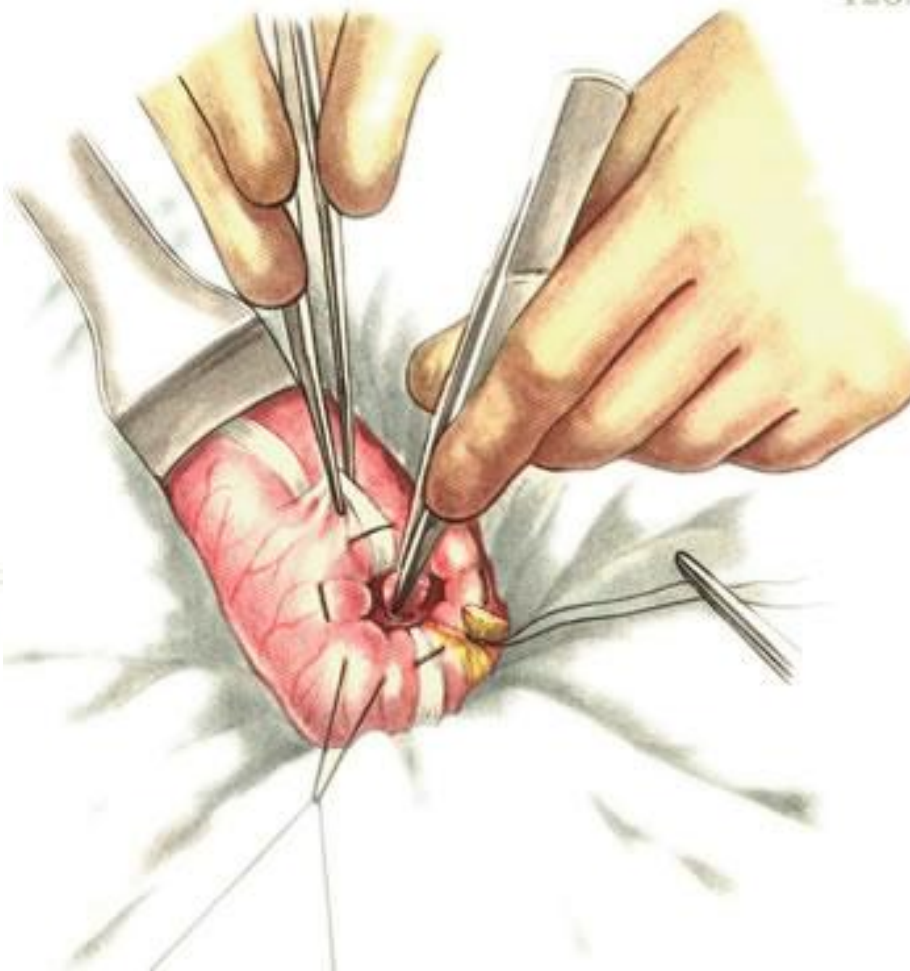
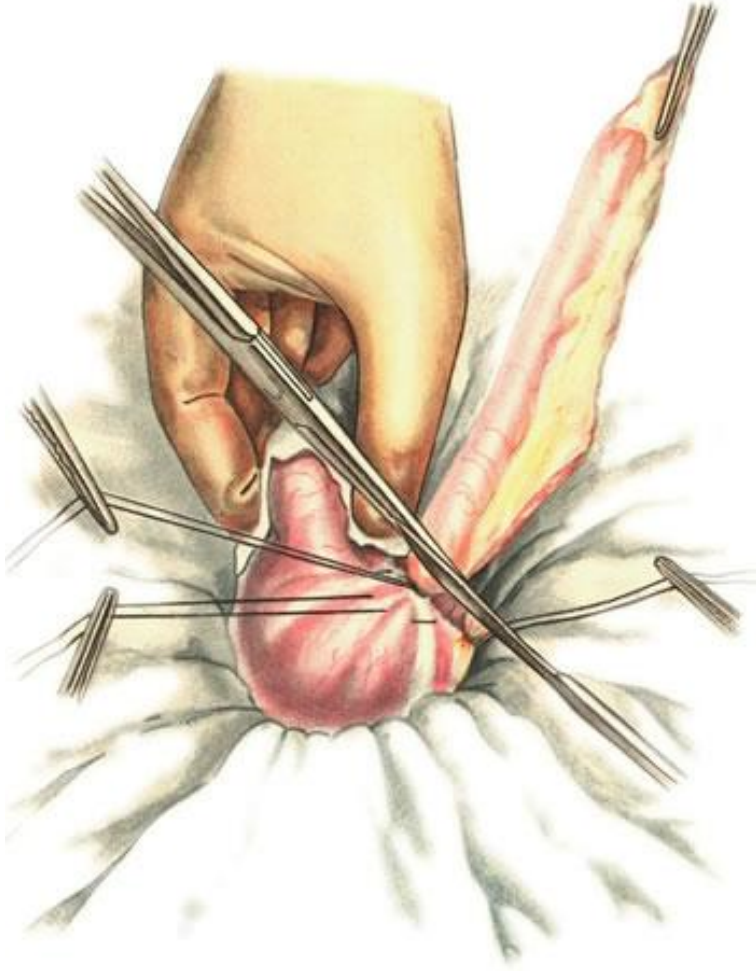
Open Appendectomy



