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ACUTE APPENDICITIS
COMPLICATIONS OF ACUTE APPENDICITIS

Textbook for students of 4 courses medical faculty of faculty surgery

Vladikavkaz

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CONTENTS

Introduction

Acute appendicitis is the most common emergency encoun-tered by the general surgeons. Men have slightly increased incidence of acute appendicitis compared to women. Incidence is 11 per I 0,000 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 duode-nal 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 describe the McBumey point of maximum tenderness.
- The first laparoscopic appendicectomy was described by Kurt Semm.
- 2009: First transvaginal removal of the appendix by Santiaggo 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:

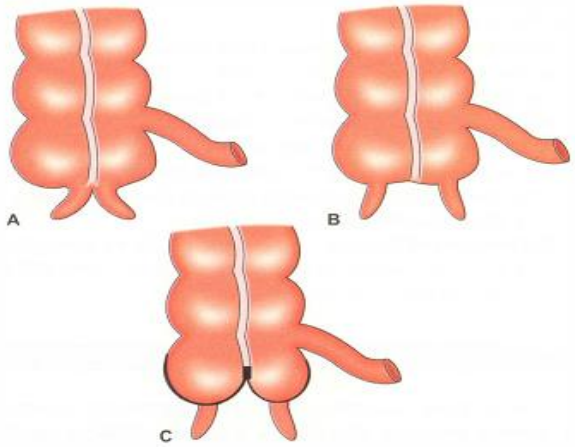
1. Duplication of the appendix is one anomaly which is further divided into following ways

   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: Tt 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)

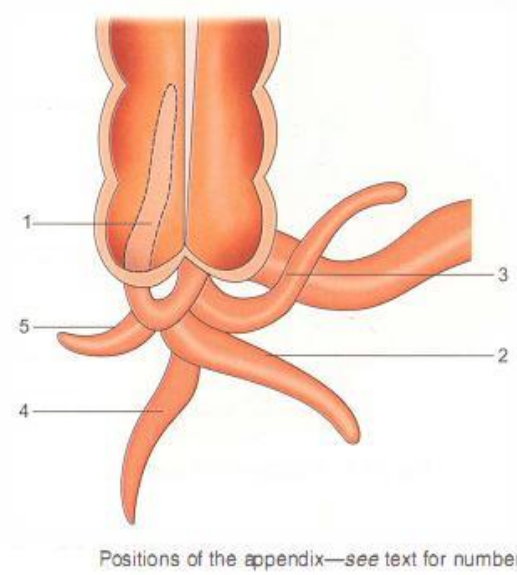
SURGICAL ANATOMY OF THE APPENDIX

- 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)



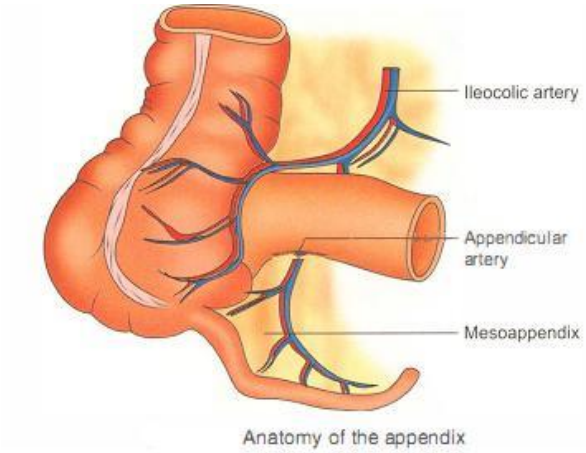
Positions of the appendix—*see* text for numbers (Fig. 3)

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 anindistinct 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.



Anatomy of the appendix (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 113rd 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

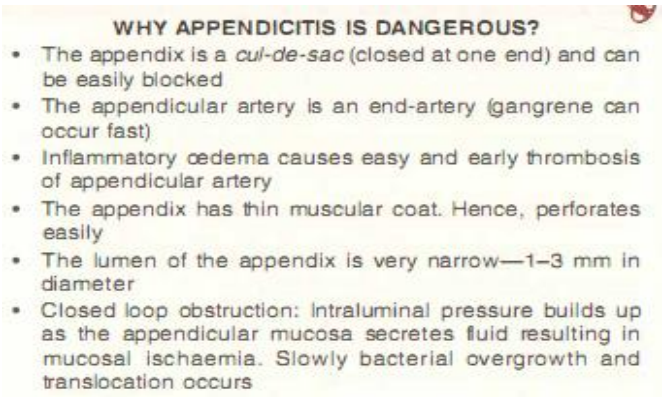
1. The area of the maximum tenderness in acute appen-dicitis is called McBurney's, point - corresponds to the site of appendix in vast majority of the cases.
2. Appendicular artery must be ligated in open or laparoscopic method - to free mesoappendix.
3. Severe inflammation of the appendix can spread 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.

