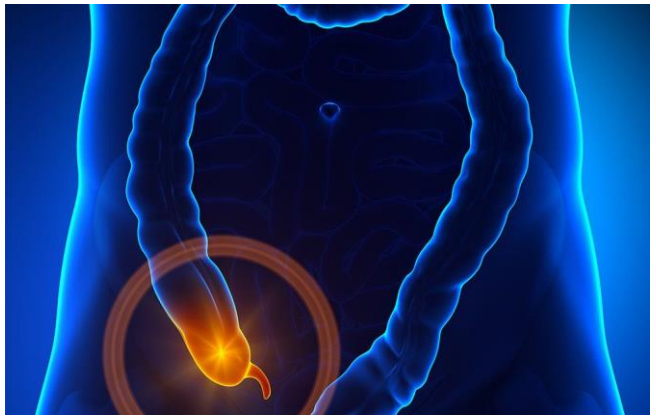


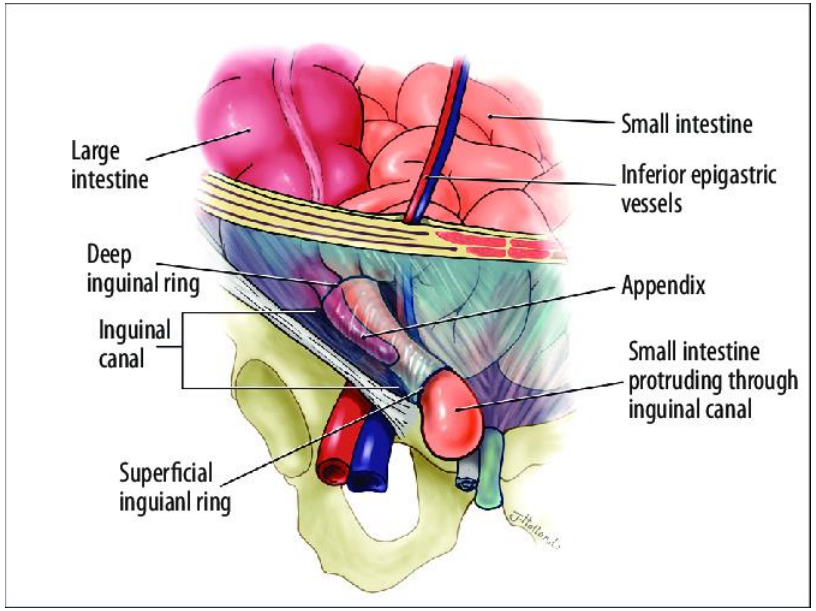
مستشفى الكِندي
Al-Kindi Hospital

THE APPENDIX

Ashraf Al-Faouri MD, MRCS, FACS
Consultant HBPS & Liver Transplantation

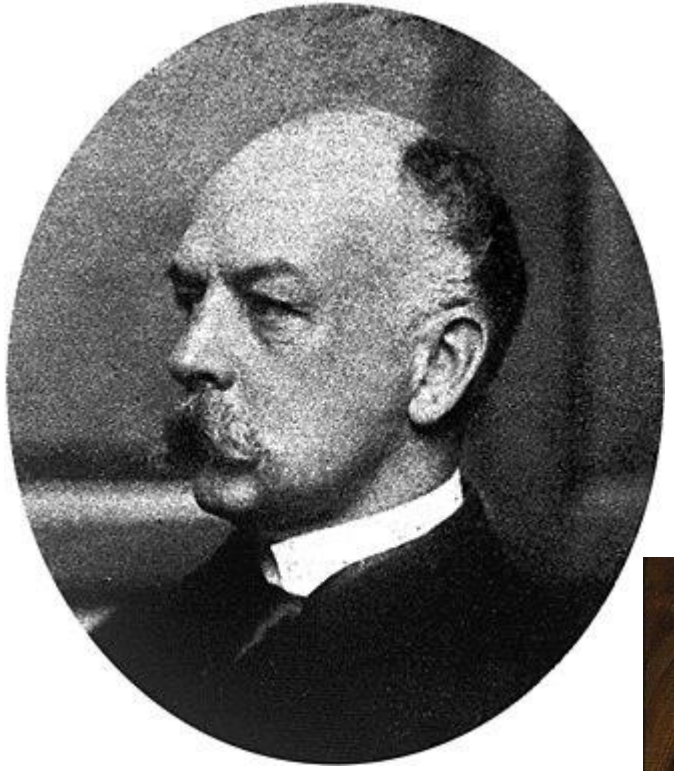
HISTORY

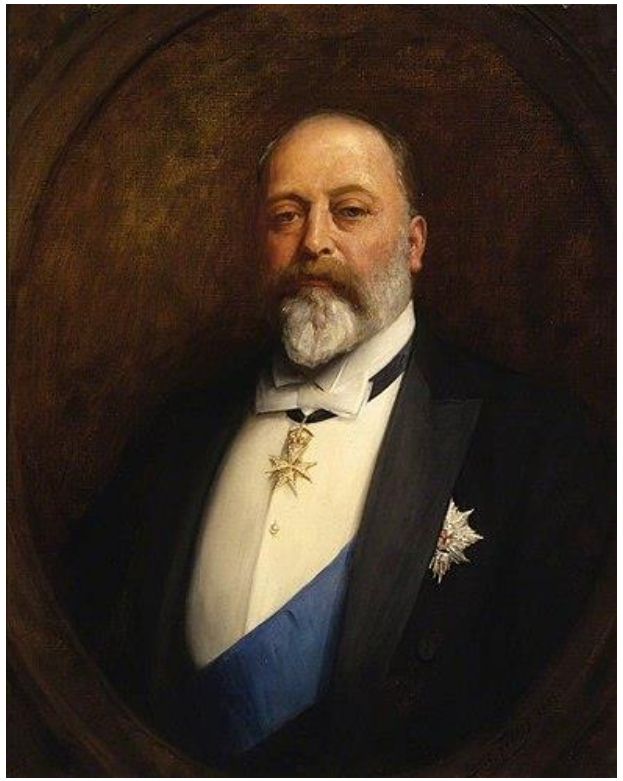
- Claudius Amyand in the early 18th century was the first surgeon to describe a successful appendectomy.
- Chester McBurney advocated for early appendectomy in his 1889 publication.
- In 1982, Kurt Semm, a gynecologist, reported on the first laparoscopic appendectomy, which is now the most widely adopted technique.



