“ ЗАТВЕРДЖЕНО”

на методичній нараді кафедри

дитячої хірургії протокол № 1

від 10 січня 2018 року

Зав. кафедрою дитячої хірургії

професор\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_А.Ф. Левицький

**THEME No1**

**ACUTE APPENDICITIS, PERITONITIS IN CHILDREN.**

**Compilers:**

Associate professor of pediatric surgery department Benzar Iryna

Associate professor of pediatric surgery department Pysmennyy Victor

P ostgraduate of pediatric surgery department Golubenko Oleksiy

**Overview**

Abdominal pain is one of the most common reasons that a child or adolescent is brought to medical attention. Evaluation of stomach pain is a challenge for the physician - possible causes can range from trivial to life threatening. Acute appendicitis is a common cause of abdominal pain and the most frequent condition leading to emergent abdominal surgery in pediatrics.

Despite diagnostic and therapeutic advancement in medicine, appendicitis remains a clinical emergency. In fact, this illness is one of the more common causes of acute abdominal pain. Left untreated, appendicitis has the potential for severe complications, including perforation or sepsis.

**Educational aims:**

The aim of this part of module is to provide help in identifying those children with abdominal pain who need surgical intervention, and to provide guidance on the initial stabilization and management of a variety of common surgical problems.

**A student must know:**

1. Relevant anatomy of the appendix and abdominal cavity in children.
2. The classic clinical manifestation of the acute appendicitis.
3. Features of clinical presentations of acute appendicitis in newborn and toddlers.
4. Lab studies and imaging studies in children with acute appendicitis.
5. Differential diagnosis of acute appendicitis and gastroenteritis.
6. Differential diagnosis of acute appendicitis and infection diseases.
7. Meckel's diverticulitis: causes, clinical presentation, diagnostic procedures, treatment.
8. Complications of appendicitis. Clinical presentations of the appendicular abscess.
9. Treatment of acute appendicitis.
10. Preoperative management in children with acute appendicitis.
11. Advantages and disadvantages of laparoscopic appendectomy.
12. Postoperative complications after appendectomy (open and laparoscopic).
13. Postoperative management after appendectomy.
14. Classification of peritonitis.
15. Causes and clinical picture of peritonitis in newborn.
16. Etiology, patophysiology, clinical presentation and management of primary peritonitis.

**A student must be able to:**

1. Look for:

* Point tenderness in the RLQ
* Evidence of advanced disease suggested by rebound tenderness, voluntary or involuntary guardin), psoas sign, or rigidity
* Other causes of RLQ abdominal pain evident on physical exam, such as incarcerated hernia

1. Do a pelvic exam in female patients to evaluate the adnexa.
2. Make the physical exam of children
3. Look for evidence of peritoneal irritation
4. Be able to use of scoring systems, particularly in the pediatric population, could help risk-stratify patients
5. Use lab tests to support the diagnosis

* CBC to look for an elevated leukocyte count
* Urinalysis
* Urine pregnancy test in females of reproductive age

**Terminology**

|  |  |
| --- | --- |
| ***Term*** | ***Definition*** |
| Appendicitis | Inflammation of the inner lining of the vermiform appendix that spreads to its other parts |
| McBurney point | Classic location of the appendix, one third of the distance from the right anterior superior iliac spine to the umbilicus |
| Cough sign, Dunphy sign | Sharp pain in the right lower quadrant after a voluntary cough |
| Blumberg sign | Rebound tenderness related to peritoneal irritation elicited by deep palpation with quick release |
| Rovsing sign | Pain in the right lower quadrant in response to left-sided palpation and strongly suggests peritoneal irritation |
| Primary (idiopathic or spontaneous) peritonitis | Infectious process involving the peritoneal cavity that has no intra-abdominal source |
| Secondary peritonitis | Chronic or acute inflammation caused by bacteria entering the peritoneum following perforation of the gastrointestinal tract (for example, ruptured appendix) |
| Tertiary peritonitis | Persistent or recurrent infection after adequate initial therapy |

CONTENT

**Appendicitis** is inflammation of the inner lining of the vermiform appendix that spreads to its other parts.

The diagnosis of appendicitis is clinical and essentially is based on history and clinical examination findings. The classic form of appendicitis may be promptly diagnosed and treated. When appendicitis appears with atypical presentations, it remains a clinical challenge. In such cases, laboratory and imaging investigation may be useful in establishing a correct diagnosis.

**History of the procedure.** The first report of an appendectomy came from Amyan, a surgeon of the English army. Amyan performed an appendectomy in 1735 without anesthesia to remove a perforated appendix. Reginald H. Fitz, an anatomopathologist at Harvard who advocated early surgical intervention, first described appendicitis in 1886. Because he was not a surgeon, his advice was ignored for a time. Then, at the end of the 19th century, the English surgeon H. Hancock successfully performed the first appendectomy in a patient with acute appendicitis. Some years after this, the American C. McBurney published a series of reports that constituted the basis of the subsequent diagnostic and therapeutic management of acute appendicitis. Currently, appendectomy, either open or laparoscopic, remains the treatment for noncomplicated appendicitis.

**Relevant anatomy.** The appendix is a wormlike extension of the cecum, and its average length is 8-10 cm (ranging from 2-20 cm). This organ appears during the fifth month of gestation, and its wall has an inner mucosal layer, 2 muscular layers, and a serosa. Several lymphoid follicles are scattered in its mucosa. The number of follicles increases when individuals are aged 8-20 years.

The inner muscular layer is circular, and the outer layer is longitudinal and derives from the taenia coli. Taenia coli converge on the posteromedial area of the cecum. This site is the appendiceal base. The appendix runs into a serosal sheet of the peritoneum called the mesoappendix. Within the mesoappendix courses the appendicular artery, which is derived from the ileocolic artery. Sometimes, an accessory appendicular artery (deriving from the posterior cecal artery) may be found. The vasculature of the appendix must be addressed to avoid intraoperative hemorrhages.

The classic location of the appendiceal tip is McBurney’s point: one third of the distance from the right anterior superior iliac spine to the umbilicus. The course of the appendix and the position of its tip may vary widely, accounting for the nonspecific signs and symptoms of appendicitis.

Inconstancy of position:

Retrocecal – 74 %;

Pelvic – 21 %;

Subcaecal – 1 – 5 %;

Postileal – 5%;

Preileal – 1%;

Paracecal – 2%;

In left iliac fossa or in the hypochondrium – very occasionally.

**Pathophysiology:**

Early stage of appendicitis: Obstruction of the appendiceal lumen leads to mucosal edema, mucosal ulceration, diapedesis of bacteria, distention of the appendix due to accumulated fluid, and increasing intraluminal pressure. This stimulates the visceral afferent nerve fibers and the patient perceives visceral periumbilical or epigastric pain. This mild pain usually lasts 4-6 hours.