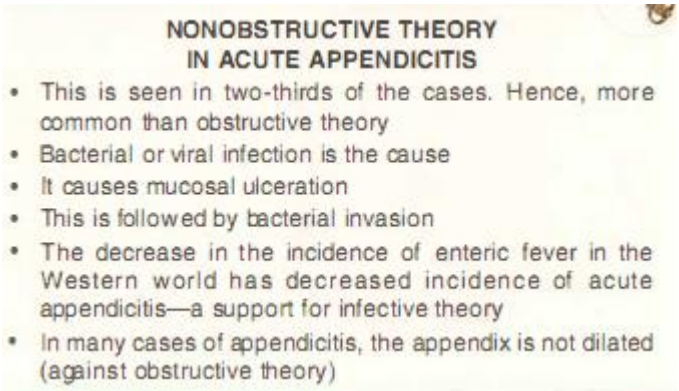
2. Familial susceptibility: It is related to having a *long retrocaecal appendix* in which case the blood supply is diminished to the distal portion and may precipitate appendicitis.

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)

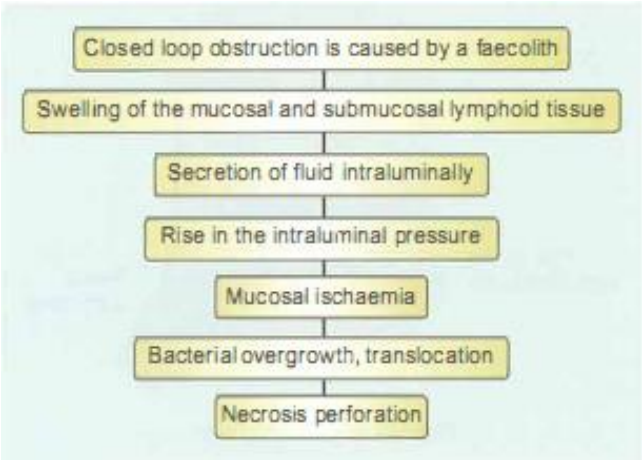
- Process of inflammation is slow and gradual.
- A mild attack may completely resolve or mucosa! and submucosal oedema can occur.
- Ulceration of the appendix results in slow bacterial invasion of lymphoid tissue.
- Gangrene and perforation are rare.



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.

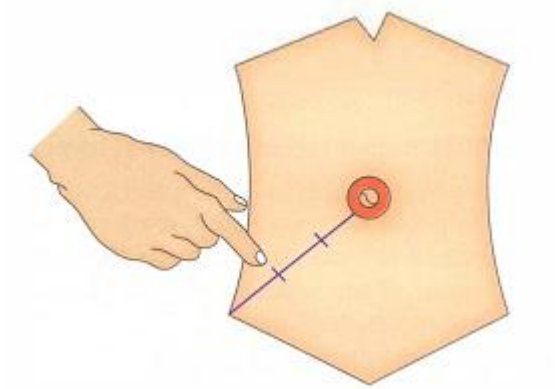
- Fever is of low grade (around 100°F) and indicates bacterial inflammation.

(Fig. 5)

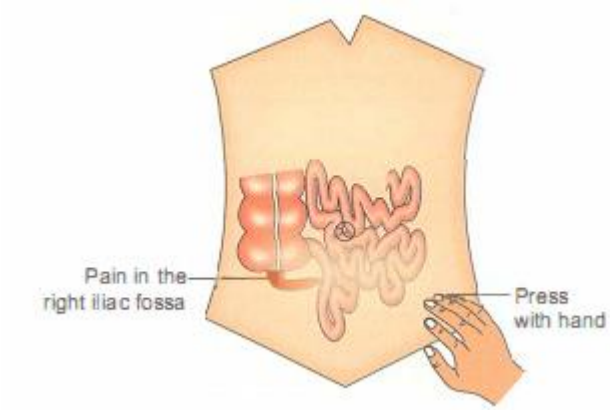
- Haematuria is uncommon and it is due to inflammatior of retrocaecal appendix which irritates the ureter in the retroperitoneum.
- Constipation is the usual feature, except in pre- and post- ileal appendicitis, where they produce diarrhoea due to irritation of ileum.

