

**State budgetary educational institution of higher
professional education**

**"North Ossetian State Medical Academy" of the Ministry of
health of the Russian Federation**

Department of surgical diseases No. 2

Kalitsova M. V., Totikov Z.V.

ACUTE APPENDICITIS

Textbook for students of 4 courses medical faculty of faculty surgery

Vladikavkaz

2020

Kalitsova M. V., Totikov Z.V.

Acute appendicitis: teaching guide for students, studying at “General Medicine” faculty. - North Ossetian state medical academy. - Vladikavkaz, 20. - 17 sh.

This teaching guide covers main issues about etiology, pathogenesis, clinical features, laboratory and instrumental diagnostics and complications of acute appendicitis.

Teaching guide “Acute appendicitis” is made for “Faculty surgery” discipline in accordance with requirements of FSES HE, and is intended for students from medical universities and faculties, studying for specialty 31.05.01 General medicine.

Reviews:

Khestanov A.K. - Professor of medical science, professor of Surgical department №3 department FSES HE NOSMA of Russian Ministry of health.

Beslekoev U.S. - Associate professor, doctor of medical science, head of General surgery department FSES HE NOSMA of Russian Ministry of health.

Approved and recommended for printing by Central Coordinational educational and methodical board FSES HE NOSMA of Russian Ministry of health (6 july protocol № 6)

© North Ossetian State Medical Academy, 2020

© Kalitsova M.V., Totikov Z.V., 2020

CONTENTS

Development and anomalies.....	4
Surgical anatomy.....	5
Acute appendicitis.....	8
Differential diagnosis.....	13

Acute appendicitis is the most common emergency encountered by the general surgeons. Men have slightly increased incidence of acute appendicitis compared to women. Incidence is 11 per 10,000 persons/year.

Appendicectomy is a simple surgery, no doubt, but sometimes it can be very difficult and disappointing-sometimes one may not be able to find the appendix. Hence, appendicectomy should not be taken lightly. The choice of surgery today is laparoscopic appendicectomy- one advantage being one can look into all quadrants of the abdomen-not to miss other causes such as perforated duodenal ulcer (*see later Valentino appendix*), etc.

Few historical events

- 1736: Claudius Amyand removed inflamed appendix from the hernia sac of a boy.
- 1886: Reginald Fitz of Boston identified the appendix as the primary cause of the right lower quadrant inflammation. He coined the word appendicitis.
- 1889: Charles McBurney suggested early laparotomy and removal of the appendix. He also described the McBurney point of maximum tenderness.
- The first laparoscopic appendicectomy was described by Kurt Semm.
- 2009: First transvaginal removal of the appendix by Santiago Horgan and Mark A. Talamini-a procedure called NOTES-Natural Orifice Transluminal, Endoscopic, Surgery (more details on page 1178).

DEVELOPMENT AND ANOMALIES

- Embryologically, the appendix and caecum develop as outpouchings of the caudal limb of the midgut loop in the sixth week of human development. By the fifth month, the appendix elongates into its vermiform shape, hence called vermiform appendix. At birth, the appendix is located at the tip of the caecum but due to unequal elongation of the lateral wall of the caecum, the adult appendix typically originates from the posteromedial wall of the caecum, caudal to the ileocecal valve. A few anomalies are given below:

1. Duplication of the appendix is one anomaly which is further divided into following ways

Type A: Single caecum-partial duplication

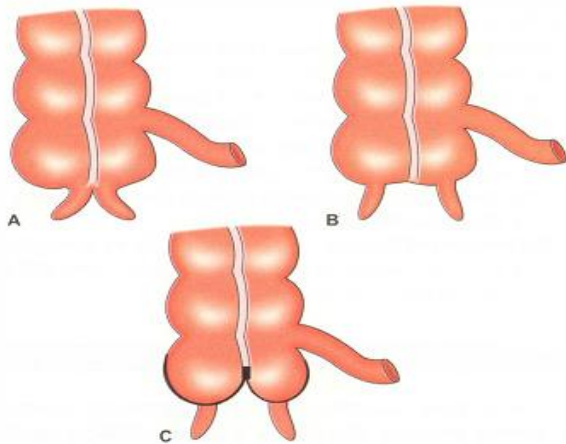
Type B: Single caecum and 2 separate appendices