Suppurative appendicitis: Increasing intraluminal pressures eventually exceed capillary perfusion pressure, which is associated with obstructed lymphatic and venous drainage and allows bacterial and inflammatory fluid invasion of the tense appendiceal wall. Transmural spread of bacteria causes acute suppurative appendicitis. When the inflamed serosa of the appendix comes in contact with the parietal peritoneum, patients typically experience the classic shift of pain to the right lower quadrant (RLQ), which is continuous and more severe than the early visceral pain.

Gangrenous appendicitis: Intramural venous and arterial thromboses ensue, resulting in gangrenous appendicitis.

Perforated appendicitis: Persisting tissue ischemia results in appendiceal infarction and perforation. Perforation can cause localized or generalized peritonitis.

Phlegmonous appendicitis or abscess: An inflamed or perforated appendix can be walled off by the adjacent greater omentum or small bowel loops and phlegmonous appendicitis or focal abscess occurs.

**The bacterial flora** of appenditis is derived from organisms that normally inhabit in the human colon. The most important pathogen is *Bacteroides fragilis*, a gram-negative, strict anaerobe. The second most important pathogene is *Escherichia coli*, a gram-negative, facultative anaerobe. Other anaerobic species, including *Streptococcus, Pseudomonas, Klebsiella* and *Clostridium*, also appear.

**Histologic findings.** In the early stages of the disease, the appendix grossly appears edematous with dilation of the serosal vessels. Microscopy demonstrates neutrophil infiltrate of the mucosal and muscularis layers extending into the lumen. As time passes, the appendiceal wall grossly appears thickened, the lumen appears dilated, and a serosal exudate (fibrinous or fibrinopurulent) may be observed as granular roughening. At this stage, mucosal necrosis may be observed microscopically.

At later stages, the appendix grossly shows marked signs of mucosal necrosis extending into the external layers of the appendiceal wall that can become gangrenous. Sometimes the appendix may be found in a collection of pus. At this stage, microscopy may demonstrate multiple microabscesses of the appendiceal wall and severe necrosis of all layers.

**Frequency**. The incidence of acute appendicitis is around 7% of the population in the United States and in European countries. In Asian and African countries, the incidence is probably lower because of the dietary habits of the inhabitants of these geographic areas.

In the last few years, a decrease in frequency of appendicitis in Western countries has been reported, which may be related to changes in dietary fiber intake. In fact, the higher incidence of appendicitis is believed to be related to poor fiber intake in such countries.

**Mortality/Morbidity.** At the time of diagnosis, the rate of perforation varies from 17 – 40% with a higher frequency occurring in younger age groups. The mortality rate for children with appendicitis ranges from 0.1-1%. Perforation increases the complication rate.

**Age:** Appendicitis occurs in all age groups.

The mean age in the pediatric population is 6-10 years.

Appendicitis in neonates is rare and warrants evaluation for cystic fibrosis as well as Hirschsprung’s disease. Neonatal appendicitis also can be indistinguishable from focal necrotizing enterocolitis confined to the appendix.

Younger children have a higher rate of perforation, with reported rates of 50-85%.

**Sex:** Male-to-female ratio is approximately 2:1.

**Clinical manifestations**

***History*.** It is important to understand the typical clinical manifestations of appendicitis in order to make an early and accurate diagnosis prior to perforation. The classic history of anorexia and periumbilical pain, followed by right lower quadrant pain and vomiting, is observed in fewer than 60% of cases.

The initial symptom is poorly defined periumbilical pain, often associated with anorexia. Acute onset of severe pain is typically present with acute ischemic conditions, such as volvulus, testicular torsion, ovarian torsion, or intussusception. In appendicitis, nausea and vomiting develop shortly after onset of pain. In most cases of appendicitis, abdominal pain precedes vomiting.

After a few hours, the pain shifts to the right lower quadrant due to inflammation of the parietal peritoneum. This pain is more intense, continuous, and more localized than the initial pain. This shift of pain rarely occurs in other abdominal conditions.

The majority of children with appendicitis either are afebrile or have a low-grade fever. High fever is not a common presenting feature unless perforation has occurred.

In neonates, the clinical features of appendicitis are nonspecific and include irritability or lethargy, abdominal distention, vomiting, a palpable abdominal mass and cellulitis of the abdominal wall.

In infants and children up to two years of age, symptoms include vomiting, pain, diarrhea and fever. Diagnosis is more difficult in this age group because the symptoms are nonspecific.

In children two to five years of age, symptoms include vomiting, abdominal pain, fever and anorexia. Tenderness of the right lower quadrant is more common in this age group than it is in younger children, who usually have diffuse tenderness.

The incidence of appendicitis increases in children six to 12 years of age and in adolescents 13 years or older, with symptoms that include vomiting and abdominal pain that worsens with movement or cough. Tenderness in the right lower quadrant is common.

***Physical*.** Children vary in their ability to cooperate with the physical examination. It is important to tailor the physical examination with respect to the child's age and developmental stage.

A child with acute appendicitis walks slowly, often humped forward protecting the right side. The facial expression reflects discomfort and apprehension. The right hip frequently is held in slight flexion. Fever, tachycardia, and signs of dehydration usually are minimal in the first 12 to 24 hours but quickly increase in the later stages.

Before examination of the abdomen, the child should be made as comfortable, as possible, with the hands folded on the chest and perhaps a pillow placed beneath the knees to flex the hips. If asked to point one finger where it hurts most, the child invariably will identify the tender point. The examiner should then begin the palpation in other less sensitive areas of abdomen. Gentleness and warm hands are important.

A careful physical examination, not limited to the abdomen, must be performed in any patient with suspected appendicitis. GI, genitourinary, and pulmonary systems must be studied.

Despite previous dogma, a rectal examination is a traumatizing and nonspecific adjunct that is unlikely to contribute to the evaluation. Even in the setting of a suspected pelvic abscess or ovarian pathologic process, these diagnoses cannot be affirmed without imaging.

Observation of the child's interaction and gait prior to the examination can be extremely helpful.

Localization of the pain depends on the position of the appendix. Typically, maximal tenderness can be found at McBurney point. It is the classic location of the appendix, one third of the distance from the right anterior superior iliac spine to the umbilicus. Additional signs such as cough sign (sharp pain in the right lower quadrant after a voluntary cough, Dunphy sign), rebound tenderness related to peritoneal irritation elicited by deep palpation with quick release (Blumberg sign), and guarding may or may be present. Rovsing sign is pain in the right lower quadrant in response to left-sided palpation and strongly suggests peritoneal irritation.

Patients with appendicitis may not have the reported classic clinical picture 37-45% of the time, especially when the appendix is located in an unusual place. In such cases, imaging studies may be important but not always available. Patients with this condition usually have accessory signs that may be helpful for diagnosis. For example, the obturator sign is present when the internal rotation of the flexed right thigh elicits pain (pelvic appendicitis), and the psoas sign is determined by placing the child on the left side and hyperextending the right leg (retroperitoneal or retrocecal appendicitis). Pain on movement may be caused by an inflammatory mass overlying the psoas muscle.