Signs

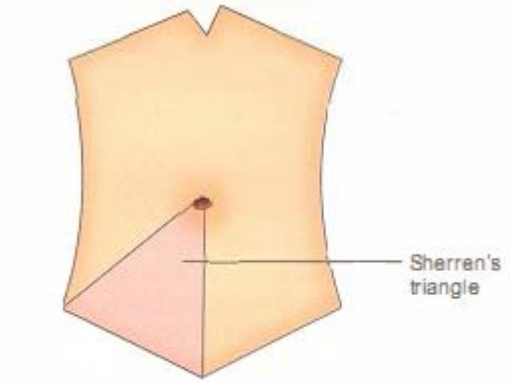
1. *Cough tenderness* indicates inflammation of parietal peritoneum. This is an important physical sign which differentiates acute appendicitis from right-sided ureteric colic.



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.

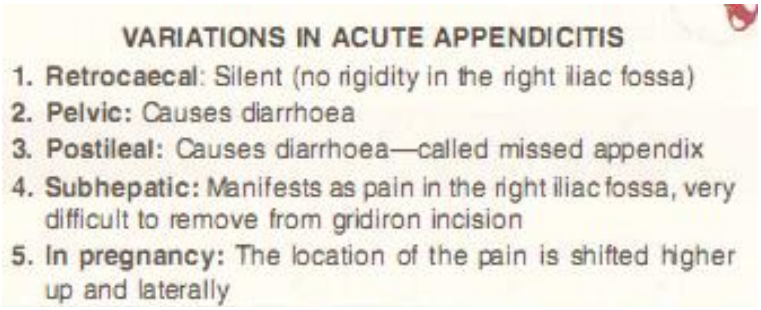


5. *Hyperaesthesia* in the Sherren's triangle: It is formed by anterior superior iliac spine, umbilicus and pubic symphysis. It is due to irritation of lower abdominal nerves.



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, diThse 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.



DIFFERENTIAL DIAGNOSIS

Investigations

1. Total WBC count is almost always increased above l 0,000 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, haernaturia and sometimes pyluria.
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 investiga- tion 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

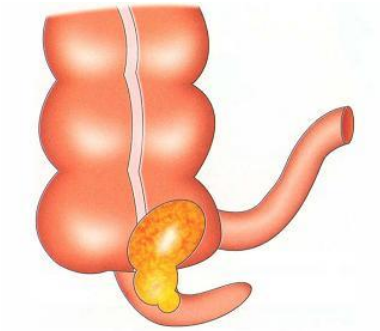
- Pregnant woman-it is contraindicated
- In children-better to avoid it for the fear of radiation exposure and risk of cancer developing at a later date
- Expensive, long time for the contrast to reach the site
- Low fat, sensitivity is less
- Allergy to contrast and contrast nephropathy (dehydration,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

COMPLICATIONS OF ACUTE APPENDICITIS

1. Rupture of appendix causes generalised peritonitis with10-20mortality rate. The treatment involves emergency laparotomy, appendicectomy and peritoneal wash followed by drainage of peritoneal cavity.
2. **Appendicular mass** (Fig.6)

- Following an attack of acute appendicitis, infection is sealed off by greater omentum, caecum, terminal ileum,etc. which results in a tender, soft to firm mass in the right iliac fossa.
- Presence of a mass is a contraindication for appendi-cectomy because it is very difficult to remove appendix from such a mass. An attempt to remove it may result in a faecal fistula.
- It is treated by Ochsner and Sherren regime. Aspiration with Ryle's tube to give rest to the gut. Bowel care-purgatives should not be used (may cause perforation).

- Charts-temperature, pulse, respiration, diameter of the mass. Swinging temperature, and increase in size of mass indicates an appendicular abscess.
- Drugs to cover all the organisms-gram-positive, gram-negative and anaerobic organisms.
- Exploratory laparotomy should not be done. However, when the condition of the patient is not improving, there is a suspicion of an abscess (Fig. 33.17) and when doubtful of the diagnosis, exploration ts indicated.
- Fluids *(see* Table)



Appendicular mass—tender, diffuse mass

(Fig.6)

Patient is kept nil orally for a few days. During this time, intravenous fluids are given to correct dehydration.