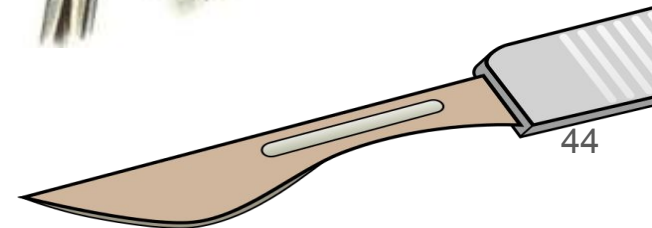
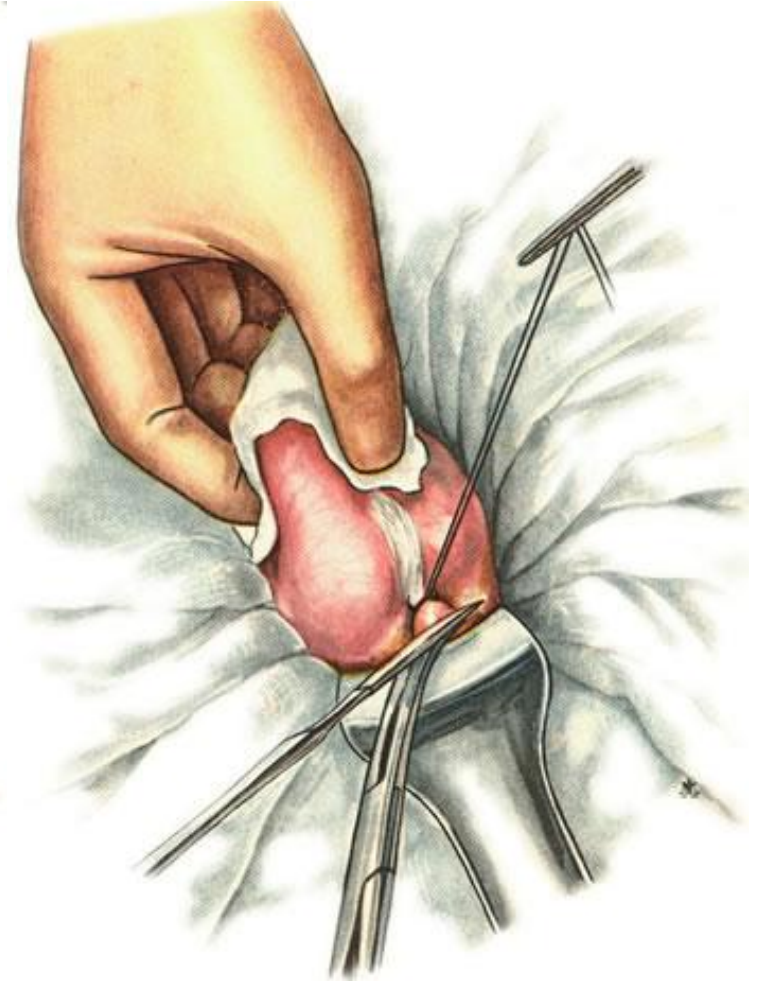
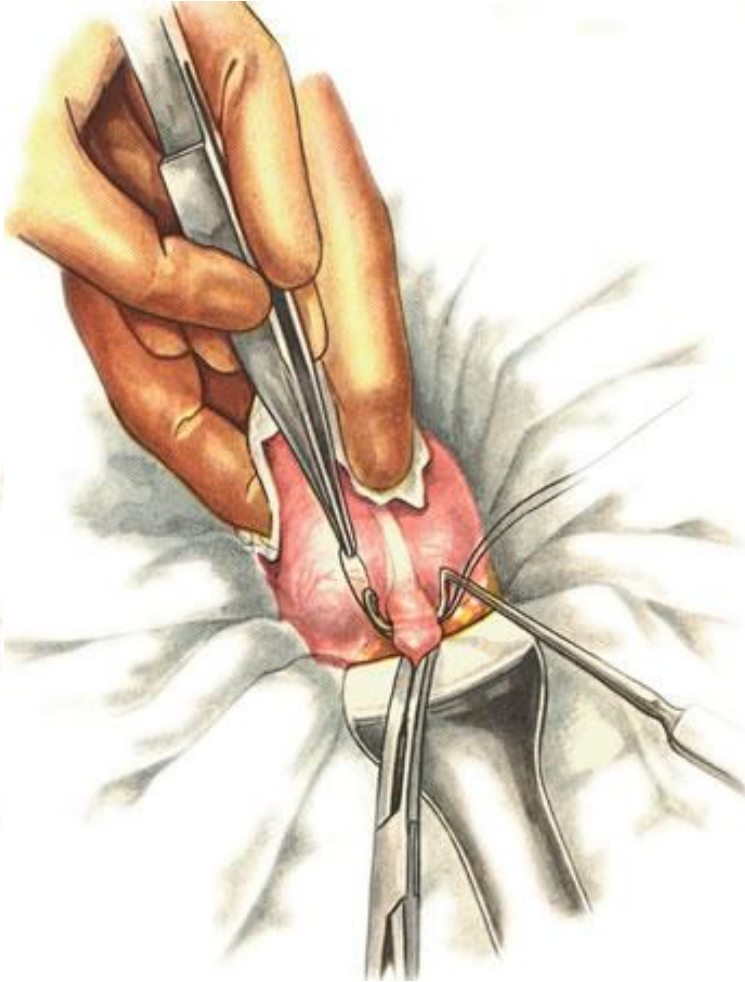
Open Appendectomy



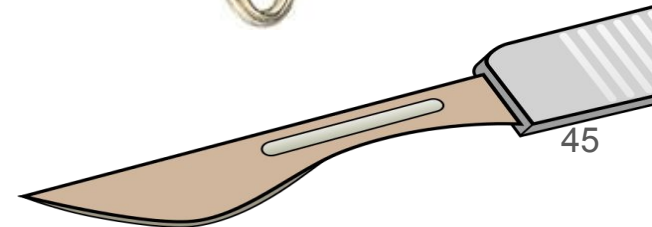
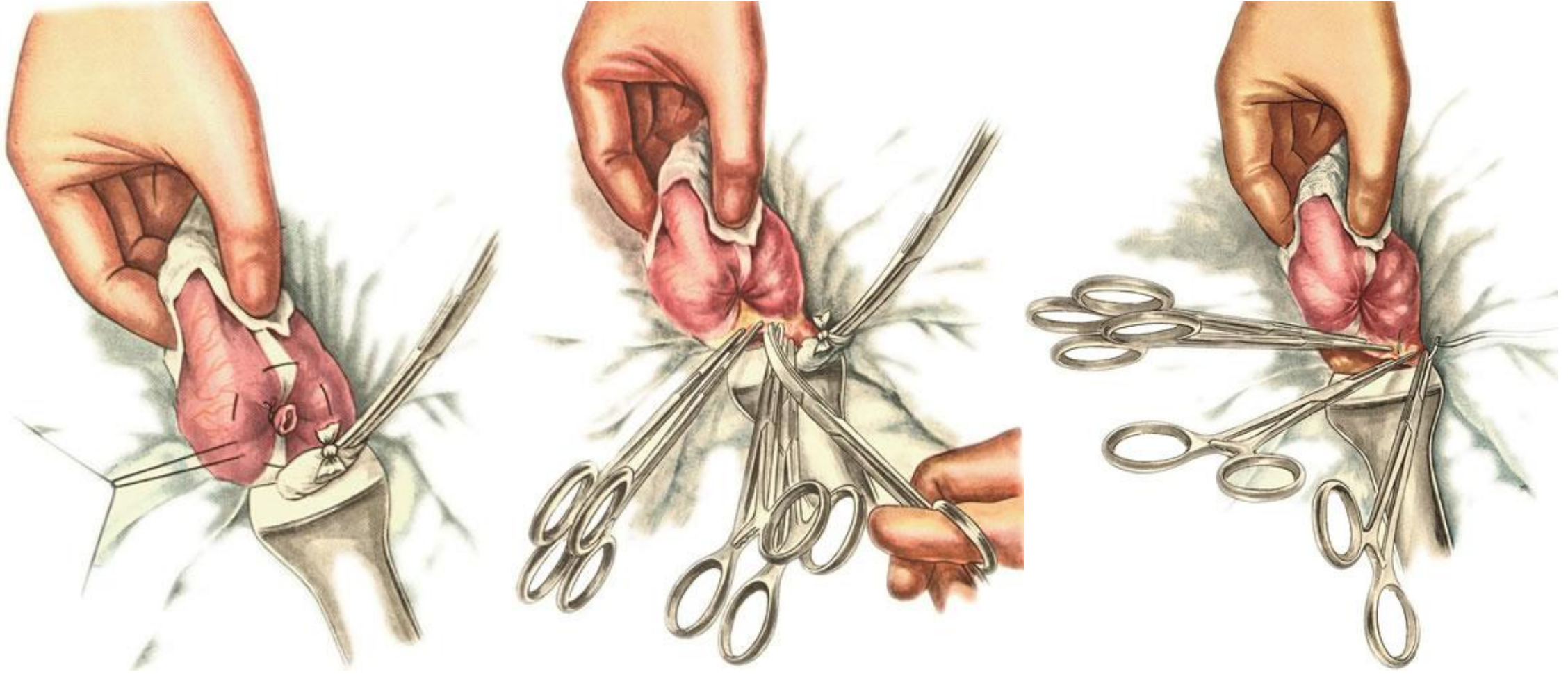
Open Appendectomy