Type C: Double caecum with each one having one appendix (Figs 1 and 2)

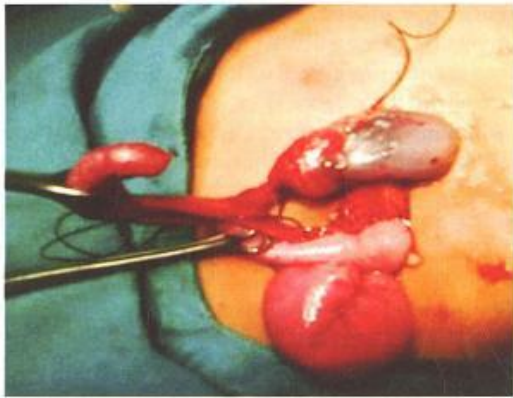
2. Situs inversus: In this condition appendix is found on the left side. Adds confusion in the diagnosis of acute appendicitis
3. Subhepatic appendix: It happens in malrotation of the gut. Patients with subhepatic appendicitis may complain of pain in the right lower quadrant. A McBurney incision is usually given only to find no

appendix in that location. Laparoscopy has the advantage of looking into all quadrants of the abdomen.

4. Congenital absence of the appendix is rare.



(Fig 1)



Appendicular duplication and gangrene in one of the moieties

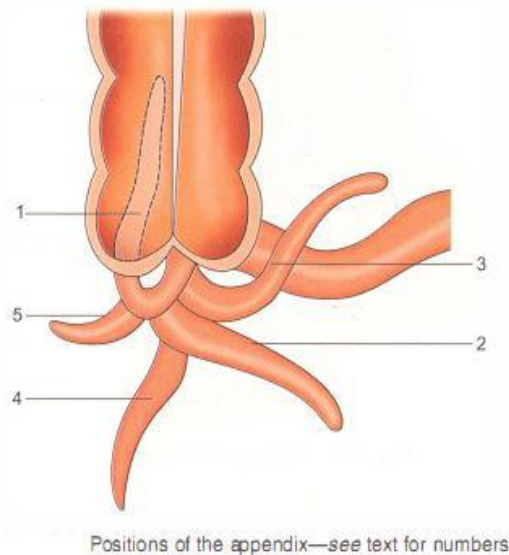
(Fig 2)

SURGICAL ANATOMY OF THE APPENDIX

- It is 8-10 cm long, may vary from 3 to 30 cm in length.
- It is situated 2 cm posteromedial to ileocaecal junction, at the point of convergence of the three taeniae coli.
- It is the primary cause of lower abdominal pain on the right side.

Positions of the appendix (Fig. 3)

1. Retrocaecal in about 70% of patients (12 o'clock)
2. Pelvic in 20% of cases (4 o'clock)
3. Preileal and postileal (2 o'clock)
4. Subcaecal (6 o'clock)
5. Paracaecal
6. Subhepatic appendix is associated with subhepatic caecum. It occurs due to malrotation of the gut (this position is not depicted in the figure)



Positions of the appendix—see text for numbers

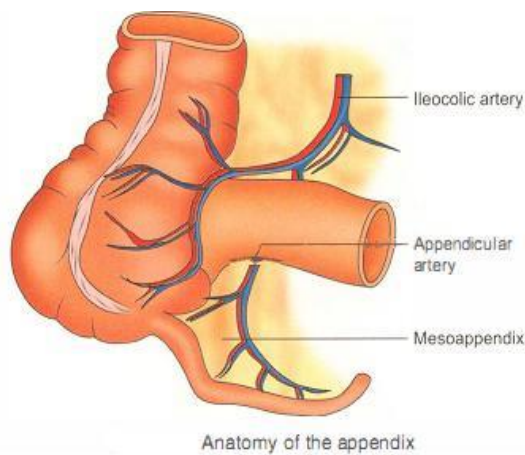
(Fig. 3)

Layers of the appendix

- Mesoappendix is the continuation of mesentery of the ileum above. It comes down carrying blood vessels in the meso- appendix.
- Appendix has a serosa and a mucosa lined by columnar epithelium (similar to intestinal mucosa) between which are the circular and longitudinal muscle fibres.
- Submucosa has rich lymphoid follicles (lamina propria). The lymphatic tissue decreases as age advances. Hence, incidence of appendicitis is less after the age of 30 years.
- Appendicular orifice is occasionally guarded by an indistinct semilunar fold of mucous membrane, known as Valve of Gerlach.