Wisdom/mistakes/surprises for surgeon while conducting appendicectomy

Observes straw-coloured fluid	Observes bile-coloured fluid	Observes 'foul' fluid	Observes haemorrhagic fluid
Completes appendicectomy	Completes appendicectomy	Completes appendicectomy	Completes appendicectomy
Closes the wound	Puts a drain	Postoperative faecal fistula	Ignores fluid
Realises 3 days later, it was acute pancreatitis	Closes the wound	Re-explores by midline incision	Patient continues to have pain
How could it have been avoided?	Postoperative biliary fistula	Perforated Meckel's diverticulum	OBG consultation given
Serum amylase, lipase were not sent. A preoperative ultrasound was not done.	Asks for contrast CT, **realises duodenal ulcer perforation**, explores, sutures the perforation	Resection, anastomosis	Twisted ovarian cyst
Surgical wisdom: If these investigations were done before surgery, they could have helped the surgeon. Luckily, the patient recovered from this unnecessary, avoidable surgery.	He had not done a simple chest X-ray or plain X-ray abdomen erect preoperatively in this case	**Surgical wisdom:** Surgeon had not examined the terminal 2 feet ileum during appendicectomy	Laparotomy and ovariectomy **Surgical wisdom:** Surgeon had not done ultrasound and gynaecological consultation was not requested before surgery.

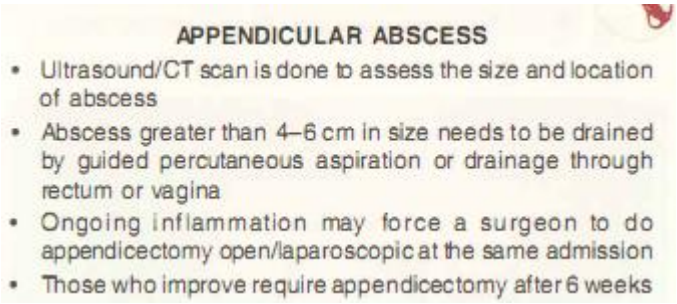
- After 3-4 days, the abdomen becomes soft, tenderness decreases and once stools are passed, Ryle's tube is removed. Clear oral fluids followed by soft diet is given.

By one week, the patient is back to normal. After 6-8 weeks, patient is advised elective appendicectomy.

3. Perforated appendicitis

- Incidence is about 8-10%.
- More common in children and elderly patients.
- Delay in seeking medical treatment is the main factor.
- Other factors which precipitate perforation are diabetes mellitus, AIDS, faecolith.
- The pain usually localises to the right lower quadrant if the perforation has been walled off by surrounding intra- abdominal structures including the omenturn.
- Diffuse pain in cases of generalised peritonitis.
- Rigors and chills with fever of 38.9°C or above.
- As a complication of perforation peritonitis, portal pyaemia (pylephlebitis) can develop, it can be very dangerous.

4. Appendicular abscess: If the infection is not controlled properly following an attack of appendicitis, an abscess can occur in relation to the appendix. They are (A) retrocaecal, (B) postileal and preileal, (C) pelvic,(D) subcaecal abscesses. Clinically, it presents with high- grade fever with chills and rigors and a tender boggy swelling in the right iliac fossa or in the right lumbar region. Pelvic abscess presents with diarrhoea. Diagnosis is by late presentation to the hospital (3-4 days) and high-grade fever with chills and rigors.



A. Retrocaecal abscess is drained by extraperitoneal approach. An incision of 5 to 6 cm is made in the right iliac fossa and all muscles are divided. However, peritoneum is not opened. It is swept medially and pus is drained outside. Appendicectomy is done at a later date (Fig. 7).

Appendicular abscess is drained by extraperitoneal route

(Fig. 7)

B. Preileal and postileal abscesses are drained by a laparotomy.
C. Pelvic abscess is drained *via* the rectum
D. Lumbar abscess (perinephric abscess) is drained through a loin incision.