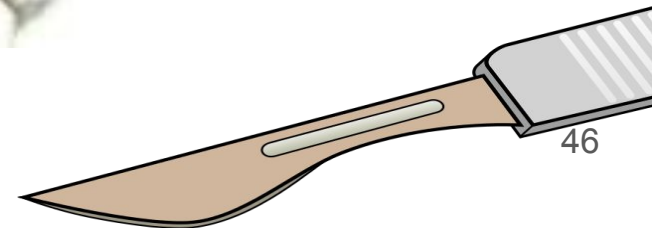
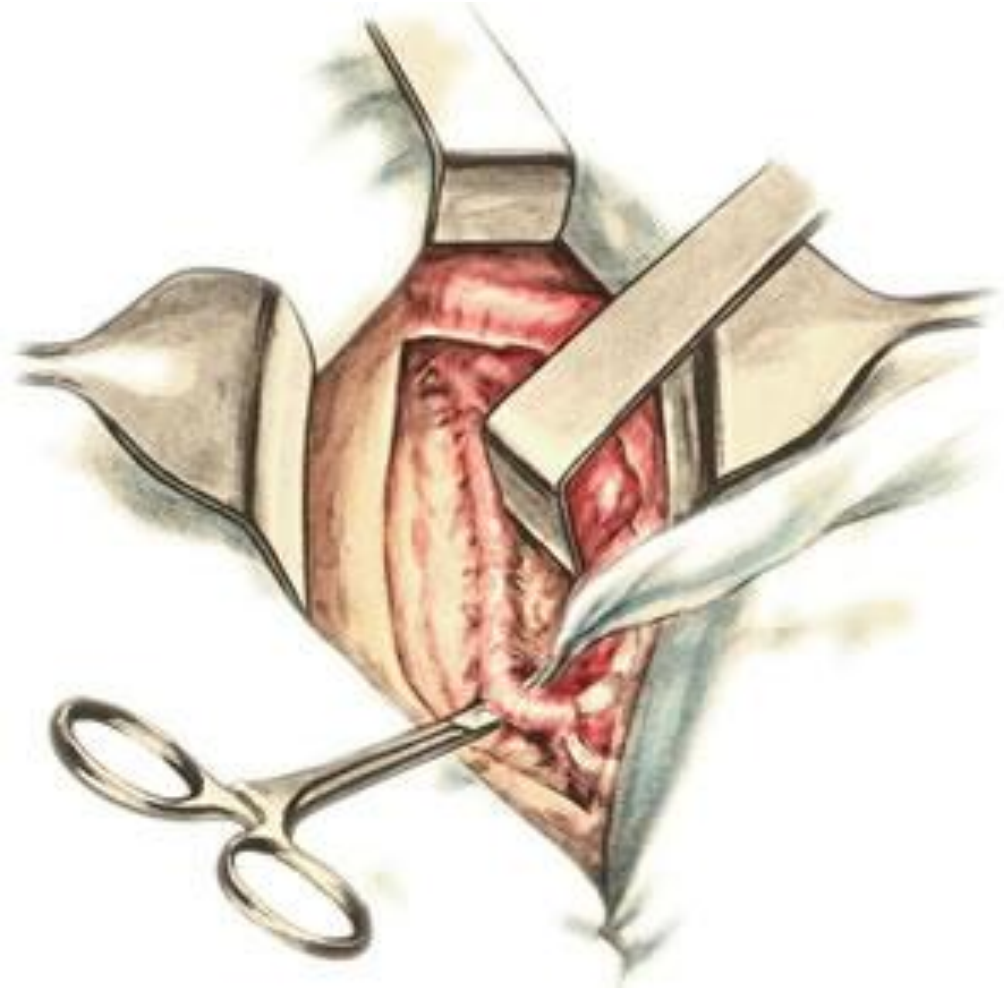
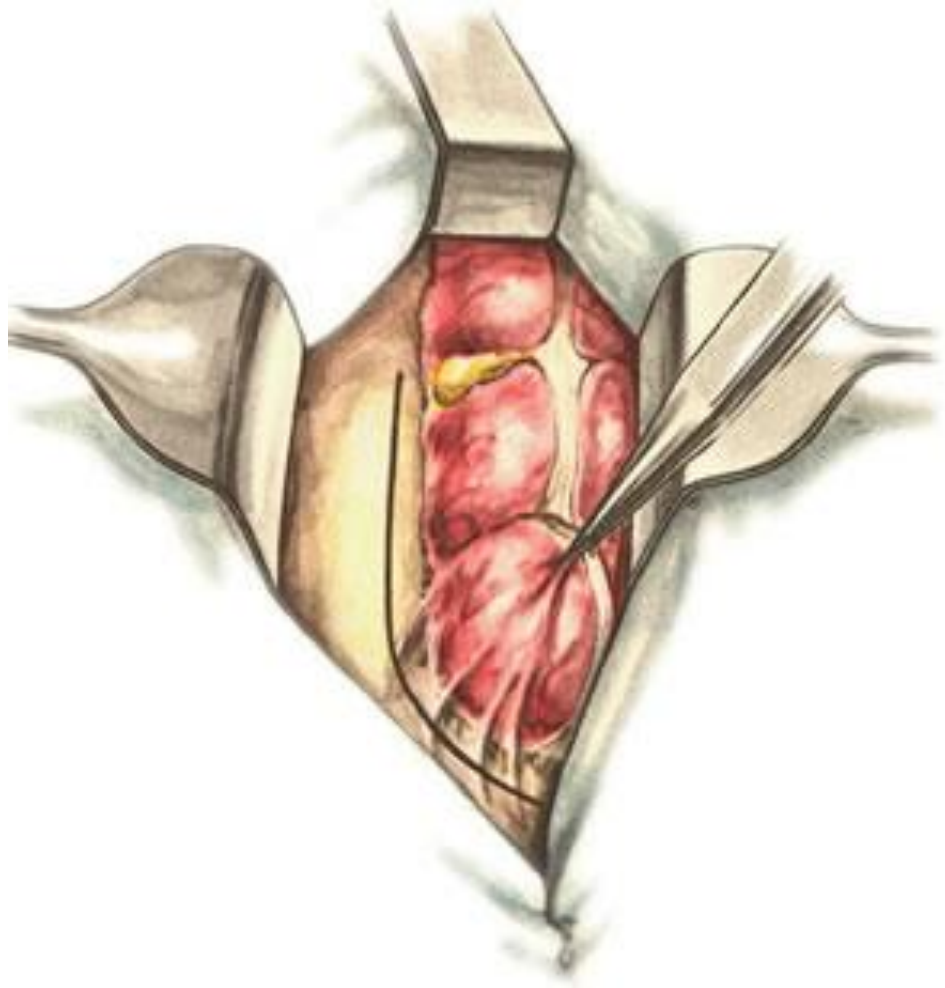
Open Retrograde Appendectomy