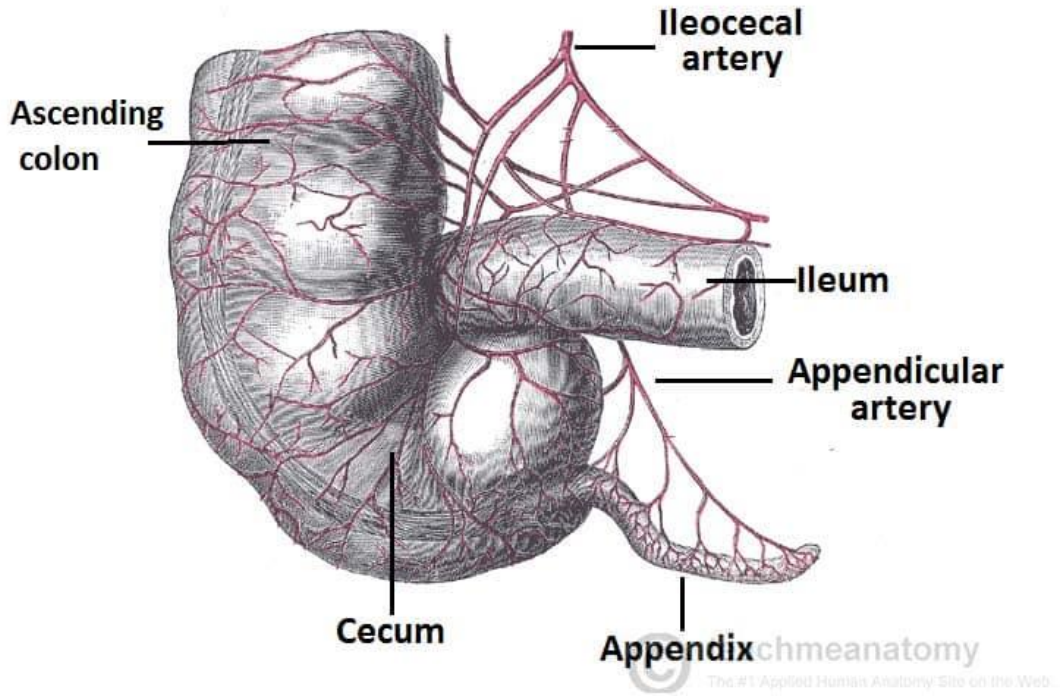
SOURCE CONTROL

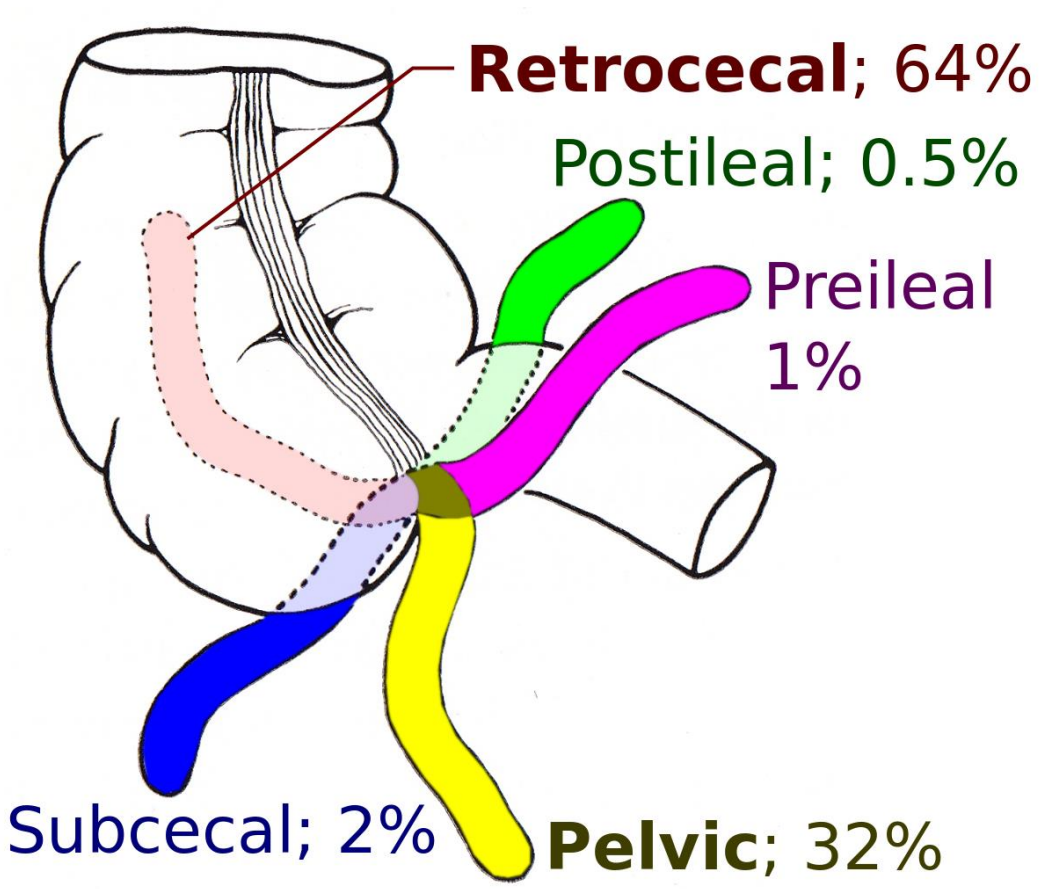
- The first intra-abdominal operation to treat infection via “source control” was appendectomy. This operation was pioneered by Charles McBurney at the New York College of Physicians and Surgeons, among others.
- McBurney’s classic report on early operative intervention for appendicitis was presented before the New York Surgical Society in 1889.
- Appendectomy for the treatment of appendicitis, previously an often fatal disease, was popularized after the 1902 coronation of King Edward VII of England was delayed due to his falling ill with appendicitis.
- Edward insisted on carrying out his schedule, despite worsening abdominal pain. Sir Frederick Treves, a prominent London surgeon, was among the consultants in attendance upon Edward. As the prince’s condition deteriorated, and as he continued to insist that he would go to Westminster Abbey to be crowned, Treves told him, “Then Sire, you will go as a corpse.” Edward relented, Treves drained a large periappendiceal abscess, and the king lived.