Preoperative resuscitation

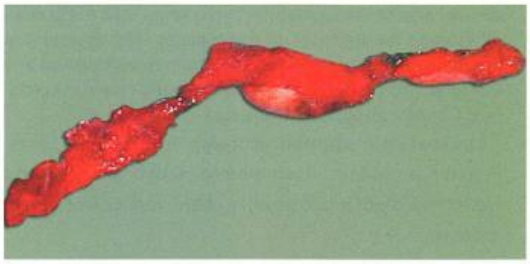
- Once diagnosis of acute appendicitis is suspected, the patient is admitted to the hospital.
- IV fluids-isotonic saline or Ringer lactate is given.
- Electrolytes are corrected especially in late cases of acute appendicitis/perforation peritonitis, etc.
- Ryle's tube is not necessary in simple appendicitis but is definitely required in complicated cases (peritonitis).

- Second generation cephalosporins along with metronidazole is given.
- Informed consent is taken.

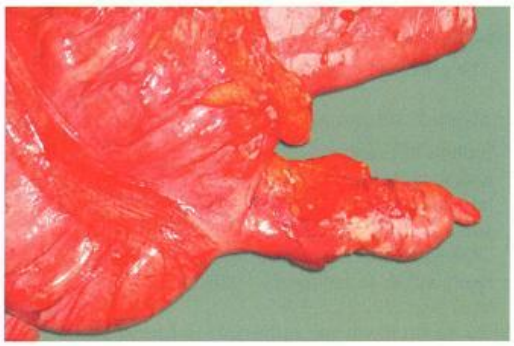
Treatment

- Emergency appendicectomy: Emergency appendicectomy is offered when patient comes within 24 to 48 hours of abdominal pain. It is very impo1tant to rule out or detect a mass, especially if a decision is made to operate around 2nd or 3rd day. If a mass is palpable, it is better not to operate at that time (please refer to operative surgery, appendicectomy). A few important steps are given here (Fig 8).

Emergency appendicectomy—base is crushed



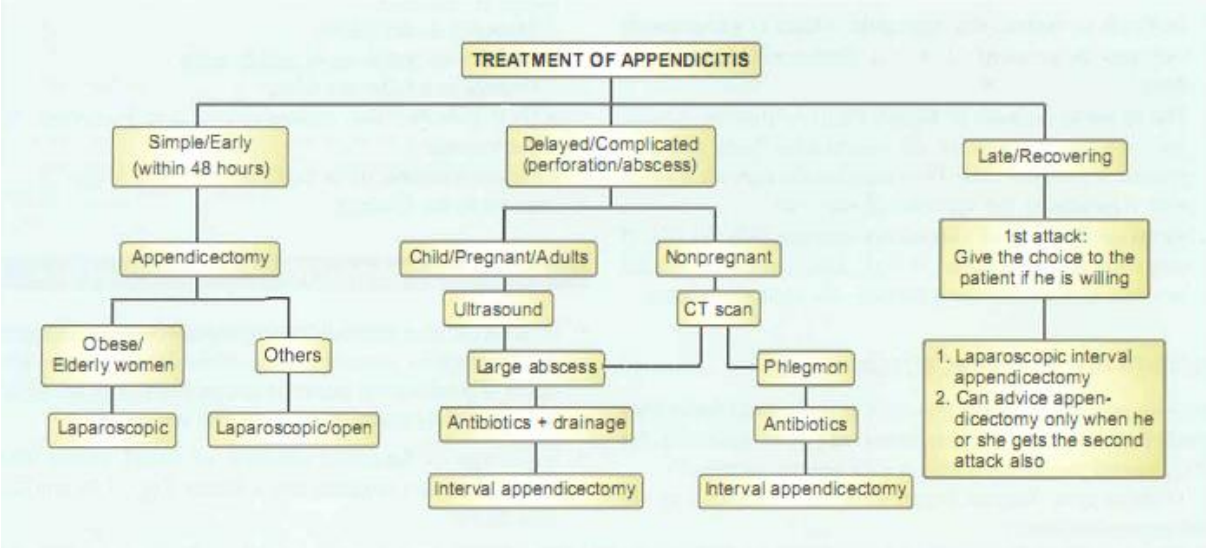
Large faecolith resulting in acute appendicitis



Inflamed appendix at surgery (*Courtesy:* Dr Prasad, S. Professor of Surgery, KMC, Manipal)

Appendicular perforation with abscess—appendicectomy could be done (*Courtesy:* Dr Annappa Kudva, Professor of Surgery, KMC, Manipal)

(Fig. 8)



- The appendix is identified by tracing *Taenia coli* which converges onto the base of the appendix. Mesoappendix is divided in between ligatures. Apursestring suture is applied all around the appendix in the caecum. The appendix is divided in between ligatures, the stump is invaginated and the purse string is tightened. The abdomen is closed in layers.
- Laparoscopic appendicectomy has become more popular nowadays. Less postoperative pain, speedy recovery. Benefit is maximum in obese, women and elderly patients.