Open Retrograde Appendectomy

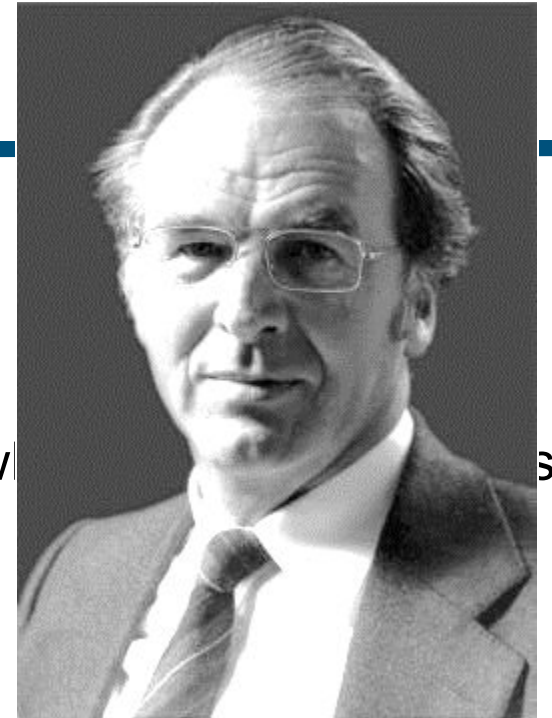


Open Appendectomy (Retroperitoneal appendix)



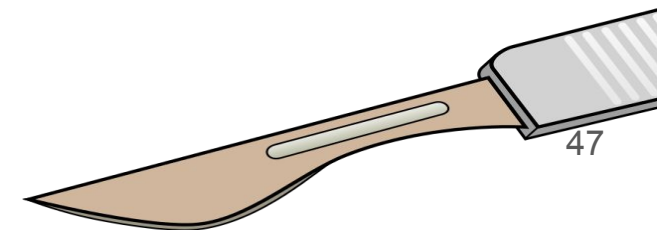
Laparoscopic Appendectomy

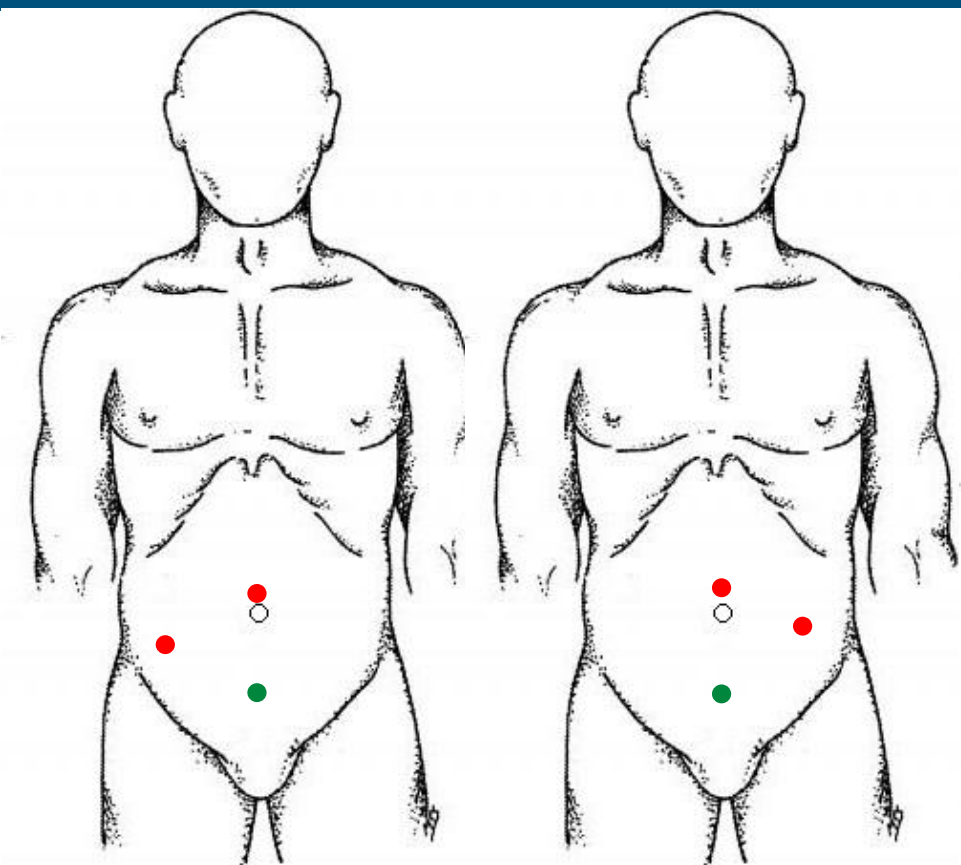
- The first reported laparoscopic appendectomy - 1983 by Semm
- An oro- or nasogastric tube and urinary catheter.
- Left arm tucked and body securely strapped to the operating table.
- Three ports. Typically, a 10- or 12-mm port is placed at the umbilicus, w are placed suprapubic and in the left lower quadrant
- Trendelenburg and tilted to the left
- An “appendiceal critical view:”
 - Appendix - 10 o'clock
 - Taenia libera is at the 3 o'clock
 - Terminal ileum at the 6 o'clock
- Laparoscopic Single-Incision Appendectomy
- Natural orifice transluminal endoscopic surgery (NOTES)



Kurt Karl Stephan Semm
(1927 – 2003)