The appendix can be in the right upper abdomen if the patient has an incomplete rotation. Likewise, if the patient has untreated nonrotation, the appendix could lie anywhere in the abdomen.

**Diagnosis**

**Lab Studies.** Laboratory findings may increase the suspicion for appendicitis but are not diagnostic. A minimum laboratory evaluation for patients with possible appendicitis includes a ***Complete blood cell count (CBC)*** with differential and urinalysis.

***The White blood cell (WBC) count*** is elevated in approximately 70-90% of patients with acute appendicitis but also is elevated in many other abdominal conditions. The predictive value of the WBC count is limited. Because at least 10% of patients with appendicitis have a WBC count within the reference range, appendicitis cannot be excluded based on a WBC count within the reference range. It is important to interpret the WBC count with respect to the clinical presentation. If the WBC count exceeds 15,000 cells/mm3, the patient is more likely to have a perforation. However, one study found no difference in the WBC count between children with simple appendicitis and those with a perforated appendicitis.

***Urinalysis*** is useful for detecting urinary tract disease, such as infection or renal stones.

Irritation of the bladder or ureter by an inflamed appendix may result in a few WBCs in the urine, but the presence of over 20 WBCs suggests a urinary tract infection.

Causes of hematuria include renal stones, urinary tract infection, Henoch-Schőnlein purpura (HSP), or hemolytic uremic syndrome (HUS).

Normal findings on urinalysis are of limited diagnostic value for appendicitis. Grossly abnormal urinalysis findings may suggest another cause of abdominal pain.

*C-reactive protein* is usuallycincreased and becomes markedly elevated with perforation.

***Electrolytes and renal function*** tests are more helpful in the management than in the diagnosis of appendicitis. Indications for assessing electrolytes include a significant history of vomiting or clinical suspicion of dehydration.

***Additional studies:***

Liver function tests, serum amylase, and serum lipase may be helpful when the etiology of the abdominal pain is unclear.

Urinary levels of human chorionic gonadotropin-beta subunit (hCG-beta) are useful in sexually active adolescent females to exclude ectopic pregnancy.

**Imaging Studies:**

***Abdomen plain film:*** Occasionally, a plain film of the abdomen may demonstrate fecalith within the appendix, but this study is rarely indicated.

***Ultrasound.*** A healthy appendix usually cannot be viewed with ultrasound (US). When appendicitis occurs, the US typically demonstrates a noncompressible tubular structure of 7-9 mm in diameter. False-positive results may occur in patients with Crohn disease. False-negative results are frequent in patients with retrocecal appendix. The main limitation of US scan is that its reliability is completely user-dependent.

***Computed tomography scan.*** The typical findings are a nonfilling appendix with distention and thickened walls of the appendix and the cecum, enlarged mesenteric nodes, and periappendiceal inflammation or fluid. Because of its cost, CT scans are generally reserved for patients with uncertain diagnosis or severe obesity.

**Possible conditions that can mimic appendicitis include:**

***Gastroenteritis*** - usually causes pain, diarrhoea and vomiting. The pain does not usually shift from centrally to the right lower part of the abdomen.

***Mesenteric adenitis*** - this is swollen glands in the abdomen and produces symptoms that are often identical to appendicitis in children. They usually have a sore throat, cough, earache or cold.

***Distal ileitis*** - this is inflammation of the last part of the small bowel. It is usually be caused by [Crohn's disease](http://www.oxmed.com/DOCS/datafiles/crohns%20disease.html), an infection called Yersinia, or tuberculosis.

***Meckel's diverticulitis*** - this is inflammation in a congenital outgrowth of the small bowel. It is present in around 2% of the population and usually causes no trouble so that a person does not know of its existence. The pain is often a little less localized than with appendicitis, but the diagnosis is often made at operation.

***Ruptured*** [***ectopic pregnancy***](http://www.oxmed.com/DOCS/datafiles/ectopic%20pregnancy.html)- this causes pain on the right if the right tube is affected. The woman has usually missed the last period, and may have bleeding from the vagina at the time of the pain.

***Right ovarian cyst*** - if this ruptures it can cause pain in the right side and mimic early appendicitis. If the cyst twists this is called torsion of an ovarian cyst and this leads to throbbing pain in the right lower abdomen. It is often of sudden onset and is associated with vomiting when the pain starts.

***Urinary tract infection*** - there is often pain on passing water and the doctor can test the urine to look for signs of infection to exclude this.

**Complications of appendicitis:**

* Perforation
* Peritonitis
* Abscess
* Dehiscence

**Treatment**

Appendectomy remains the only curative treatment for appendicitis.

Thousands of classic appendectomies (open procedure) have been performed in the last 2 centuries. Mortality and morbidity have gradually decreased, especially in the last few decades because of antibiotics, early diagnosis, and improvements in anesthesiologic and surgical techniques.

Since 1987, many surgeons have begun to treat appendicitis laparoscopically.

***Laparoscopy*** has some advantages, including decreased postoperative pain, better aesthetic result, a shorter time to return to usual activities, and lower incidence of wound infections or dehiscence. Laparoscopy offers the substantial advantage of allowing excellent visualization of the entire abdominal cavity, removing therapeutic concerns of an alternative diagnosis. This procedure is higher cost because of equipment needs and but may require more operative time compared with open appendectomy, increased training and experience required for surgeons and ancillary support staff. Although laparoscopic appendectomy is safe and effective and its utilization has increased dramatically over the past decade.

**Preoperative details:** Preparation of patients undergoing appendectomy is similar for both open and laparoscopic procedures.

Because they may mask the underlying disease, do not administer analgesics and antipyretics to patients with suspected appendicitis who have not been evaluated by the surgeon.

Perform complete routine laboratory and radiologic studies before intervention.

Venous access must be obtained in all patients diagnosed with appendicitis. Venous access allows administration of isotonic fluids and broad-spectrum intravenous antibiotics prior to the operation.

Patients presenting with perforated appendicitis may be volume depleted and require aggressive fluid resuscitation.

The antibiotic regimen must provide broad-spectrum coverage of enteric organisms.

In simple, acute appendicitis, a single dose of antibiotics is adequate preoperative coverage.

Prior to the start of the surgical procedure, the anesthesiologist performs endotracheal intubation to administer volatile anesthetics and to assist respiration.

The abdomen is washed, antiseptically prepared, and then draped.

**Contraindications**: Patients with appendicitis always need urgent referral and prompt treatment. No contraindications to appendectomy are known for patients with suspected appendicitis except in the case of a patient with a long history of symptoms and signs of a large abscess. If a periappendiceal abscess exists secondary to appendiceal perforation or rupture, some physicians may choose a conservative approach with broad-spectrum antibiotics and percutaneous drainage followed by appendectomy later.