Blood supply of the appendix

- Appendicular artery is a branch of ileocolic artery. Accessory appendicular artery of Sheshachalam (a branch of posterior caecal artery) is a branch of ileocolic artery, which runs in the mesoappendix (Fig.4).
- Veins follow the artery and end in the superior mesenteric vein, thus draining into portal vein. This is the reason for development of pylephlebitis in cases of suppurative appendicitis.



(Fig. 4)

Surgical importance

- Suppurative appendicitis can give rise to pylephlebitis (inflammation of portal venous radicles).

Locating the appendix

- Trace the taenia coli or trace ilea! loops at laparotomy. Taenia coli point to the base of the appendix. However, surface marking of the appendix is done as follows: Draw a line from anterior superior iliac spine to the umbilicus. The junction of lateral 1/3rd and medial 2/3rds of this line indicates the location of appendix. This is the point of maximum tenderness in appendicitis.

Lymphatics

- The lymphatic channels which are 4 to 6 in number drain into ileocolic nodes, ileocaecal nodes and appendicular nodes in mesoappendix.

Surgical anatomy and significance

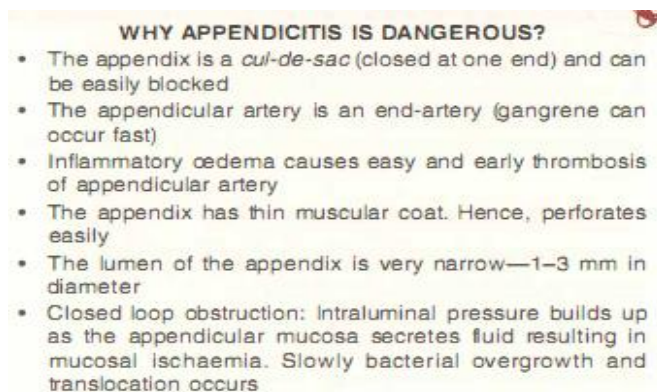
1. The area of the maximum tenderness in acute appendicitis is called McBurney's point - corresponds to the site of appendix in vast majority of the cases.
2. Appendicular artery must be ligated in open or laparoscopic method - to free mesoappendix.
3. Severe inflammation of the appendix can spread to portal vein via ileocolic vein and can result in portal pyaemia, a very dangerous condition.
4. Malrotation of the gut - appendix may be in subhepatic region - to be kept in mind in cases wherein appendix is not found in the right iliac fossa.

ACUTE APPENDICITIS

It is one of most common surgical emergencies encountered by general surgeons. Sometimes acute appendicitis can be dangerous.

Definitions

- Acute appendicitis: Sudden appearance of signs and symptoms of appendicitis.
- Recurrent appendicitis: Recurrent attacks of acute appendicitis-incidence is 15 to 25%.
- Grumbling appendicitis: Low grade recurrent bouts of colics, vomiting with frequent admission, self-limiting cases.
- Simple appendicitis: If duration of symptoms is less than 48 hours or imaging does not show any abscess or phlegmon.
- Complicated appendicitis: Acute appendicitis with perforation or large abscess/phlegmon.
- Pseudoappendicitis: Acute ileitis mimics appendicitis following *Yersinia* infection. It can also be due to Crohn's disease.
- Stump appendicitis: It is the inflammation and infection of appendicular stump, if a big stump is left behind (post- operative cases). It may require stump appendicectomy. It is important to ligate and divide at the base of the appendix to avoid this complication (more so in laparoscopic appendicectomy).