Problems encountered during appendicectomy

1. The incision is small: Location is higher up-never hesitate to close the incision and a midline incision is given and do appendicectomy. An attempt to remove the appendix with traction and limited exposure through McBurney incision may result in faecal fistula.
2. Normal appendix is found: Remove the appendix. Other-wise it may cause confusion to the next surgeon when this patient presents with abdominal pain. However, look for Meckel 's diverticulitis, intestinal obstruction, stricture, etc.
3. Gangrenous appendix involving base: Problem one can face here is that the purse string can be applied but invagination of the stump is not possible. Risk of faecal fistula is also present. Appendicectomy, wash and a drain is kept.
4. Difficult to isolate the appendix which is gangrenous but pus is present: Limited ileocecectomy can be done.
5. The appendix cannot be found: First mobilise the caecum and look for subcaecal or retrocaecal sites. Look also into preileal or postileal sites. Then mobilise the ascending colon also. Agenesis of the appendix is very rare.

6. Surprise findings of carcinoma caecum (Fig. 33.25): If suspicion of a carcinoma is high, hemicolectomy should be done. Otherwise take a biopsy-do appendicectomy.

INCIDENTAL APPENDICECTOMY

It means removal of normal appendix at laparotomy for another condition. Examples: Laparotomy and ilea! resection for stricture and anastomosis (can we do appendicectomy?).

Ovarian cyst: Torsion (right) ovary is removed. Can we add appendicectomy? Since benefits of appendicitis/appendicectomy is more in young patients, if patient is under 30 years, it may be justifiable to do incidental appendicectomy provided it can be removed through same incision, without much difficulty.

The patient should be stable to tolerate the procedure.

What to do if normal appendix is found at surgery?

- Nonnal white appendix is called Lily-white appendix.
- It is removed because the 'scar' should not add confusion later to a doctor whether appendix was removed or not.
- However, examine:
  - Meckel's diverticulum
  - Mesenteric lymph node enlargement
  - Ovaries and fallopian tubes
  - Gall bladder for cholecystitis and pancreas for pancreatitis.
- Rule out duodenal ulcer perforation.
- Document the findings

POST-APPENDICECTOMY FAECAL FISTULA

- It can occur after appendicectomy especially when gangrene of the appendix extends to base of the caecum. It can also occur if purse-string suture is not properly applied, injury to the terminal ileum or caecum, etc. occurs.
- Discharge of faeculent contents or faecal matter after appendicectomy suggests faecal fistula (Fig. 9 and Key Box 33.8).

This patient had faecal fistula which healed after two weeks of conservative management

(Fig. 9)

FAECAL FISTULA—CAN OCCUR

- After drainage of appendicular abscess
- After appendicectomy—if purse string sutures are not properly applied
- If the caecum is also involved by inflammation
- If the cause of appendicitis is carcinoma
- If chronic diseases develop or are present—tuberculosis, Crohn's or actinomycosis
- If appendicitis is associated with carcinoma caecum

- Usually discharge stops after a few days provided there is no distal obstruction.

NEOPLASM OF THE APPENDIX

1. Carcinoid tumour

- It is the most common neoplasm of the appendix, less aggressive, majority are benign and cured with simple appendicectomy *(see* Chapter 28 for more details).
- Goblet cell carcinoid tumour it is more aggressive, requires right hemicolectomy if the tumour is more than 2 cm, has more than 2 mitosis per high power field and lymphovascular invasion, adenocarcinoma of the appendix.

2. Carcinoma

- It is very rare.
- Often it is colonic type. Other type is mucinous adeno-carcmoma.
- Can present as acute appendicitis due to obstruction caused by the tumour.
- Mucinous variety has better prognosis.
- Colonic variety should be treated by right hemicolec-tomy.

3. Cystic neoplasm of the appendix

- Rare occurrence

- Simple cyst (non-neoplastic mucocoele) and mucinous cystadenoma (like pancreatic).
- Can attain large size.
- Diagnosis is by ultrasound/CT scan.
- Appendicectomy is the treatment of choice.
- It can rupture into peritoneal cavity resulting in pseudo-myxoma peritonei.

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