Nontoxic patients with a localized walled-off abscess may be candidates for initial medical management with antibiotics, followed by an elective appendectomy.

Certain contraindications exist for laparoscopic appendectomy. These contraindications are extensive adhesions, radiation or immunosuppressive therapy, severe portal hypertension, and coagulopathies.

**Intraoperative details**

***Open appendectomy***

Prior to incision, the surgeon should carefully perform a physical examination of the abdomen to detect any mass and to determine the site of the incision.

Open appendectomy requires a transverse incision in the RLQ over the McBurney point (two thirds of the way between the umbilicus and the anterior superior iliac spine).

The abdominal wall fascia (Scarpa fascia) and the underlying muscular layers are sharply dissected or split in the direction of their fibers to gain access to the peritoneum. If necessary (eg, because of concomitant pelvic pathologies), the incision may be extended medially, dissecting some fibers of the oblique muscle and retracting the lateral part of the rectus abdominis. The peritoneum is opened transversely and entered. Note the character of any peritoneal fluid to help confirm the diagnosis and then suction it from the field; if purulent, collect and culture the fluid.

Retractors are gently placed into the peritoneum. The cecum is identified and medially retracted. It is then exteriorized by a moist gauze sponge or Babcock clamp, and the taenia coli are followed to their convergence. The convergence of teniae coli is detected at the base of the appendix, beneath the Bauhin valve (ie, the ileocecal valve), and the appendix is then viewed. If the appendix is hidden, it can be detected medially by retracting the cecum and laterally by extending the peritoneal incision.

After exteriorization of the appendix, the mesoappendix is held between clamps, divided, and ligated. The appendix is clamped proximally about 5 mm above the cecum to avoid contamination of the peritoneal cavity and is cut above the clamp by a scalpel. Fecaliths within the lumen of the appendix may be detected. The appendix must be ligated to prevent bleeding and leakage from the lumen. The residual mucosa of the appendix is gently cauterized to avoid future mucocele. The appendix may be inverted into the cecum with the use of a pursestring suture or z-stitch. Although performed by several surgeons, the appendiceal stump inversion is not mandatory.

The cecum is placed back into the abdomen. The abdomen is irrigated. When evidence of free perforation exists, peritoneal lavage with warm saline is recommended. After the lavage, the irrigation fluid must be completely aspirated. The use of a drain is not commonly required in patients with acute appendicitis.

The wound closure begins by closing the peritoneum with a running suture. Then, the fibers of the muscular and fascial layers are reapproximated and closed with a continuous or interrupted absorbable suture. Lastly, the skin is closed with subcutaneous sutures or staples.

***Laparoscopic appendectomy***

The surgeon typically stands on the left of the patient, and the assistant stands on the right. The anesthesiologist and the anesthesia equipment are placed at the patient's head, and the video monitor and instrument table are placed at the feet.

Although some variations are possible, 3 cannulae are placed during the procedure. Two of them have a fixed position (umbilical and suprapubic). The third is placed in the right periumbilical region, and its position may vary greatly depending on the patient’s anatomy.

Pneumoperitoneum (10-14 mm Hg) is established and maintained by insufflating carbon dioxide. Through the access, a laparoscope is inserted to view the entire abdomen cavity.

A 12-mm cannula is introduced through an umbilical incision, and pneumoperitoneum is established. Diagnostic laparoscopy is then performed. Two 5-mm ports are then placed, one in the left midabdomen and one in the left suprapubic area.

The appendix is grasped and retracted upward to expose the mesoappendix. The mesoappendix is divided using a dissector. Then, a linear Endostapler, Endoclip, or suture ligature is passed through the suprapubic cannula to ligate the mesoappendix. The mesoappendix is transected using a scissor or electrocautery. To avoid perforation of the appendix and iatrogenic peritonitis, the tip of the appendix should not be grasped.

The appendix may now be transected with a linear Endostapler, or, alternately, the base of the appendix may be suture ligated in a similar manner to that in an open procedure. The appendix is now free and may be removed through the umbilical or the suprapubic cannula using a laparoscopic pouch to prevent wound contamination. Peritoneal irrigation is performed with saline solution. Completely aspirate the irrigant. The cannulae are then removed and the pneumoperitoneum is reduced.

The fascial layers at the cannula sites are closed with absorbable suture, while the cutaneous incisions are closed with interrupted subcuticular sutures or sterile adhesive strips.

**Postoperative complications**

After an appendectomy there is a 10% risk of infection in the wound, which can usually be treated by the GP prescribing antibiotics. Occasionally it will require a small operation in hospital.

A small number of patients can get an [abscess](http://www.oxmed.com/DOCS/datafiles/abscess.html) in the abdomen, especially if the appendix had perforated. These cause diarrhoea and make the patient unwell often a few days after the operation. It may be necessary to have another operation but they can usually be treated with a drain placed into the abdomen using a scanner to guide the placement and the prescription of antibiotics.

Fifteen to 20% of appendectomies are performed in cases for which test results are later determined to be falsely positive, as appendicitis is difficult to diagnose in infants and toddlers.

**Postoperative care**

Antibiotics considered for patients with appendicitis must offer full aerobic and anaerobic coverage. Duration of the administration is closely related to the stage of appendicitis at the time of the diagnosis, considering either intraoperative findings or postoperative evolution. According to several studies, antibiotic prophylaxis should be administered before every appendectomy. When the patient becomes afebrile and the WBC count normalizes, antibiotic treatment may be stopped.

**Length of stay.** Hospital stay averages two to three days after the operation if the appendix was not perforated and there were no complications.

A longer stay of five to seven days is required for treatment of a perforated appendix. Bowel function normally returns after two to four days, but intravenous antibiotics are required for at least four to five days and sometimes longer, depending upon the child's fever and white blood cell count. When the appendix is perforated, the chance for an infection of the incision site are about five to ten percent and the chance that an abscess (pus collection) will develop inside the abdomen is less than five percent. If a wound infection develops, the would will be opened partially and dressing changes begun. If there is an abscess inside the abdomen it is usually possible to drain it by insertion of a needle without the need for re-operation. These complications may delay discharge if they occur.

**Diet.** If the appendix did not rupture and a nasogastric tube is not needed, clear liquids by mouth are usually started the first day after the operation. The diet is then advanced to normal if the child tolerates the clear liquids (no vomiting or nausea).

Children with perforation of the appendix are started on clear liquids once the child has passed gas or stool from the rectum. Again, as long as the child is tolerating the clear liquids, diet is advanced.

**Activity.** After appendectomy, children may usually return to school within a week of discharge from the hospital, although they may find that they tire quickly. Vigorous activities and contact sports should be limited for at least three weeks. When the appendectomy is done using a laparoscope, children may resume their usual physical activities as soon as they feel ready--there are no activity constraints.

**Prognosis** is excellent. In fact, no mortality has been reported in patients with a nonperforated appendix. The mortality rate for complicated appendicitis has dropped to nearly zero. Antibiotics have markedly decreased the incidence of infections complications.