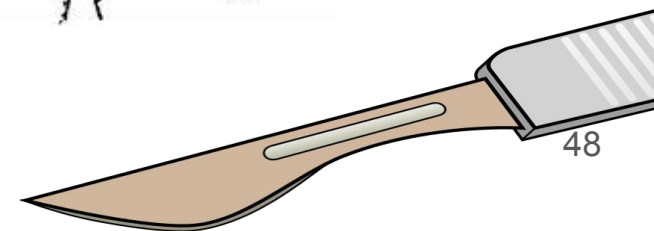
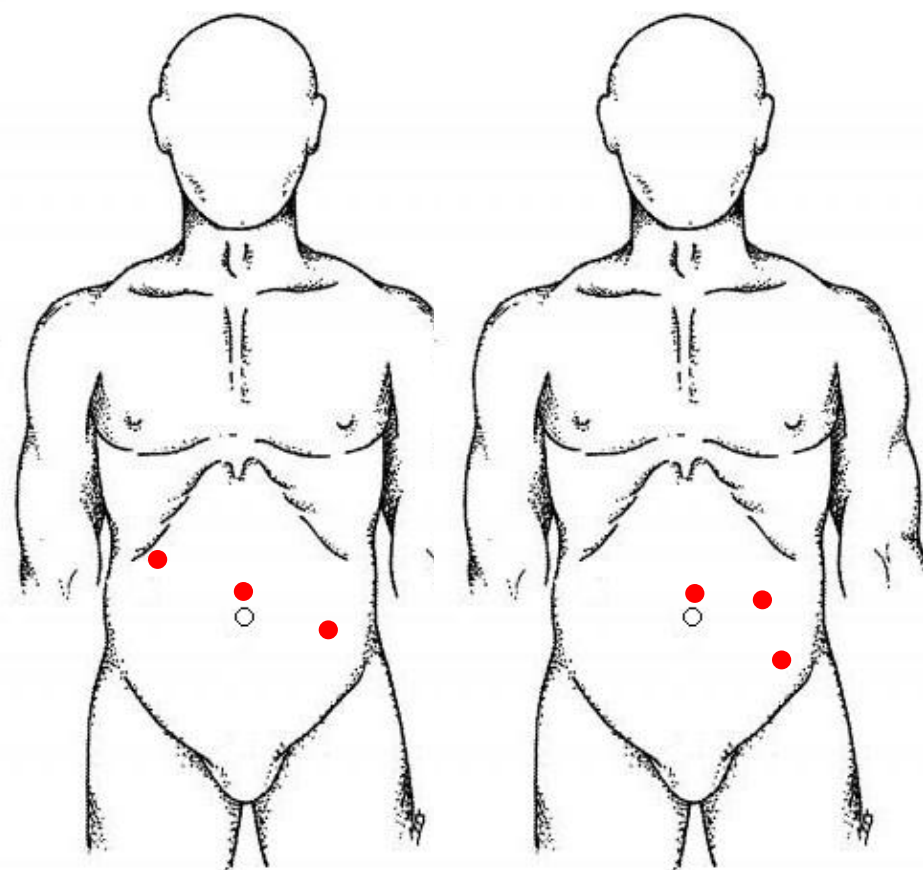
- Laparoscopic Single-Incision Appendectomy
- Natural orifice transluminal endoscopic surgery (NOTES)



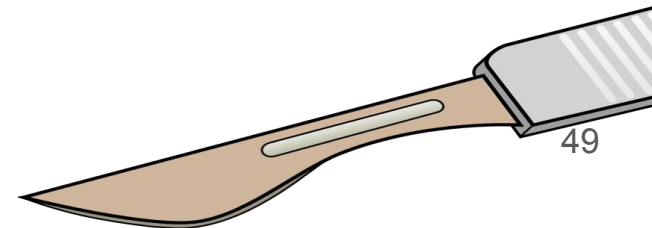
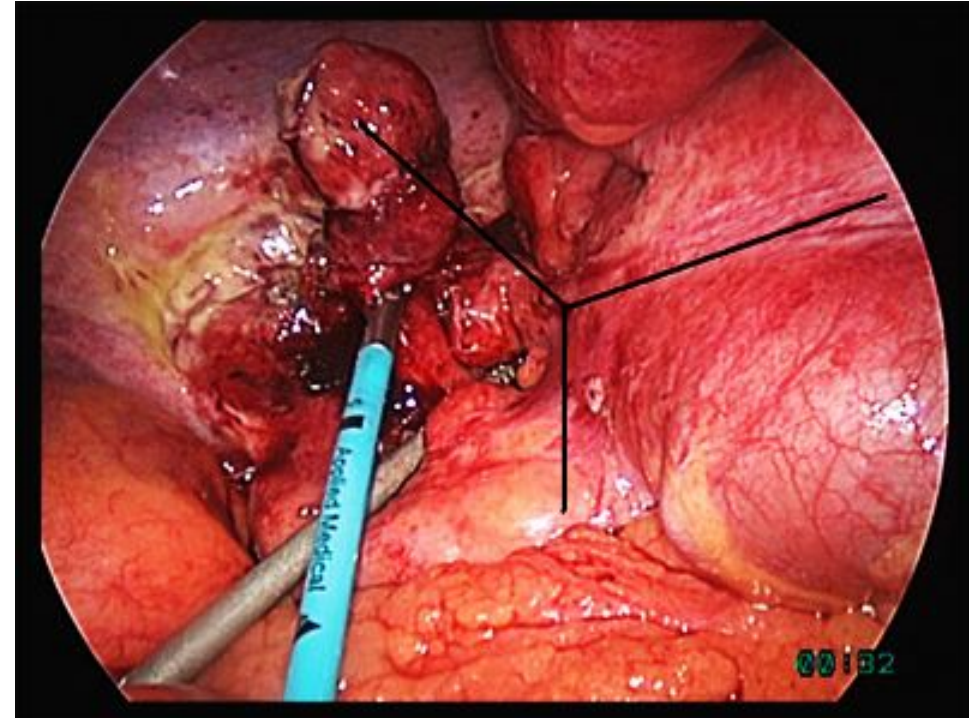