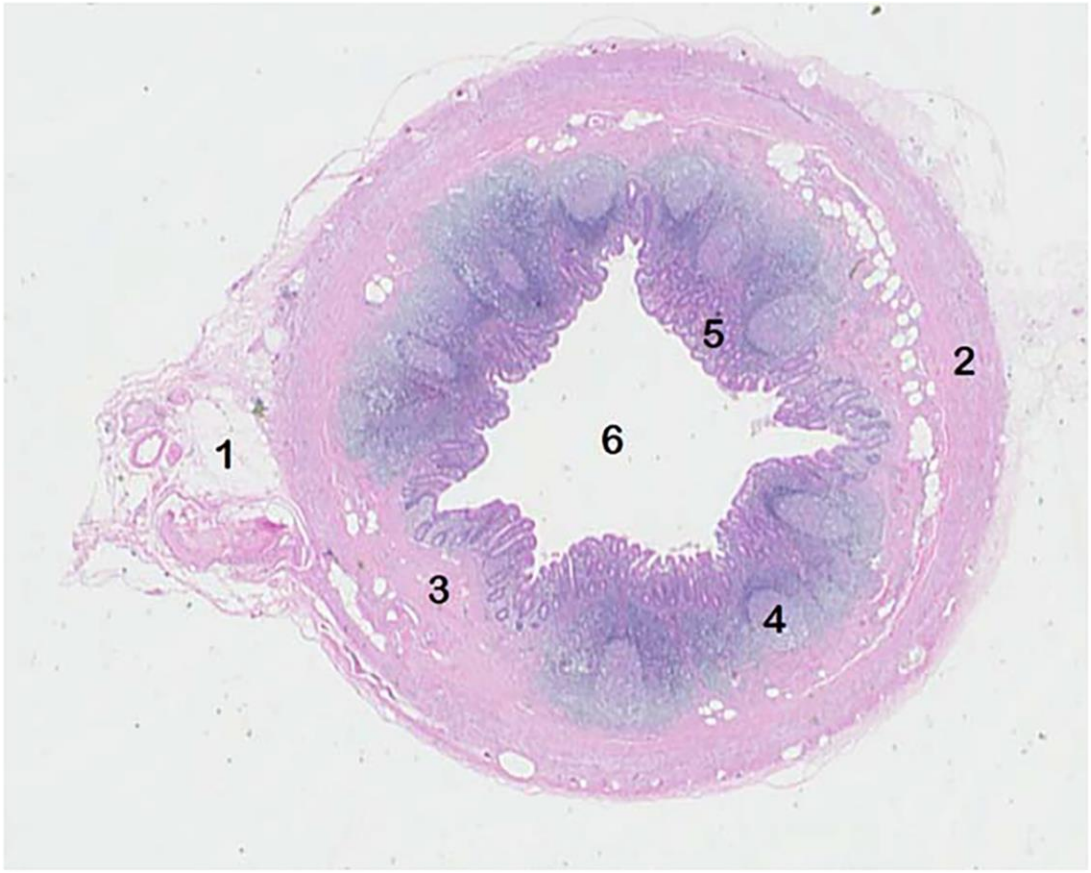


ANATOMY


Ileocecal artery
Ascending colon
Ileum
Appendicular artery
Cecum
Appendix

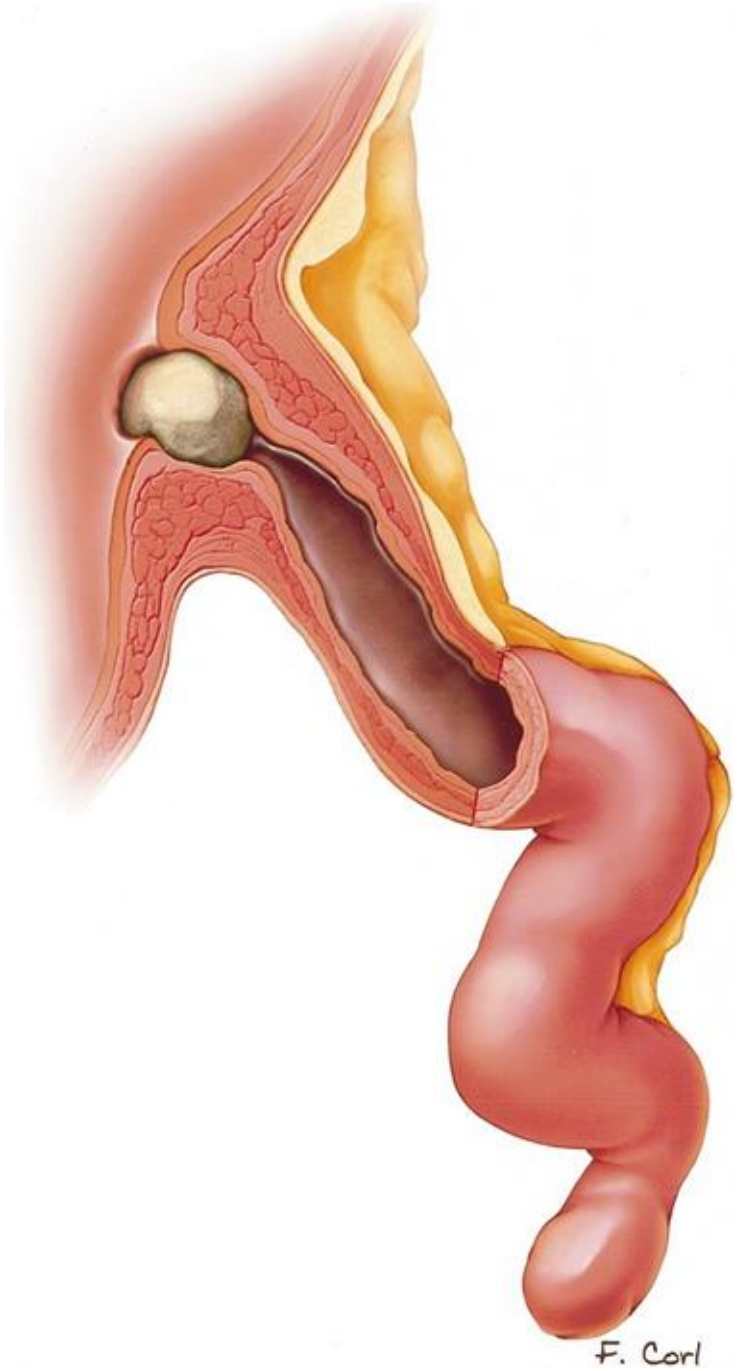

Retrocecal; 64%
Postileal; 0.5%
Preileal 1%
Subcecal; 2%
Pelvic; 32%

HISTOLOGY



ACUTE APPENDICITIS

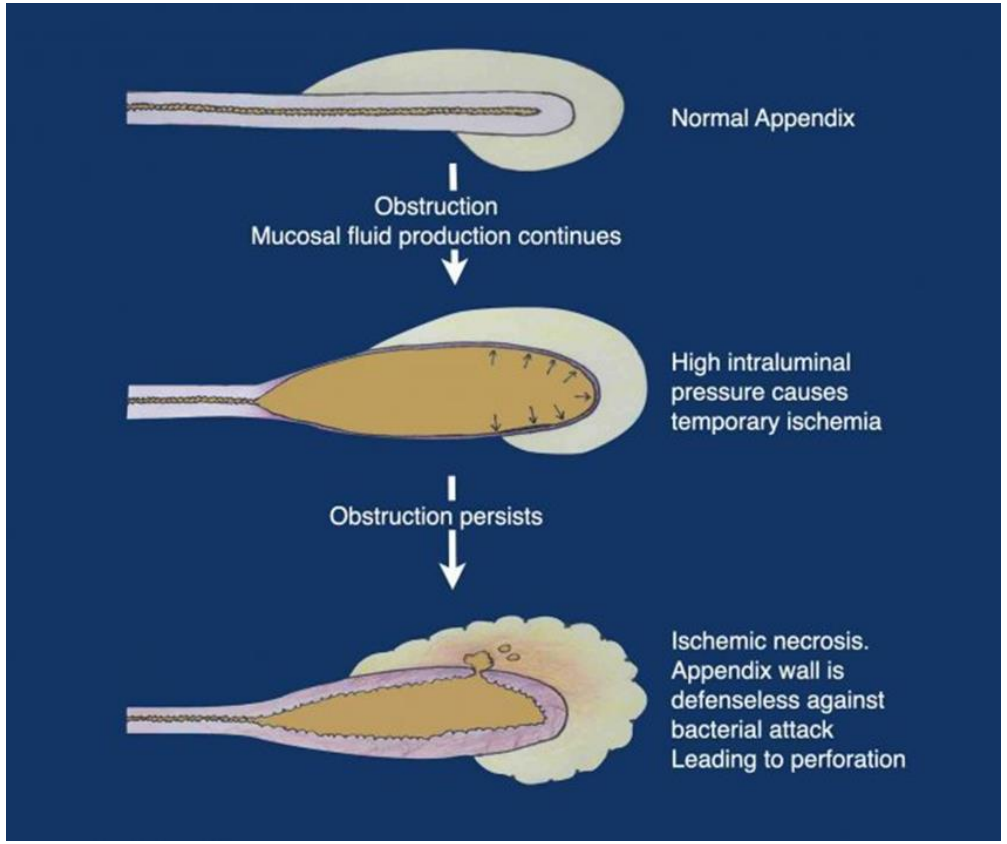
- The lifetime incidence: 8.6% in men and 6.7% in women, with the highest incidence occurring in the second and third decade of life.
- The most frequent emergent abdominal operations.
- The etiology of appendicitis is perhaps due to luminal obstruction that occurs as a result of lymphoid hyperplasia in pediatric populations; in adults, it may be due to fecaliths, fibrosis, foreign bodies (food, parasites, calculi), or neoplasia.