**Peritonitis**

**Peritoneum** is multilayered membrane which lines the abdominal cavity, and supports and covers the organs within it. The part of the membrane that lines the abdominal cavity is called the parietal peritoneum. The portion that covers the internal organs, or viscera, is known as the visceral peritoneum and forms the outer layer (serosa) of most of the intestinal tract. The supportive peritoneum forms sheets of greatly modified membranes called mesenteries. These tissues hold the organs of the digestive tract in position and convey nerves, blood vessels, and lymphatic ducts to the viscera. The space between the visceral and parietal membranes contains a watery fluid that permits the abdominal organs to slide freely against the abdominal wall.

**Peritonitis** is defined as inflammation of the peritoneum. Peritonitis is often caused by introduction of an infection into the otherwise sterile peritoneal environment through perforation of the bowel, such as a ruptured appendix or colonic diverticulum. The disease may also be caused by introduction of a chemically irritating material, such as gastric acid from a perforated ulcer or bile from a perforated gall bladder or a lacerated liver. In women, localized peritonitis most often occurs in the pelvis from an infected fallopian tube or a ruptured ovarian cyst.

Inflammation and/or infection of the peritoneal cavity are commonly encountered problems in the practice of clinical medicine today. In general, the term peritonitis refers to a constellation of signs and symptoms, which includes abdominal pain and tenderness on palpation, abdominal wall muscle rigidity, and systemic signs of inflammation. Patients may present with an acute or insidious onset of symptoms, limited and mild disease, or systemic and severe disease with septic shock. The peritoneum reacts to a variety of pathologic stimuli with a fairly uniform inflammatory response.

**Classification**.

Depending on the underlying pathology, the resultant peritonitis may be infectious or sterile (ie, chemical or mechanical).

Peritoneal infections are classified as primary (spontaneous), secondary (related to a pathologic process in a visceral organ), or tertiary.

***Primary peritonitis*** (also referred to as idiopathic or spontaneous peritonitis) has been defined as an infectious process involving the peritoneal cavity that has no intra-abdominal source.

***Secondary peritonitis*** is a chronic or acute inflammation caused by bacteria entering the peritoneum following perforation of the gastrointestinal tract, for example, ruptured appendix. The irritant can be gastric juice, small bowel contents or faeces from the colon.

***Tertiary peritonitis***is persistent or recurrent infection after adequate initial therapy.

The intra-abdominal infection may be localized or generalized, with or without abscess formation.

***Microbiology*** includes a mixture of aerobic and anaerobic organisms. The most commonly isolated aerobic organism is *Escherichia coli*, and the most commonly observed anaerobic organism is *Bacteroides fragilis*. A synergistic relationship exists between these organisms. In patients who receive prolonged antibiotic therapy, yeast colonies (*candidal species*) or a variety of nosocomial pathogens may be recovered from peritoneal fluids.

Skin flora may be responsible for abscesses following a penetrating abdominal injury.

The type and density of aerobic and anaerobic bacteria isolated from intra-abdominal fluid depend upon the nature of the microflora associated with the diseased or injured organ.

**Clinical features.**

Initial diagnosis is based on symptoms and a physical examination. Abdomen will be tender, and often distended. Children with peritonitis will often feel the need to protect their abdominal area from touch. In neonates abdominal distention usually accompanied by erythema and edema of abdominal wall ad scrotum.

Many patients have a significant septic response, volume depletion, and catabolic state. This syndrome may include high cardiac output, tachycardia, low urine output, and low peripheral oxygen extraction. Initially, respiratory alkalosis due to hyperventilation may occur. If left untreated, this progresses to metabolic acidosis. Sequential multiple organ failure is highly suggestive of intra-abdominal sepsis.

Once an initial diagnosis and assessment of the probably causes has been made, tests are carried out.

Tests for spontaneous and secondary peritonitis include:

* Culture of peritoneal fluid (which is found in the peritoneal cavity and acts as a lubricant between the layers of the peritoneum) - a bacteriological laboratory test to identify infectious organisms in the fluid.
* Chemical examination or laboratory analysis of peritoneal fluid.
* Blood culture to determine the presence of microorganisms in the blood.

Other possible tests for peritonitis, especially spontaneous peritonitis, include:

* An abdominal X-ray to rule out other possible reasons for symptoms such as abdominal pain.
* An abdominal ultrasonography

***SPECIFIC TYPES OF ACUTE PERITONITIS***

**Meconium Peritonitis**

Meconium peritonitis is an aseptic peritonitis caused by spill of meconium in the abdominal cavity through one or several intestinal perforations which have taken place during intrauterine life.

***Etiology/Pathophysiology***. The most common causes of meconium peritonitis are ischemic lesions of the small bowel associated with mechanical obstruction (atresia, volvulus, intussusception, congenital bands, Meckel diverticulum, internal hernia, meconium ileus). However, in some cases it is impossible to find its etiology, in spite of pathological changes. Meconium is a sterile mixture and consists of desquamated epithelial cells, vernix, lanugo hair, and intestinal secretions containing cholesterol and mucopolysaccharides. When meconium spills into the peritoneum it acts as an irritant and an inflammatory serosal reaction. A secondary inflammatory response results in the production of fluid (ascites), fibrosis, calcification and sometimes cyst formation.

There are 3 types of meconium peritonitis:

1. *Fibroadhesive* - an intense adhesive peritoneal reaction with no active leak of bowel contents. This type produces obstruction by adhesive bands and the site of perforation is usually sealed off.

2. *Cystic* - a localized cavity formed by adjacent loops of bowel. This condition prevents communication of the perforation with the remainder of the viscera.

3. *Generalized* - no adhesions or calcifications, seen in cases where the bowel perforation occurs just before birth. Calcified meconium is scattered throughout the peritoneal cavity and the bowel loops are adherent by thin fibrinous adhesions.

The ***prenatal*** ***sonographic findings*** vary depending on several factors: the etiology, the time interval since perforation and the degree of inflammatory response. It may be seen as early as 13 weeks gestation. In the typical case, diffuse hyperechoic punctate echoes with or without acoustic shadowing may be seen in the abdominal cavity, on the hepatic surface and in the scrotal sac. In addition, depending upon the etiology, ascites, polyhydramnios or fetal bowel distention may be present. Polyhydramnios, reported in approximately 50% of patients, may be caused by peristaltic deficiency associated with decreased swallowing activity. If the inflammatory response remains localized a meconium pseudocyst may occur. This appears sonographically as a cystic heterogeneous mass with an irregular, calcified wall.

In the absence of an intra-abdominal mass such as a meconium pseudocyst, the major differential diagnostic possibilities for bright echoes within the abdomen is “hyperechogenic bowel”. In this condition, the bowel appears as bright as bone. This is often normal, particularly in the third trimester, but has been described to be associated with cystic fibrosis and chromosomal abnormalities.