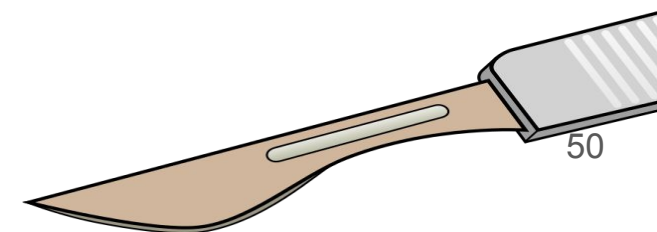
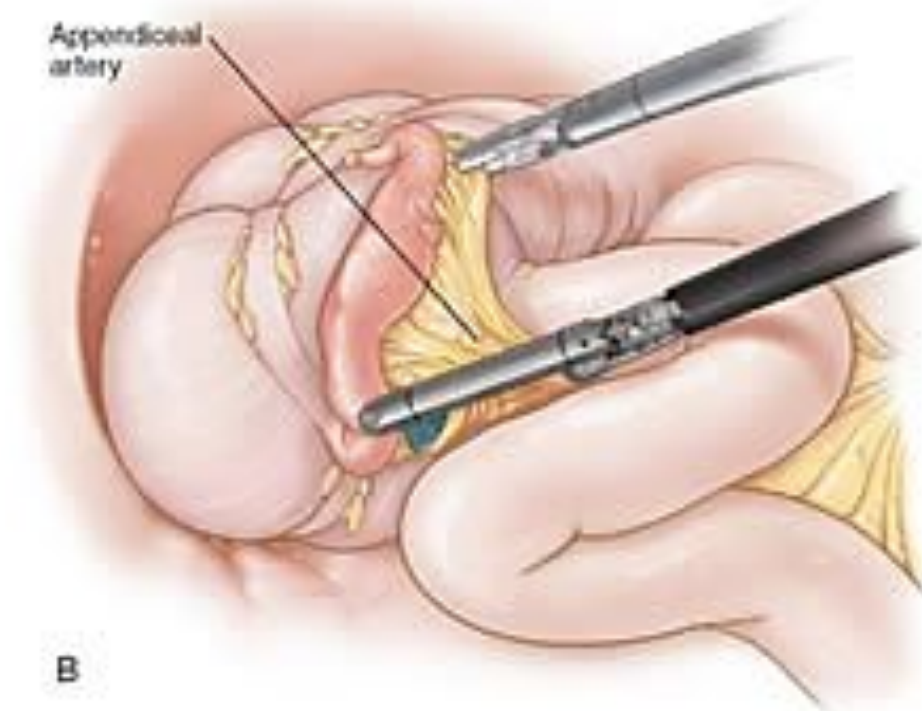
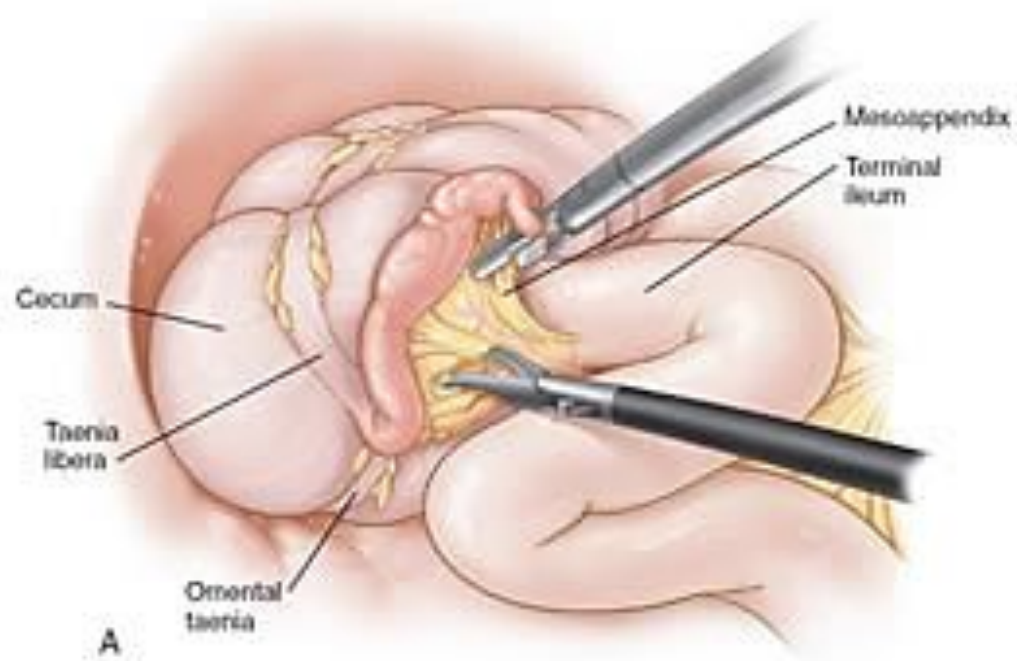
Classical Port Sites