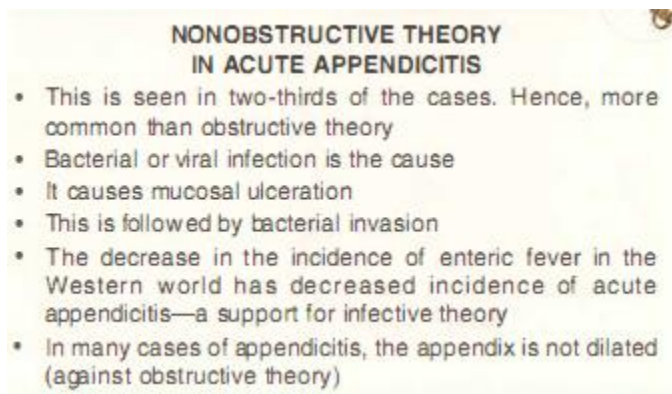
Aetiology

1. Racial and dietary factors
 - It is more common in white race than in coloured persons. Young males are affected more often.
 - It may be related to Westernisation of food—a diet rich in meat precipitates appendicitis and *a diet rich in fibre* (cellulose) protects the person from appendicitis.
2. Familial susceptibility: It is related to having a *long retrocaecal appendix* in which case the blood supply is diminished to the distal portion and may precipitate appendicitis.
3. Socioeconomic status: Appendicitis is common in middle class and rich people. The exact reasons are not known.
4. Obstructive theory: Obstruction to the lumen of the appendix due to faeco-liths, worms, ova, cysts of *Entamoeba* causes obstructive appendicitis. It is seen only in one-third cases.

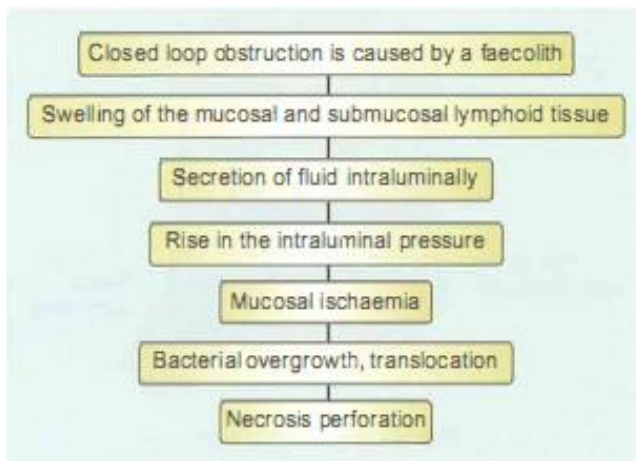
5. Nonobstructive theory: It is due to bacteria such as *E. coli*, Enterococci, Proteus, Pseudomonas, Klebsiella and anaerobes which produce diffuse inflammation of appendix and cause appendicitis. This seems to be more common cause than obstruction.

Pathology

1. In nonobstructive cases (catarrhal appendicitis)
 - Process of inflammation is slow and gradual.
 - A mild attack may completely resolve or mucosa! and submucosal oedema can occur.
 - Ulceration of the appendix results in slow bacterial invasion of lymphoid tissue.
 - Gangrene and perforation are rare.



2. In obstructive cases
 - Symptoms are abrupt, vomiting is more, pain is more and tenderness is more.
 - It is a more dangerous variety.
 - Appendix looks inflamed, with congested blood vessels. Tip especially looks more inflamed. As the inflammation is more severe, the outer aspect looks dull and purulent exudates may be seen. Areas of blackening or green colour indicates gangrene or necrosis with perforation. In acute inflammation neutrophils are dominant and in cases of gangrenous appendicitis, vascular thrombosis is a feature. The important pathological events can be summarised as follows--due to obstruction, the contents get infected fast and the tension increases. The appendix becomes a closed loop, which results in septic thrombosis of vessels. Gangrene of appendix, perforation, peritonitis, followed by a local abscess can occur.