***Postnatal diagnosis*** is based on clinical and radiological, and ultrasonographic findings of intestinal obstruction, and occasionally one or more of the following: calcification, pneumoperitoneum, cyst formation or ascites. Typical symptoms of meconium peritonitis are abdominal distension immediately or it soon after birth, bile-stained vomiting and failure to pass meconium. X-ray and ultrasound examination show the intestinal ileus, the ascites when it exists, the ground-glass appearance of the abdomen due to the meconium and rarely the presence of a pneumoperitoneum, since the quick formation of adhesions prevents the intestinal gas from escaping. Intra-abdominal calcifications are characteristic and can easily be seen on plain abdominal films.

Early diagnosis is a decisive factor for the prognosis of these newborns, because the commencement of bacterial colonization of the meconium starts after birth.

***Treatment***. The indication for operation in newborns with meconium peritonitis is a clear sign of intestinal obstruction or perforation. The diagnosis of meconium peritonitis without intestinal obstruction or pneumoperitoneum does not constitute an indication for operation. Infants with neonatal meconium calcification, meconium ascites with hydrocele, or calcified meconium found in the hernial sac do not require operation, but they have to be observed and feeding withheld for 48 hours. With an absence of clinical symptoms, enteral feeding can be started with caution, gradually progressing to formula. Antibiotic coverage is desirable.

The ***prognosis*** depends upon the etiology. Bowel perforations may heal and the ascites and bowel dilatation may resolve, leaving only peritoneal calcifications as the only sonographic sign of meconium peritonitis. While cystic fibrosis is universally seen in cases of meconium ileus, it is seen in only 7-40% of cases of meconium peritonitis

**Primary peritonitis**

Primary peritonitis (also referred to as idiopathic or spontaneous peritonitis) has been defined as an infectious process involving the peritoneal cavity that has no intra-abdominal source. The infection may reach the abdomen through hematogenous or lymphatic routes or by direct extension from the vagina. With the exception of the ends of the fallopian tubes, the peritoneal cavity is a completely closed space that can be penetrated by foreign bodies such as ventriculoperitonel shunts and peritoneal dialysis catheters. In prepubertal and adolescent girls, retrograde spread of fluid out the through the fallopian tubes may account for the "presence of an ascending vulvovaginitis or “swimming pull peritonitis”.

The first reported case of fatal spontaneous bacterial peritonitis may have been in 1581 in a girl who expired after an episode of painless diarrhea. By the early 1900s, as many as 10% of abdominal operations in children fell into the category of primary peritonitis an associated mortality of up to 50%. Today, this condition represents less than 1% of all pediatric laparotomies because the diagnosis is made and treatment initiated without the need for operation. Most cases of primary peritonitis in the pediatric age group are associated with nephrotic syndrome or chronic hepatic states in which ascites or cirrhosis is present. This group includes infants and children with biliary atresia, cystic fibrosis, hepatic fibrosis, and lupus erythematosus. Organisms isolated from the peritoneal cavity will vary according to the various associated conditions. For instance, gram-positive organisms, including *Streptococcus pneumoniae* and group A streptococci, and variety of gram-negative species are most commonly found in patients with nephrotic syndrome. The same gram-positive groups are cultured in patients with underlying liver disease, whereas the spectrum of gram-negative isolates includes *Esherichia coli*, Klebsiella *pneumonia*, and *Pseudomonas* species.

Clinical history. Children with primary peritonitis have acute abdominal pain associated with a febrile illness, nausea, vomiting, diarrhea, or other viral-like prodromes. The time course may be more protracted then that for secondary peritonitis, and diffuse rebound tenderness is often present. The absence of localized pain may result from irritation of visceral organ surfaces. Diagnostic paracentesis may be helpful in the presence of ascites, as is sampling of the dialysate in children with renal failure on peritoneal dialysis program. In children with impaired hepatic function, cirrhosis, and ascites, the primary peritonitis that develops is often associated with the gram-negative organisms that normally populate the intestinal tract, such as *E. coli* and *K. pneumoniae*, whereas the gram-positive isolates include *S. pneumoniae* and *Staphylococcus aureus*.

The literature identified a group of healthy children with idiopathic peritonitis and simultaneously positive cultures for group A streptococci from trachea, pharynx, or tonsils.

When the clinical picture is not improving despite intravenous antibiotics, diagnostic laparoscopy or laparotomy is indicated. An appendectomy can be done safely even in the presence of cloudy exudate, and the bowel surface can be inspected for secondary causes of the infection. After the surgical intervention, antibiotics are continued until the leukocytosis normalizes and the ileus resolves.

***Abdominal Abscess***

Intra-abdominal abscesses are localized collections of pus that are confined in the peritoneal cavity by an inflammatory barrier. This barrier may include the omentum, inflammatory adhesions, or contiguous viscera. The abscesses usually contain a mixture of aerobic and anaerobic bacteria from the GI tract.

**Pathophysiology**. Bacteria in the peritoneal cavity, in particular those arising from the large intestine, stimulate an influx of acute inflammatory cells. The omentum and viscera tend to localize the site of infection, producing a phlegmon. The resulting hypoxia in the area facilitates growth of anaerobes and impairs bactericidal activity of granulocytes. The phagocytic activity of these cells degrades cellular and bacterial debris, creating a hypertonic milieu that expands and enlarges the abscess cavity in response to osmotic forces. If untreated, the process continues until bacteriemia develops, which then progresses to generalized sepsis with shock.

**Clinical**.

Intra-abdominal abscesses are highly variable in presentation. Persistent abdominal pain, focal tenderness, spiking fever, prolonged ileus, leukocytosis, or intermittent polymicrobial bacteriemia suggest an intra-abdominal abscess in patients with predisposing primary intra-abdominal disease or following abdominal surgery. If a deeply seated abscess is present, many of these classic features may be absent. The only initial clues may be persistent fever, mild liver dysfunction, persistent GI dysfunction, or nonlocalizing debilitating illness.

The diagnosis of an intra-abdominal abscess in the postoperative period may be difficult because postoperative analgesics and incisional pain frequently mask abdominal findings. In addition, antibiotic administration may mask abdominal tenderness, fever, and leukocytosis.

In patients with subphrenic abscesses, irritation of contiguous structures may produce shoulder pain, hiccup, or unexplained pulmonary manifestations such as pleural effusion, basal atelectasis, or pneumonia. With pelvic abscesses, frequent urination, diarrhea, or tenesmus may occur.

**Relevant Anatomy.** The 6 functional compartments within the peritoneal cavity include the (1) pelvis, (2) right paracolic gutter, (3) left paracolic gutter, (4) infradiaphragmatic spaces, (5) lesser sac, and (6) interloop potential spaces of the small intestine.