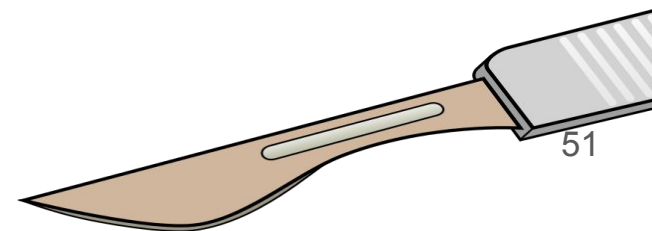
Alternative Port Sites

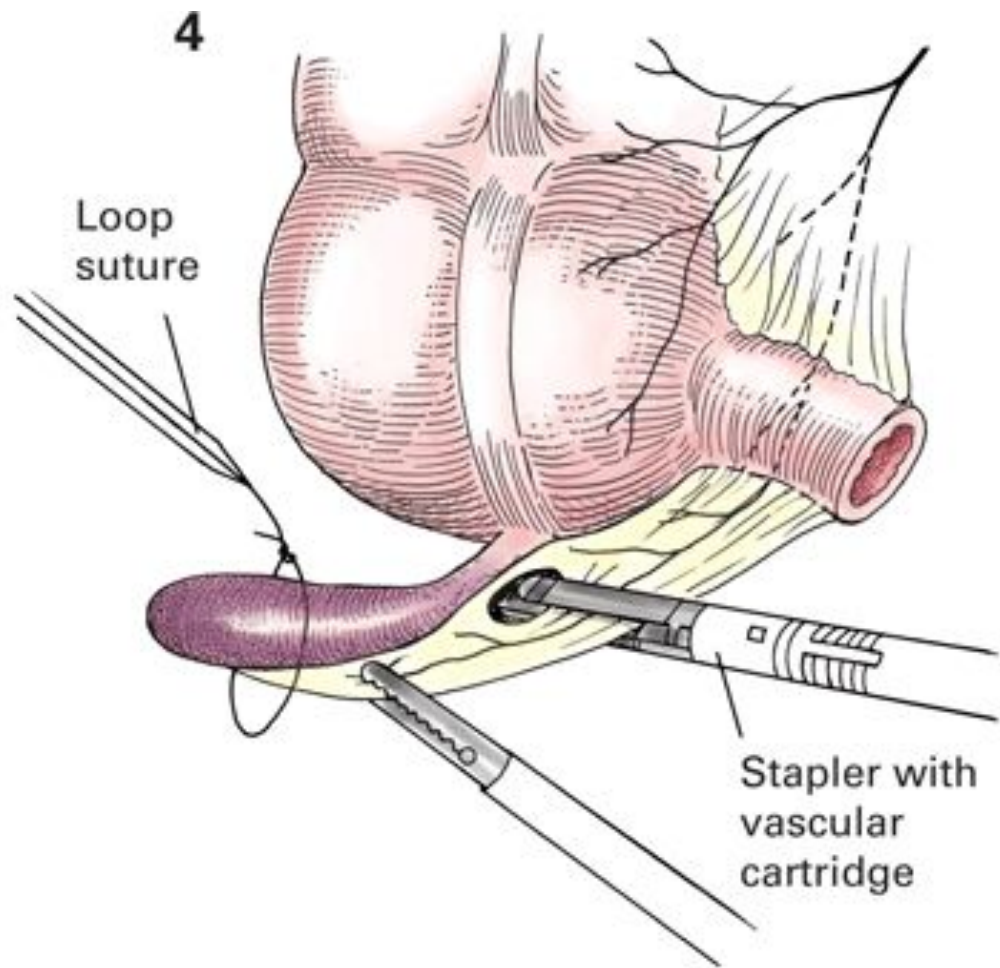


- Incomplete appendectomy → Stump Appendicitis
- ~9 years after their initial surgery.
- More likely to have complicated appendicitis,
- “**Appendiceal critical view**” (appendix placed at 10 o’clock, taenia coli/libera at 3 o’clock, and terminal ileum at 6 o’clock)
- The remaining stump should be no longer than 0.5 cm

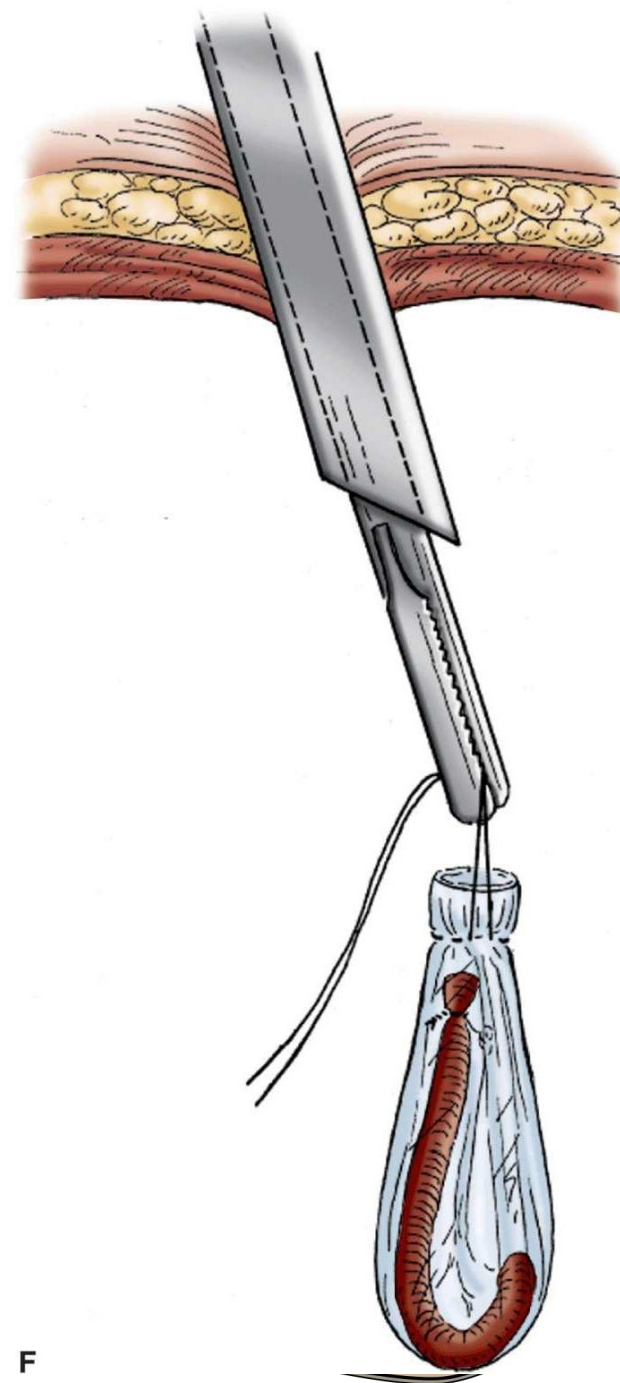






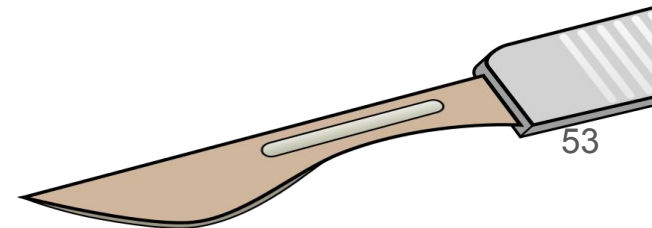


Source: Zollinger RM, Ellison EC: *Zollinger's Atlas of Surgical Operations*, 9th Edition:
<http://www.accesssurgery.com>
 Copyright © The McGraw-Hill Companies, Inc. All rights reserved.



INCIDENTAL APPENDECTOMY

- Neither clinically nor economically appropriate
- Exceptions:
 - Children about to undergo chemotherapy
 - Disabled who cannot describe symptoms or react normally to abdominal pain
 - Crohn's disease in whom the cecum is free of macroscopic disease,
 - Travel to remote places where there is no access to medical or surgical care
- Appendectomy is routinely carried out during the performance of Ladd's procedure



Tumors of the Appendix

Carcinoid

- Firm, yellow, bulbar located in the tip
- Tumor can occasionally obstruct the appendiceal lumen → acute appendicitis.

Treatment for tumors ≤ 1 cm is **appendectomy**.