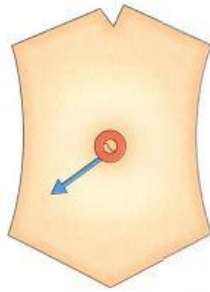
- In children, greater omentum is very thin. Hence, it cannot localise the infection. In adults, omentum is like a fatty apron which localises the infection.
- In aged patients, because of atherosclerosis, gangrene occurs very fast resulting in peritonitis. Obstruction is caused by faecoliths, worms and bands which cause tenting. *Obstructed appendicitis is one of the examples for closed loop obstruction.* Other causes are volvulus, carcinoma hepatic flexure, etc.
- Common bacteria encountered in acute appendicitis are *Bacteroides fragilis*, *Escherichia coli*, *Clostridium perfringens*, *Streptococcus faecalis*, *Pseudomonas aeruginosa*, etc.

Clinical features

The peak incidence is in the second and third decades. Very uncommon before the age of two.

Symptoms

- Pain is severe, colicky type, initially felt in the umbilical region and it is due to *distension of appendix*. This is a visceral pain. After a few hours, the pain localises to the right iliac fossa. It is a *somatic pain* which is due to *inflammation of parietal peritoneum*. This is called *shifting pain of acute appendicitis* (Fig. 5). This is called *migratory pain-most reliable symptom of acute appendicitis*.
- Normal appendix is mobile. So, the site of maximum pain and tenderness can vary.
- Vomiting occurs once or twice due to reflex pylorospasm. It contains stomach contents. However, it is never frequent such as in intestinal obstruction.
- Appendicitis is unlikely in patients with normal appetite. Usually patients have anorexia.
- Fever is of low grade (around 100°F) and indicates bacterial inflammation.



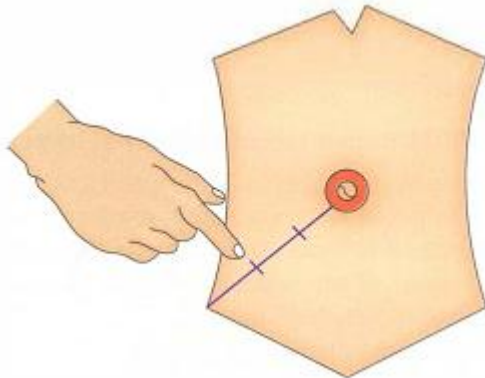
Shifting pain (migratory pain)—most reliable symptom

(Fig. 5)

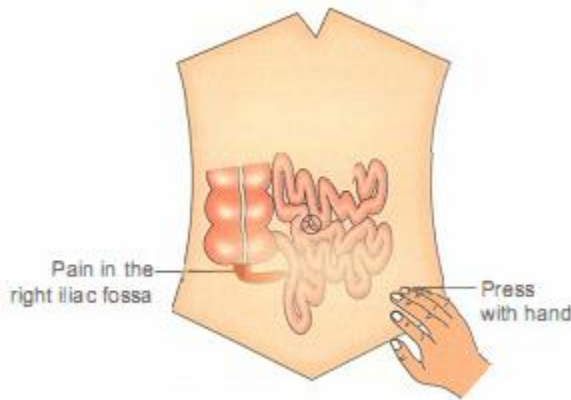
- Haematuria is uncommon and it is due to inflammation of retrocaecal appendix which irritates the ureter in the retroperitoneum.
- Constipation is the usual feature, except in pre- and post- ileal appendicitis, where they produce diarrhoea due to irritation of ileum.

Signs

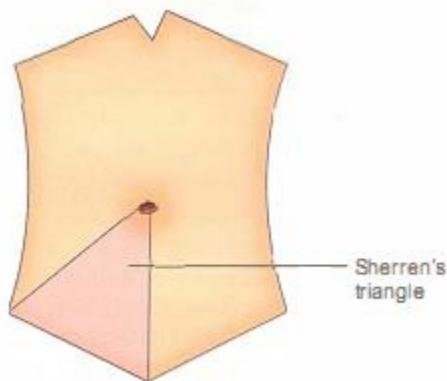
1. *Cough tenderness* indicates inflammation of parietal peritoneum. This is an important physical sign which differentiates acute appendicitis from right-sided ureteric colic.