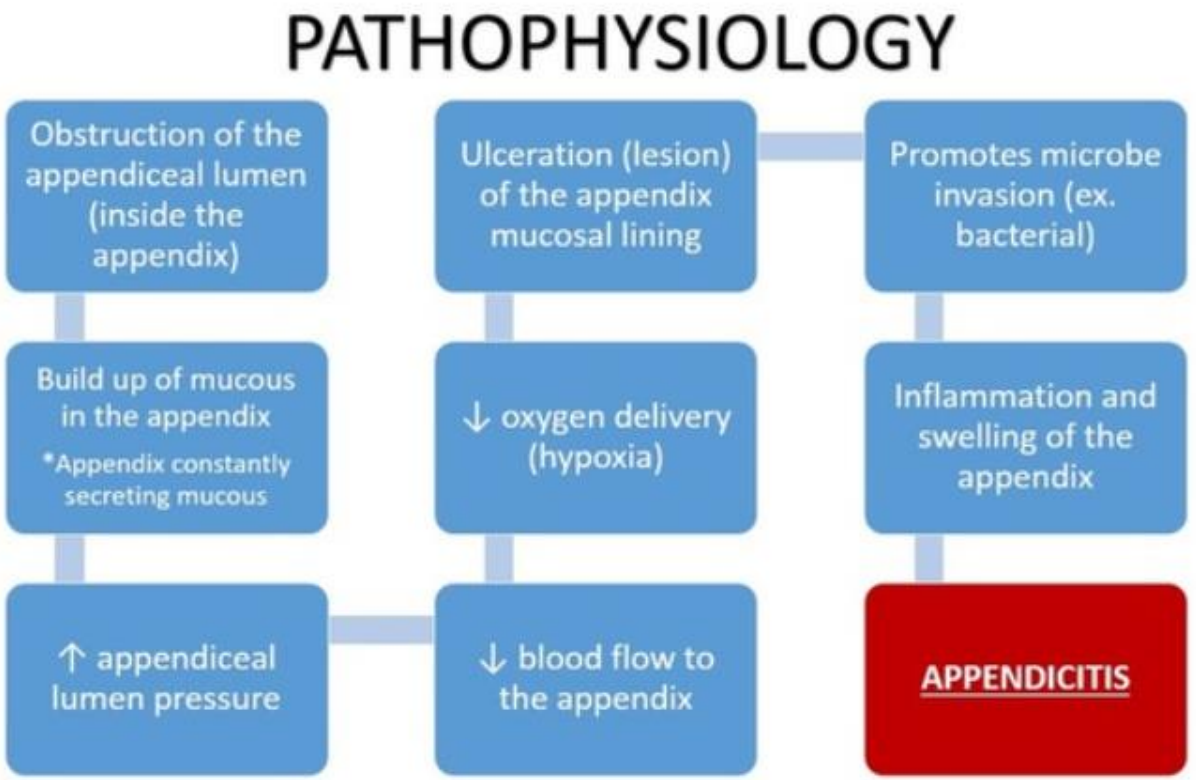


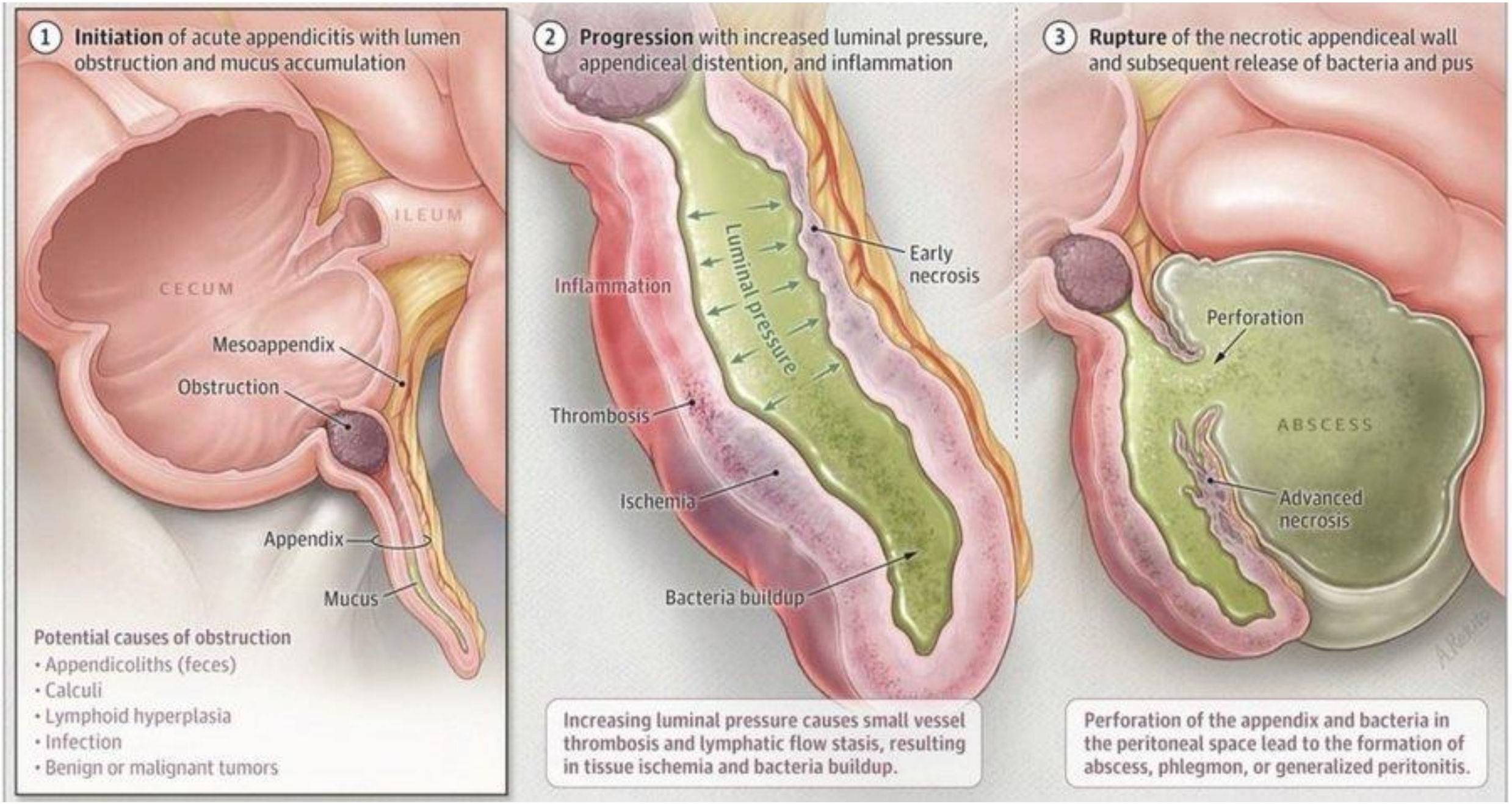
OBSTRUCTION

- Lymphoid hyperplasia, predominantly in young patients (60%)
- Appendicolith/ Fecolith (33%)
- Foreign bodies (4%)
- Crohn disease or other rare causes, e.g. stricture, tumor, parasite
- Appendiceal tumor (usually in patients over 50 years old)