The paracolic gutters slope into the subhepatic and subdiaphragmatic spaces superiorly and over the pelvic brim inferiorly. In a supine patient, the peritoneal fluid tends to collect under the diaphragm, under the liver, and in the pelvis. More localized abscesses tend to develop anatomically in relation to the affected viscus. For example, abscesses in the lesser sac may develop secondary to severe pancreatitis, or periappendiceal abscesses from a perforated appendix may develop in the right lower quadrant. Small bowel interloop abscesses may develop anywhere from the ligament of Treitz to the ileum. An understanding of these anatomic considerations is important for recognizing and draining these abscesses.

**Lab Studies.**

Hematologic parameters suggesting infection (eg, leukocytosis, anemia, abnormal platelet counts, abnormal liver function) frequently are present, although patients who are debilitated often fail to mount reactive leukocytosis or fever.

Blood cultures indicating persistent polymicrobial bacteremias strongly implicate the presence of an intra-abdominal abscess. Because more than 90% of intra-abdominal abscesses contain anaerobic organisms, particularly B fragilis, postoperative Bacteroides species bacteremia suggests intra-abdominal sepsis.

**Imaging Studies.**

***Plain abdominal radiographs***, though rarely diagnostic, frequently indicate the need for further investigation.

Abnormalities on plain abdominal films may include a localized ileus, extraluminal gas, air-fluid levels, mottled soft tissue masses, absence of psoas outlines, or displacement of viscera.

In subphrenic or even subhepatic abscesses, the chest radiograph may show pleural effusion, elevated hemidiaphragm, basilar infiltrates, or atelectasis.

In experienced hands, ultrasonography has an accuracy rate greater than 90% for diagnosing intra-abdominal abscesses.

***Ultrasonography*** is readily available, portable, and inexpensive. The findings can be quite specific when correlated with the clinical picture.

A drawback is that marked obesity, bowel gas, intervening viscera, surgical dressings, open wounds, and stomas can create problems with definition. In addition, the quality of the procedure is operator-dependent. These disadvantages may limit efficacy in postoperative patients.

***CT scan*** has greater than 95% accuracy and is the best diagnostic imaging method. The presence of ileus, dressings, drains, or stomas does not interfere with reliability.

Identify any occult abscesses using serial images obtained from the diaphragm to the pelvis.

The appearance of an air bubble within a fluid collection or a low-attenuation extraluminal mass is diagnostic of an intra-abdominal collection.

CT scans can document inflammatory edema in the adjacent fat (obliteration of fat plane) and hyperemia in the abscess wall (enhancement).

Drawbacks include nonportability, relative difficulty in diagnosing intraloop abscesses, and, possibly, poor patient cooperation.

Recent intra-abdominal surgery also may pose a diagnostic problem in patients in whom intra-abdominal abscesses are suspected. CT scan is not recommended for use in the diagnosis of such abscesses until approximately the eighth postoperative day. By that time, postoperative tissue edema is reduced, and nonsuppurative fluids (eg, hematoma, seroma, intraoperative irrigation fluid) should be reabsorbed. In most postoperative patients, signs of intra-abdominal abscesses do not develop within the first 4-5 days.

**Treatment.**

**Medical therapy**. Antibiotic therapy involves the administration of parenteral empirical antibiotics. Begin therapy prior to abscess drainage, and conclude therapy when all systemic signs of sepsis resolve. Because abscess fluid usually contains a mixture of aerobic and anaerobic organisms, direct initial empiric therapy against both sets of microbes. This may be accomplished with antibiotic combination therapy or with broad-spectrum, single-agent therapy. Specific therapy then is guided by the results of cultures retrieved from the abscess.

In patients who are immunosuppressed, candidal species may play an important pathogenic role, and treatment with amphotericin B or fluconasol may be indicated.

**Surgical therapy.**

Drainage of pus is mandatory and is the first line of defense against progressive sepsis. Percutaneous CT-guided catheter drainage has become the standard treatment for most intra-abdominal abscesses. It avoids possibly difficult laparotomy, requires anesthesia, prevents the possibility of wound complications from open surgery, and may reduce the length of hospitalization. It also obviates the possibility of contamination of other areas within the peritoneal cavity. CT-guided drainage delineates the abscess cavity and may provide safe access for percutaneous drainage. When performed by experienced hands, it also prevents the possibility of injury to adjacent viscera or blood vessels.

After surgical drainage, clinical improvement should occur within 48-72 hours. Lack of improvement within this time frame mandates a repeat CT scan to check for additional abscesses.

Criteria for removal of percutaneous catheters include resolution of sepsis signs, minimal drainage from the catheter, and resolution of the abscess cavity as demonstrated by a sonogram or CT scan. Persistent drainage usually reflects the presence of an enteric fistula, and a CT scan with contrast should be performed. Frequently, this fistula can be documented by sonography.

Complications of percutaneous drainage include bleeding or inadvertent puncture of the GI tract.

***Surgical intervention***.

Open surgical drainage is mandatory if percutaneous drainage fails or if collections are not amenable to catheter drainage. The surgical approach may be either extraperitoneal or transperitoneal.

With accurate preoperative localization, direct surgical drainage may be possible through an extraperitoneal approach. This technique reduces the risk of bowel injury, spread of contamination, and bleeding. It also allows for a faster return of bowel function.

The transperitoneal approach is made safer by the judicious use of preoperative antibiotics. Although contamination of otherwise uninfected sites remains a major concern, this complication is particularly reduced if the organisms involved are sensitive to the chosen drugs. . Transperitoneal exploration is indicated for multiple abscesses not amenable to CT-guided drainage, such as interloop collections or an enteric fistula feeding the abscess.

Pelvic abscesses often are palpable as tender fluctuant masses impinging on the vagina or rectum. Draining these abscesses transvaginally or transrectally is best to avoid the transabdominal approach.

During the course of a laparotomy, the surgeon must use digital or direct exploration to be certain that all loculations are broken down and that all debris, such as hematomas or necrotic tissue, is evacuated.

Improved clinical findings within 3 days after treatment indicate successful drainage. Failure to improve may indicate inadequate drainage or another source of sepsis. If left untreated, the septic state inevitably produces multiple organ failure.

**Basic literature:**

1. Sato T.T., Аrca M.J. Pediatric abdomen / In: Greenfields Surgery Scientific Principles&Practice, 6th edition, 2017.
2. Maffi M., Lima M. Acute Appendicitis / In: Lima M. Pediatric Digestive Surgery. Springer, 2017 –P.279 – 290.
3. Feroze Sidhwa , Charity Glass , Shawn J. Rangel. Appendicitis / In: Fundamentals of Pediatric Surgery, 2nd edition, edited by P.Mattei, Springer, 2017 –P. 537 – 544.
4. Dunn J.C. Appendicitis / In: Pediatric surgery – 7th edition / editor in chief A.G Coran ; associate editors, N.S. Adzick, A.A. Caldamone, T.M. Crummel et al., Philadelphia, 2013 – P. 1231-1235, 1255-1264.