2. *Tenderness and rebound tenderness* are present at McBurney's point. Rebound tenderness is called Blumberg sign. It is due to inflammation of the parietal peritoneum. This physical sign can be elicited in all cases of peritonitis.
3. *Guarding and rigidity* are present in the right iliac fossa. However, guarding and rigidity of back muscles (erector spinae) indicates retrocaecal appendicitis.
4. *Rovsing sign*: Palpation of left iliac region of abdomen produces pain in the right iliac region. It is because of displacement of colonic gas and small bowel coils impinging upon the inflamed appendix.



5. *Hyperaesthesia* in the Sherren's triangle: It is formed by anterior superior iliac spine, umbilicus and pubic symphysis. It is due to irritation of lower abdominal nerves.



6. *Cope's psoas test*: Seen in retrocaecal appendicitis. There will be irritation of psoas major which produces flexion at the hip. If any attempt is made to extend the hip, it produces pain.
7. *Cope's obturator test*: Seen in pelvic appendicitis due to irritation of the obturator muscle. Flexion and medial rotation produces pain.
8. *Features of generalised peritonitis* are seen only when there is a rupture. Gangrene and perforation is more common in elderly patients because of atherosclerosis. In infants, omentum is very thin without much of fat. Hence, diffuse peritonitis occurs very fast.
9. *Rectal examination*: There is tenderness in the right rectal wall—differential tenderness.
10. *Per vaginal examination*: Presence of ovarian mass, tenderness on movement of cervix, adnexal tenderness may suggest obstetric pathology.
- Signs and symptoms vary depending upon the location.

VARIATIONS IN ACUTE APPENDICITIS

1. **Retrocaecal**: Silent (no rigidity in the right iliac fossa)
2. **Pelvic**: Causes diarrhoea
3. **Postileal**: Causes diarrhoea—called missed appendix
4. **Subhepatic**: Manifests as pain in the right iliac fossa, very difficult to remove from gridiron incision
5. **In pregnancy**: The location of the pain is shifted higher up and laterally

DIFFERENTIAL DIAGNOSIS

Investigations

1. Total WBC count is almost always increased above 10,000 cells/mm³, in most of the patients (95%).
 - A very high white blood cell count (> 20,000/mm³) suggests complicated appendicitis with gangrene or perforation.
2. Urine examination is mainly to rule out urinary tract infection, haematuria and sometimes pyuria.
3. C-reactive protein is elevated in any inflammatory condition such as appendicitis. Elevated in the first 12 hours of acute inflammation very non-specific.
4. Plain X-ray abdomen erect is taken to rule out perforation and intestinal obstruction. It may show dilated small bowel loops in the right iliac fossa.
5. Abdominal ultrasound to rule out other causes including gynaecological causes. Ultrasound can demonstrate a non-compressible, aperistaltic tubular organ with a thick wall. It can be used to elicit probe tenderness (sensitivity of 85%, specificity 90%).

Advantages

- It is a simple bedside investigation
- Economical
- Can confirm acute appendicitis in about 50% of the patients
- Appendicolith, pericaecal fluid collection or inflammation can be diagnosed-indirect features of acute appendicitis
- More sensitive and specific in children-thin abdominal wall.

Disadvantages

- It is operator-dependent
 - It is not a choice in fatty obese patient
 - Gas within the dilated intestine may obscure the appendix
6. CECT-Contrast Enhanced CT scan is the investigation of choice (sensitivity 90%, specificity 90%), specially when diagnosis is not established or in unclassic cases. All the findings mentioned in the ultrasound can also be defined by CT scan (Fig. 33.11).

Advantages

- More objective
- Sensitivity and specificity is almost about 95%
- Helps to rule out carcinoma caecum, duodenal perforation, acute pancreatitis, etc.

Disadvantages

- Pregnant woman-it is contraindicated
- In children-better to avoid it for the fear of radiation exposure and risk of cancer developing at a later date
- Expensive, long time for the contrast to reach the site
- Low fat, sensitivity is less
- Allergy to contrast and contrast nephropathy (dehydration, high creatinine, diabetics precipitating factors).