PATHOPHYSIOLOGY



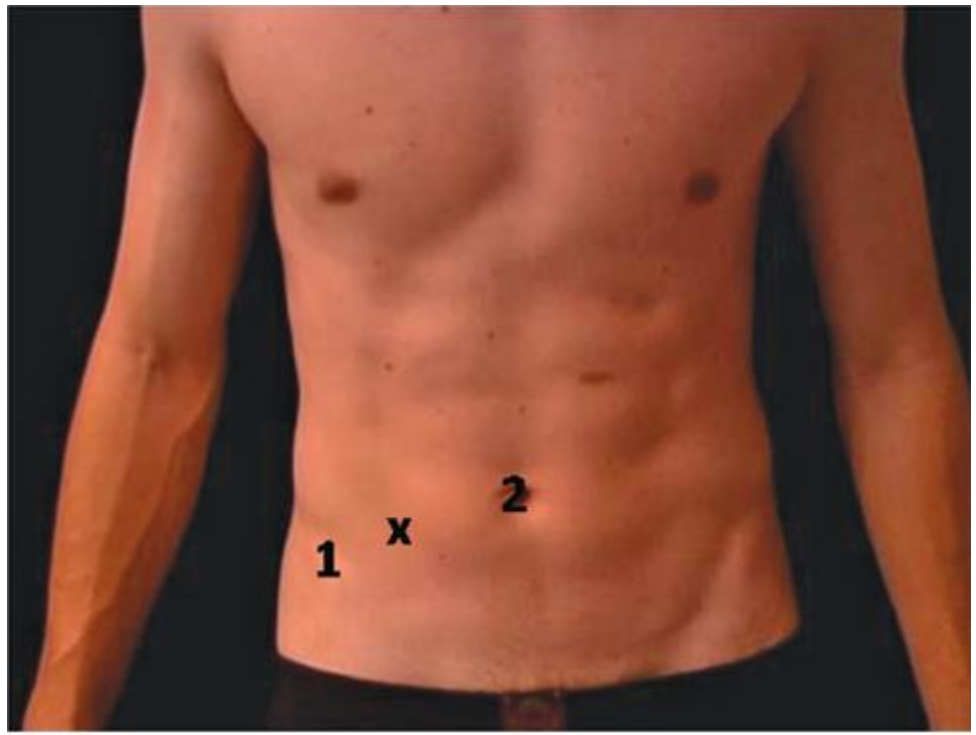



1 Initiation of acute appendicitis with lumen obstruction and mucus accumulation
ILEUM
CECUM
Mesoappendix
Obstruction
Appendix
Mucus
Potential causes of obstruction
• Appendicoliths (feces)
• Calculi
• Lymphoid hyperplasia
• Infection
• Benign or malignant tumors
2 Progression with increased luminal pressure, appendiceal distention, and inflammation
Luminal pressure
Early necrosis
Inflammation
Thrombosis
Ischemia
Bacteria buildup
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
ABSCESS
Advanced necrosis
Perforation of the appendix and bacteria in the peritoneal space lead to the formation of abscess, phlegmon, or generalized peritonitis.

SX & SG

	TRUE POSITIVE LIKELIHOOD RATIO	95% CONFIDENCE INTERVAL	TRUE NEGATIVE LIKELIHOOD RATIO	95% CONFIDENCE INTERVAL
Duration of symptoms (hours)				
>9	1.01	0.97–1.05	0.94	0.62–1.42
>12	0.96	0.90–1.04	1.19	0.87–1.63
>24	0.65	0.47–0.90	1.47	1.14–1.90
>48	0.49	0.36–0.67	1.20	1.08–1.34
Fever	1.64	0.89–3.01	0.61	0.49–0.77
Gastrointestinal dysfunction				
Anorexia	1.27	1.14–1.41	0.59	0.45–0.77
Nausea	1.15	1.04–1.36	0.72	0.57–0.91
Vomiting	1.63	1.45–1.84	0.75	0.69–0.80
Pain				
Pain migration	2.06	1.63–2.60	0.52	0.40–0.69
Pain progression	1.39	1.29–1.50	0.46	0.27–0.77
Direct tenderness	1.29	1.06–1.57	0.25	0.12–0.53
Indirect tenderness	2.47	1.38–4.43	0.71	0.65–0.77
Psoas sign	2.31	1.36–3.91	0.85	0.76–0.95
Rebound	1.99	1.61–2.45	0.39	0.32–0.48
Percussion tenderness	2.86	1.95–4.21	0.49	0.37–0.63
Guarding	2.48	1.60–3.84	0.57	0.48–0.68
Rigidity	2.96	2.43–3.59	0.86	0.72–1.02

	TRUE POSITIVE LIKELIHOOD RATIO	95% CONFIDENCE INTERVAL	TRUE NEGATIVE LIKELIHOOD RATIO	95% CONFIDENCE INTERVAL
Temperature (degrees centigrade)				
>37.7	1.57	0.90–2.76	0.65	0.31–1.36
>38.5	1.87	0.66–5.32	0.89	0.71–1.12
White blood cells (10^9/L)				
≥10	4.20	2.11–8.35	0.20	0.10–0.41
≥15	7.20	4.31–12.00	0.66	0.56–0.78
C-reactive protein (mg/L)				
>10	1.97	1.58–2.45	0.32	0.20–0.51
>20	2.39	1.67–3.41	0.47	0.28–0.81



DDX

TABLE 76.1 Differential diagnosis of acute appendicitis.

Children	Adult	Adult female	Elderly
Gastroenteritis	Regional enteritis	Mittelschmerz	Diverticulitis
Mesenteric adenitis	Ureteric colic	Pelvic inflammatory disease	Intestinal obstruction
Meckel's diverticulitis	Perforated peptic ulcer	Pyelonephritis	Colonic carcinoma
Intussusception	Torsion of testis	Ectopic pregnancy	Torsion appendix epiploicae
Henoch–Schönlein purpura	Pancreatitis	Torsion/rupture of ovarian cyst	Mesenteric infarction
Lobar pneumonia	Rectus sheath haematoma	Endometriosis	Leaking aortic aneurysm