For tumors

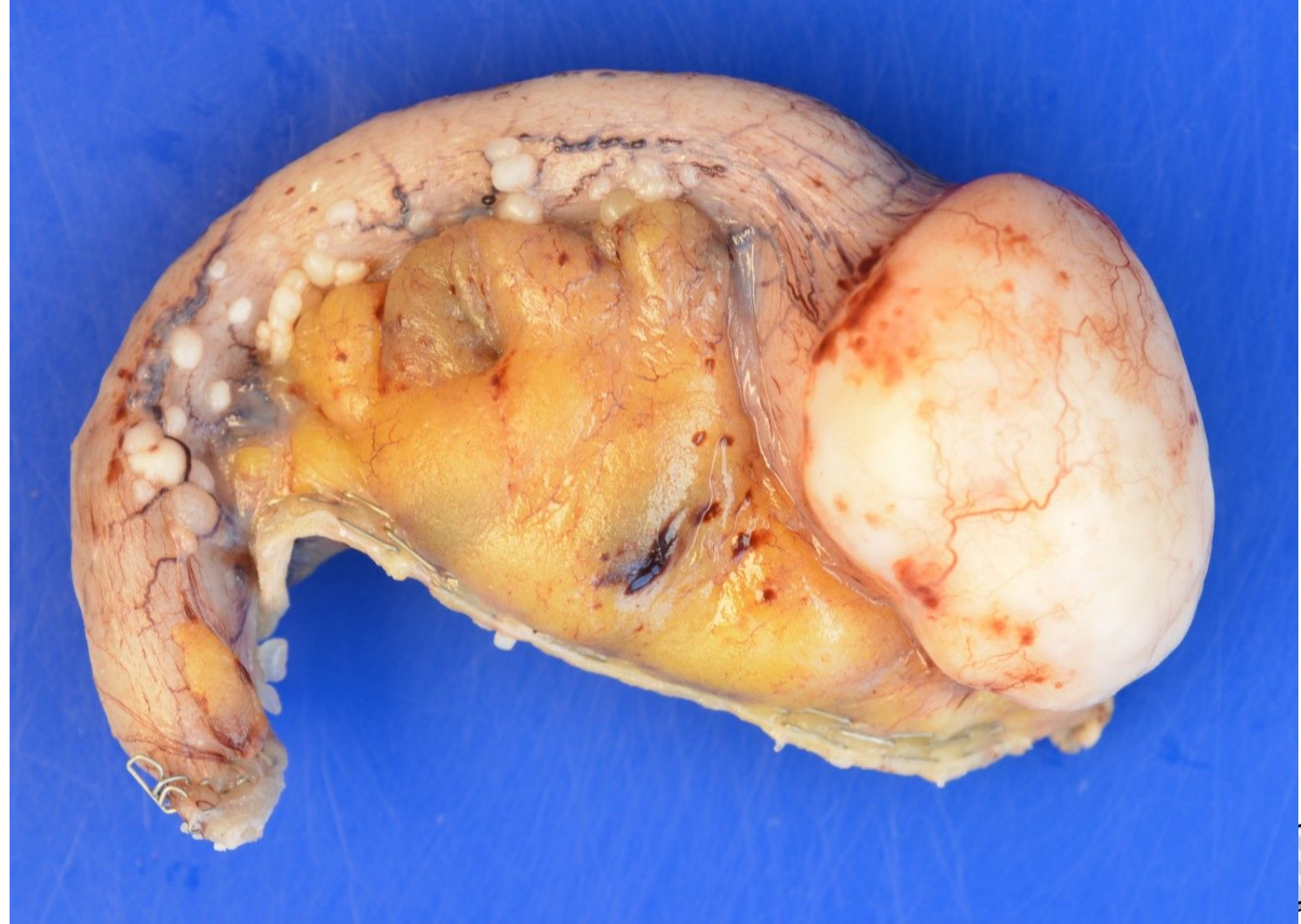
Larger than 1 to 2 cm

Located at the base

Involving the mesentery

Lymph node metastases

- **Right hemicolectomy**



Tumors of the Appendix

Adenocarcinoma

- Rare
- Right hemicolectomy

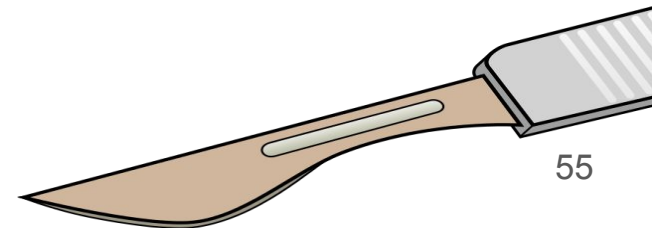
Lymphoma

- site for non-Hodgkin's lymphoma.
- Burkitt's lymphoma
- Appendiceal lymphoma usually presents as acute appendicitis
- Confined to the appendix → appendectomy.
- Beyond the appendix onto the cecum or mesentery → Right hemicolectomy

Mucocele

Retention cysts
Mucosal hyperplasia
Cystadenomas
Cystadenocarcinomas

- Incidental finding.
- Ruptured → Conversion to open laparotomy is recommended.
- **Resection of the appendix**, wide resection of the mesoappendix to include all the appendiceal lymph nodes, collection and cytologic examination of all intraperitoneal mucus, and careful inspection of the base of the appendix.
- **Radical right hemicolectomy** or ileocecectomy

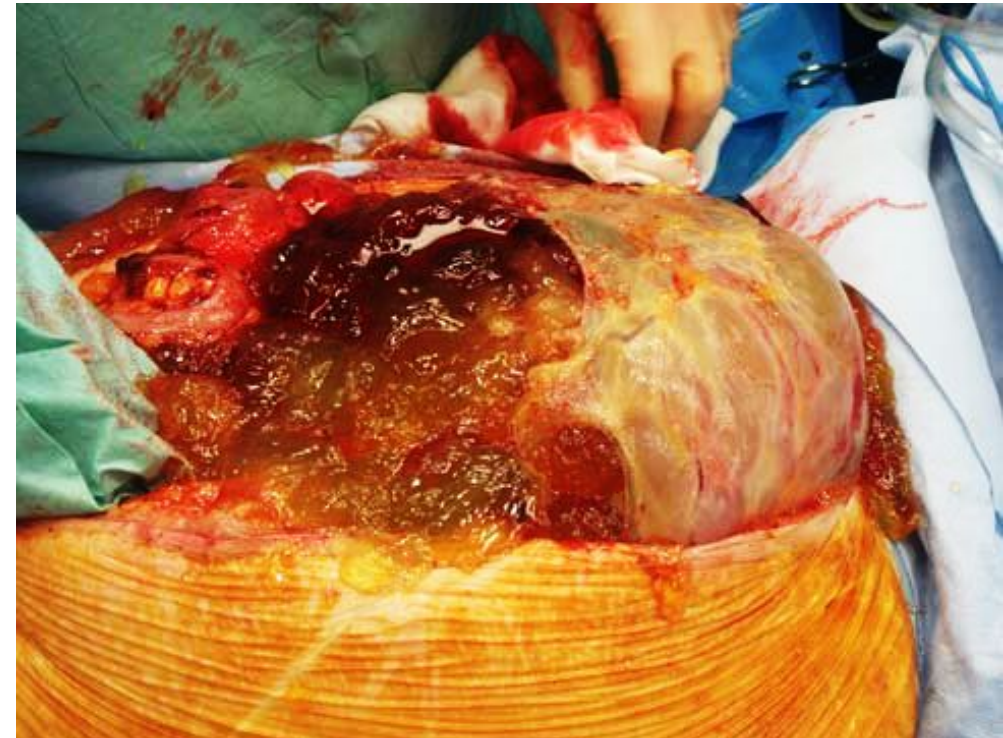


Tumors of the Appendix

Pseudomyxoma Peritonei

- Gelatinous fluid
- Mucinous implants
- Appendix is the site of origin
- Neoplastic mucus-secreting cells
- Abdominal pain, distention, or a mass.
- Ureteral obstruction
- Slow progress
- 76% of patients developed recurrences
- Mucinous ascites is found together with tumor deposits

- Surgical debulking
- Appendectomy
- Hysterectomy with bilateral salpingo-oophorectomy
- Intraperitoneal hyperthermic chemotherapy
- Surgery for recurrent disease is usually difficult



Thank you!