1. The most common position of the appendix is:

- A. Subhepatic
- B. Subcaecal
- C. Retrocaecal
- D. Pelvic

2. The incidence of appendicitis is less after 30 years because:
- A. The appendix undergoes involution
 - B. The lymphatic tissue in the appendix decreases
 - C. Most people would have had their appendices removed
 - D. The vascularity reduces
3. Appendicular orifice is occasionally guarded by an indistinct semilunar fold of mucous membrane called:
- A. Valve of Gerlach
 - B. Valve of Heister
 - C. Valve of Kerckring
 - D. Valve of Houston
4. The most common scoring system used for appendicitis is scoring system.
- A. Child-Pugh
 - B. Furtado
 - C. Murray
 - D. Alvarado
5. Palpation of left iliac region of abdomen produces pain in the right iliac region in appendicitis because of:
- A. Sympathetic reaction
 - B. Displacement of colonic gas and small bowel coils
 - C. Sigmoid colon is also affected
 - D. Ileocolic reflex
6. Cope's psoas test is positive in:
- A. Retrocaecal appendicitis
 - B. Pelvic appendicitis
 - C. Preileal appendicitis
 - D. Subcaecal appendicitis
7. Rebound tenderness in acute appendicitis is called:
- A. McBurney's sign
 - B. Blumberg's sign
 - C. Rovsing's sign
 - D. Sherren's sign
8. The most common cause of nonobstetric emergency with abdominal pain in pregnancy is due to:
- A. Acute appendicitis
 - B. Acute cholecystitis
 - C. Acute gastritis
 - D. Acute hepatitis

9. Contraindications for incidental appendectomy include all of the following except:
- A. Crohn's of caecum
 - B. Radiation treatment of the rectum
 - C. Immunocompetent individuals
 - D. Previous vascular reconstruction in the abdomen
10. The following statement is TRUE about appendicular abscess:
- A. Abscess greater than 4-6 cm in size needs to be drained by laparotomy
 - B. Appendicectomy must be done along with laparotomy or appendicular abscess
 - C. Can present with diarrhoea
 - D. Conservative management is advised till inflammation settles down.

ANSWERS

1-C. 2-B. 3-A. 4-D. 5-B. 6-A. 7-B. 8-A. 9-C. 10-C.

Literature:

1. K Rajgopal Shenoy, Anitha Shenoy. Manipal Manual of Surgery. CBS Publishers & Distributors. Fourth Edition. 824-840.
2. Harold Ellis, Sir Roy Calne, Christopher Watson. General Surgery Lecture Notes. Wiley BlackWell. 2016. 201-205
3. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. Am J Epidemiol 1990;132: 910-25.

4. Murphy J. Two thousand operations for appendicitis, with deductions from his personal experience. *Am J Med Sci* 1904;128: 187-211.
5. Styrud J, Eriksson S, Nilsson I, Ahlberg G, Haapaniemi S, Neovius G, et al. Appendectomy versus antibiotic treatment in acute appendicitis: a prospective multicenter randomized controlled trial. *World J Surg* 2006;30: 1033.
6. Andersson RE, Olaison G, Tysk C, Ekblom A. Appendectomy and protection against ulcerative colitis. *N Engl J Med* 2001;344: 808-14.
7. C. J. Hawkey FMedSci Jaime Bosch MD, PhD Joel E. Richter MD, FACP, MACG Guadalupe Garcia-Tsao MD Francis K. L. Chan MD. Acute Appendicitis.
8. Wolfe J, Henneman P. Acute Appendicitis. In: Marx J, Hockberger R, Walls R, editors. *Rosen's Emergency Medicine*. Philadelphia: Mosby/Elsevier; 2010. pp. 1193–9.
9. Holzheimer RG, Mannick JA, editors. Munich: Zuckschwerdt; 2001. *Surgical Treatment: Evidence-Based and Problem-Oriented*.
10. Per-Olof Nyström, M.D., Ph.D. Appendicitis. 2001

All the illustrated materials are taken from « Manipal Manual of Surgery. CBS Publishers & Distributors. Forth Edition. Edited by K Rajgopal Shenoy, Anitha Shenoy»