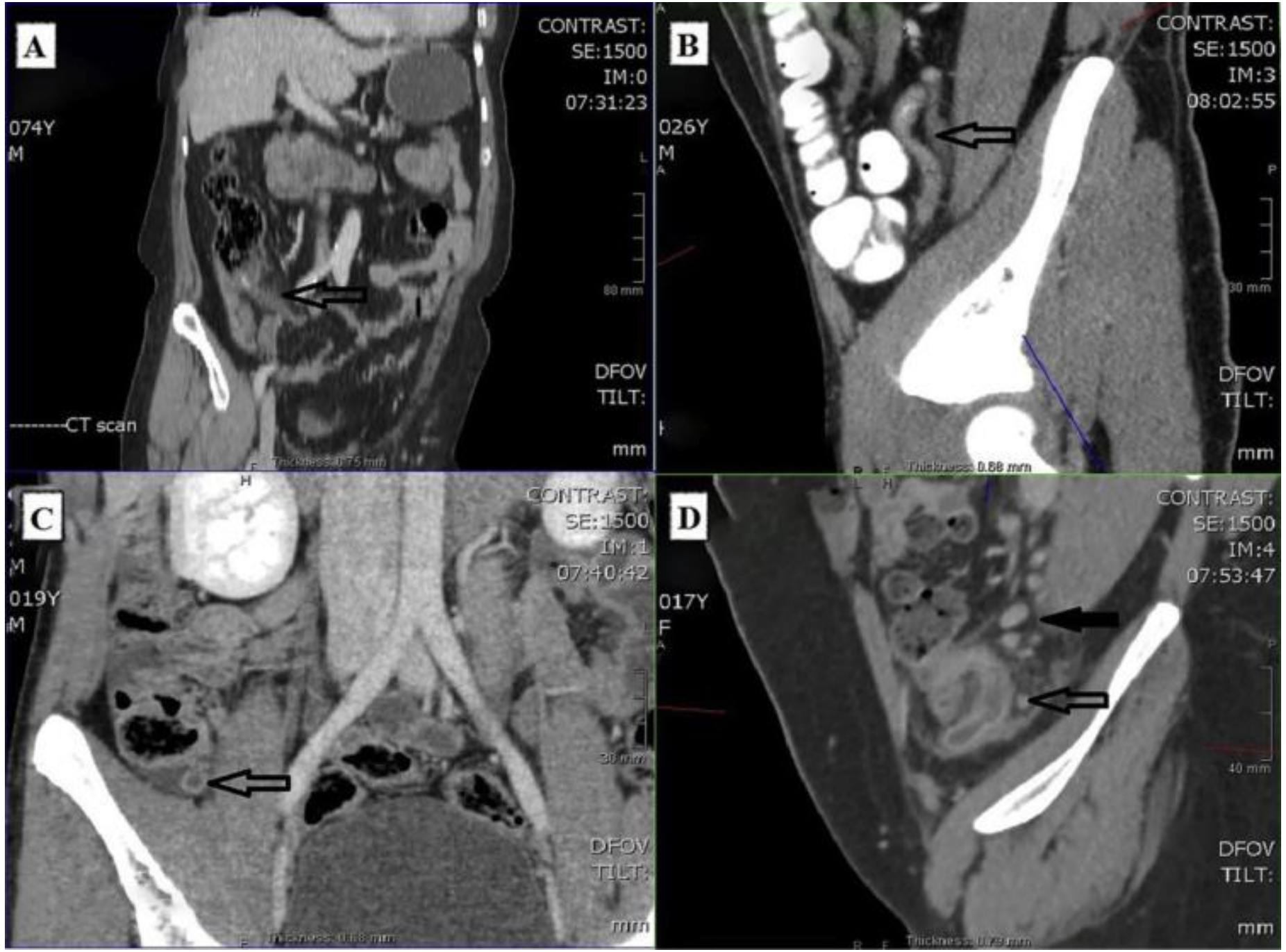
Med J Armed Forces India. 2016 Oct;72(4):332-337. doi: 10.1016/j.mjafi.2016.06.007. Epub 2016 Aug 11.

The Alvarado score versus computed tomography in the diagnosis of acute appendicitis: A prospective study

Ashraf F Al-Faouri [1], Khaled Y Ajarma [2], Abdulhamid M Al-Abbadi [3], Abdullah H Al-Omari [4], Tariq S Almunaizel [3], Alaa A Alzu'bi [3], Ra'ed Y Al-Jarrah [3], Omar Y Abo-Zaiton [3]

The Alvarado score for evaluation of suspected acute appendicitis.

Variable	Score
Symptoms	
Migratory right iliac fossa pain	1
Anorexia	1
Nausea/vomiting	1
Signs	
Right iliac fossa tenderness	2
Rebound tenderness	1
Elevated temperature > 37.3 °C	1
Laboratory tests	
Leukocytosis > 10.0×10^9/L	2
Neutrophils > 75% or left shift	1


A
CONTRAST:
SE:1500
IM:0
07:31:23
074Y
M
80 mm
DFOV
TILT:
mm
-------CT scan
B
CONTRAST:
SE:1500
IM:3
08:02:55
026Y
M
30 mm
DFOV
TILT:
mm
C
CONTRAST:
SE:1500
IM:1
07:40:42
019Y
M
DFOV
TILT:
mm
D
CONTRAST:
SE:1500
IM:4
07:53:47
017Y
F
40 mm
DFOV
TILT:
mm

Alvarado score diagnostic performance in both genders.

Criterion	Overall	Male	Female
Sensitivity (%)	84.96 (79.62–89.35)	87.5	79.7
Specificity (%)	59.57 (48.95–69.58)	84.1	38
Positive predictive value (%)	83.48 (78.04–88.04)	95	65.5
Negative predictive value (%)	62.22 (51.38–72.23)	66.1	55.9
Positive likelihood ratio	2.1 (1.63–2.70)	5.5	1.29
Negative likelihood ratio	0.25 (0.18–0.36)	0.15	0.53
Accuracy (%)	77.5	86.74	62.9

CTS diagnostic performance in both genders.

Criterion	Overall	Male	Female
Sensitivity (%)	94.2 (87.75–97.83)	93.7	94.9
Specificity (%)	90.0(79.49–96.24)	90.0	89.5
Positive predictive value (%)	94.2 (87.75–97.83)	96.7	90.2
Negative predictive value (%)	90.0 (79.49–96.24)	94.4	81.8
Positive likelihood ratio	9.42 (4.40–20.15)	9.01	9.37
Negative likelihood ratio	0.06 (0.03–0.14)	0.07	0.57
Accuracy (%)	92.6	92.8	92.2

Comparison of the diagnostic performance of AS against CTS in 112 patients.

Criteria	AS	CTS	*p*-Value
Sensitivity %	85.4	94.2	0.0382
Specificity%	65.0	90.0	0.0010
Positive likelihood ratio	2.4411	9.4175	0.0003
Negative likelihood ratio	0.2240	0.0647	0.0101

p-Value < 0.05 is statistically significant.

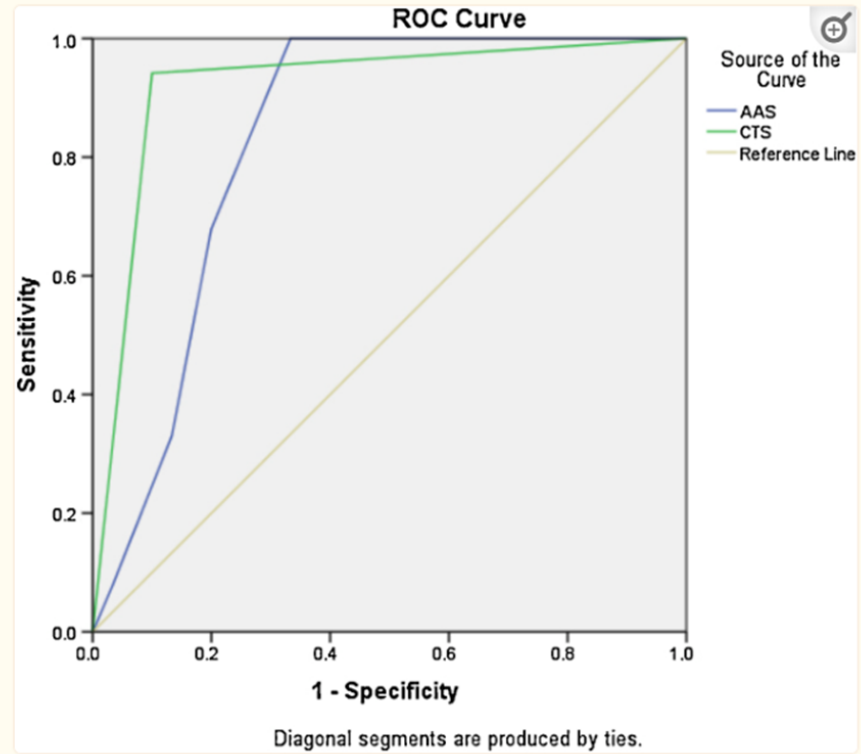


Fig. 2

Area under the ROC (receiver operating characteristic) curve for CTS is significantly higher than that of AS (0.921 versus 0.752, *p*-value 0.05).

Meta-analyses comparing CT scan and US outcomes

		AUTHOR					SUMMARY
		TERASAWA	WESTON	DORIA	AL-KHAYAL	VAN RANDEN	
Year		2004	2005	2006	2007	2008	
No. of studies		22	21	57	25	6	
No. of patients	CT	1172	NR	NR	NR	NR	
	US	1516	NR	NR	NR	NR	
	Total	2688	5039	13697	13046	671	
Sensitivity	CT	94% (CI: 91%–95%)	97% (CI: 95%–98%)	94% (CI: 92%–97%)	93% (CI: 92%–95%)	91% (CI: 84%–95%)	CT more sensitive than US in five of five meta-analyses
	US	86% (CI: 83%–88%)	87% (CI: 85%–89%)	88% (CI: 86%–90%)	84% (CI: 82%–85%)	78% (CI: 67%–86%)	
Specificity	CT	95% (CI: 93%–96%)	95% (CI: 93%–96%)	94% (CI: 94%–96%)	93 (CI: 92%–94%)	90% (CI: 85%–94%)	CT more specific than US in four of five meta-analyses
	US	81% (CI: 78%–84%)	93% (CI: 92%–94%)	93% (CI: 90%–96%)	96 (CI: 95%–96%)	83% (CI: 76%–88%)	
Positive predictive value	CT	NR	94% (CI: 92%–95%)	NR	90% (CI: 89%–92%)	NR	CT has superior positive predictive value in one of two meta-analyses
	US	NR	89% (CI: 87%–90%)	NR	90% (CI: 89%–91%)	NR	
Negative predictive value	CT	NR	97% (CI: 96%–98%)	NR	96% (CI: 95%–97%)	NR	CT has superior negative predictive value in both meta-analyses
	US	NR	92% (CI:91%–93%)	NR	93% (CI: 92%–94%)	NR	
Accuracy	CT	NR	NR	NR	94% (CI: 93%–94%)	NR	CT is more accurate in the one study reporting results
	US	NR	NR	NR	92% (CI: 92%–96%)	NR	

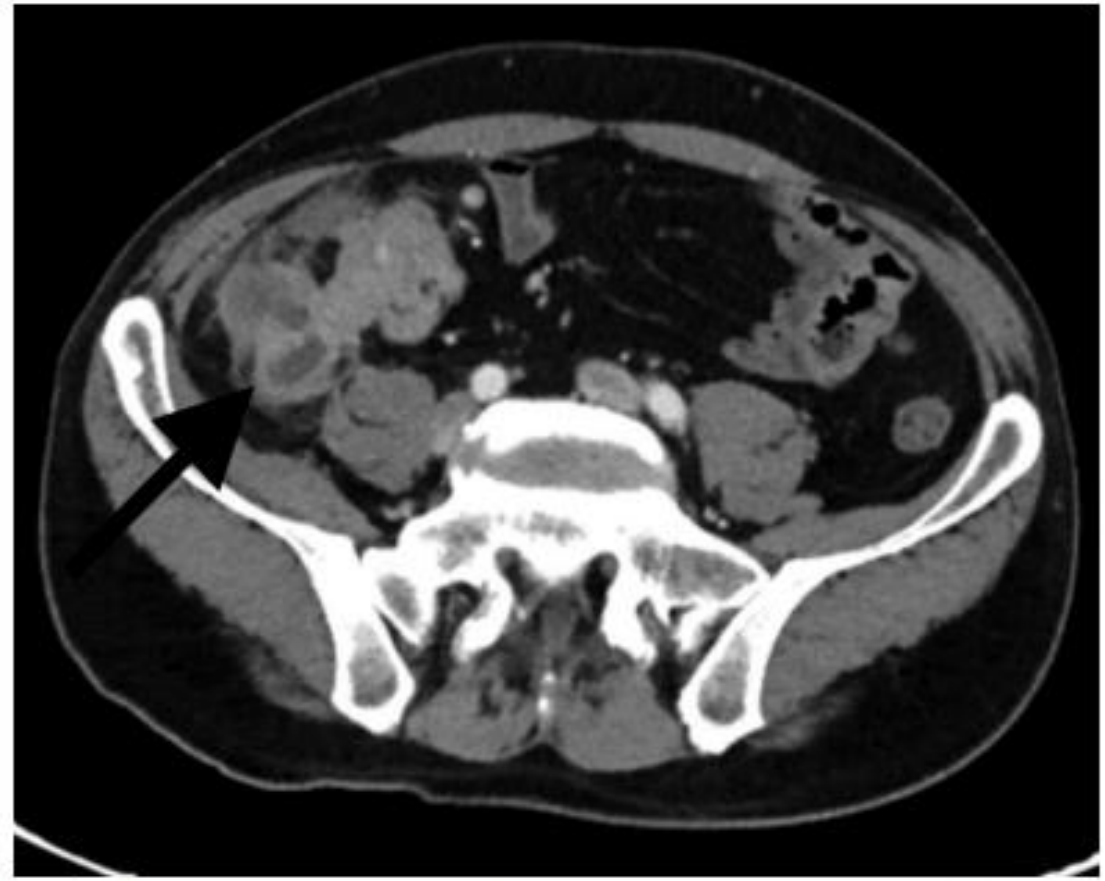


Figure 1. Computed tomography image showing appendiceal mass


0 cm
1
2
3
4
11
12