**Additional literature:**

1. Ashcraft’s Pediatric Surgery / edited by G. W. Holcomb III, J. P. Murphy, associate editor D. J. Ostlie. — 5th ed. – SAUNDES Elselvier, 2010 – P. 429 - 455, 526 – 531, 549 – 556.
2. Pediatric surgery / edited by P. Puri, M. E. Höllwarth – Springer-Verlag Berlin, 2006 – P. 321 – 327.
3. Pediatric surgery / edited by J.L.Grosfeld, J.A.O’Neilly, A.G.Coran, 6th ed. – MOSBY Elsevier, 2006 – P.1304 – 1312, 1427 – 1453, 14375 – 1479, 1501 - 1514.
4. Pediatric surgery / Robert M. Arensman, Daniel A. Bambini, P. Stephen Almond, 2nd ed., - l Texas, 2009 – P. 288 - 297.
5. Fundamentals of Pediatric Surgery / Edited by Peter Mattei - Springer Science, 2010 – P. 495 – 491.

**Tests for initial level of knowledge**

* 1. What is the most common position of the appendix?

1. Retrocecal
2. McBurney point
3. Pelvic /Descending
4. Subcecal
5. Preileal

2. Which of the following is the least common position of appendix?

1. Retroileal
2. Retroceacal
3. Postileal
4. Pelvic

3. Most common malignancy of appendix is?

1. Carcinoid tumor
2. Adenocarcinoma
3. Squmaous cell carcinoma
4. Mixed cellularity

4. All are features of acute appendicitis on ultrasound examination except?

1. A compressible blind ending tube
2. Diameter of more than 7 mm
3. Loss of submucosal echogenicity
4. All are true

5. What is not true as differential diagnosis for appendicitis in children younger than 3 years?

1. Gastroenteritis
2. Adenocarcinoma appendix
3. Pyelonephritis
4. Colitis
5. Calculous cholecystitis

6. Which of the following is true regarding blood supply of appendix?

1. Artery appendicularis, brunch of a. ileocolica
2. Artery appendicularis, brunch of a. colica dextra
3. Artery appendicularis, brunch of a. colica sinistra
4. Artery colica media
5. Artery mesenterica inferior
6. What is appendicitis?
7. Severing of the appendix from the colon
8. Inflammation of the appendix
9. Shrinking of the appendix
10. Removal of the appendix from the colon
11. What are symptoms of appendicitis?
12. Loss of appetite, abdominal tenderness
13. Abdominal pain, fever, vomiting
14. A & B
15. Appendicitis usually has no symptoms
16. Who is most likely to develop appendicitis?
    * 1. Newborn
      2. Children between 6 and 10 years
      3. Children younger than 3 years
      4. Toddlers
      5. Teenagers
17. Which of the following is not a CT feature of acute appendicitis
18. Diameter of lumen of appendix more than 5 mm
19. Circumferential wall thickening and enhancement of appendix (Halo sign)
20. Periappendiceal fat strandling, phlegmon
21. Appendicolith

***Keys for tests:***

1. B. McBurney's point, the junction of the lateral and middle thirds of the line that joins the right anterior superior iliac spine to the umbilicus, is used as a surface marking for the base of the appendix.
2. B
3. B. It was previously believed that carcinoid tumors are the most common tumors of the appendix ( Sabiston 17th) but now data from SEER ( Surveillane, epidimology and End results) show that mucinous adenocarcinomas are more common
4. D
5. A
6. A
7. B
8. C. Symptoms of appendicitis may take 4 to 48 hours to develop. Early symptoms are often hard to separate from other conditions including gastroenteritis.
9. B
10. A. CT scan has a sensitivity of 95% and specificity of more than 85% in diagnosing acute appendicitis. As in Ultrasound, a luminal diameter of more than 7 mm and not 5 mm is diagnostic of acute appendictis. Circumferential thickening of wall of appendix with enhamncement causes the so called Halo sign. Appendicolith and Periappendiceal fat strandling and phlegmon are also diagnostic of appendicits. CT scan more or less settles the question of Acute appendictis

**Tests for final level of knowledge**

* 1. You see a 7 year old girl with her mother during a GP surgery. She has had abdominal pain for one day. The pain is generalised and relieved by rest. The girl walks into the surgery but is clearly in some discomfort. Her temperature is 38°C and her abdomen is tender in the right iliac fossa, with rebound tenderness. You perform a urine dip test that is normal except for the presence of blood. What should you do next?

1. Arrange to admit her to hospital urgently
2. Reassure her and her mother that it is most likely a viral gastroenteritis and review her again if she deteriorates
3. Give a course of broad spectrum antibiotics and ask them to return in three days for further assessment
4. Refer her for assessment of haematuria and give antibiotics for pyelonephritis in the interim period
   1. You are called to the emergency department to see a 9 year old girl who has developed abdominal pain and vomiting. She is lying flat and looks pale. On examination there is tenderness in the right iliac fossa, and you think she may have appendicitis.

Which of the following signs is NOT suggestive of appendicitis?

1. A palpable mass in the right iliac fossa
2. Rebound tenderness
3. Guarding
4. Microscopic haematuria
5. An olive sized mass in the right hypochondrium

3. You are caring for patients on a ward who have developed vomiting and abdominal distension. You would like to confirm if their symptoms are due to perforation of stomach. Which early simple investigation has the highest sensitivity for detecting the perforation of follow organ?

1. Ultrasound
2. X-ray
3. KT
4. MRI

4. You see a 15 year old girl who has a one week history of fatigue, localized abdominal pain in right iliac fossa and subfebrile temperature. She tells you she has also noticed pain shifting from periumbilical to right iliac region. You suspect that she may have appendicular abscess. Which investigation should you order to confirm your suspicion?

1. Ultrasound
2. X-ray
3. Urinalysis
4. EKG

5. [Reginald Fitz](http://quiz.thefullwiki.org/Reginald_Heber_Fitz) first described acute and chronic appendicitis in 1886,and it has been recognized as one of the most common causes of some symptom worldwide. What is the symptom?

1. Abdominal pain
2. Vomiting
3. Fever
4. Seizures
5. Hematuria

6. Most appendicitis patients with acute appenditis recover easily with surgical treatment, but complications can occur if treatment is delayed:

1. Gastroenteritis
2. Perforation and peritonitis
3. Colitis
4. Nephritis

7. When the appendiceal inflammation increases, the pain can be localized clearly to one small area, which is:

Between the front of the right hip bone and the navel

The central portion of the belly

The small intestine

The left iliac fossa

The navel

8. A 8 years old girl hospitalized to surgical department 3 hours after the disease onset with complaints about abdominal pain, temperature 38°С, vomiting. At examination – pain at palpation over all abdominal surface, rigidity of muscles of anterior abdominal cavity, slight mucosal vaginal discharge, blood analysis shows high leucocytosis. What is the diagnosis?

А. Vulvovaginitis.

В. Mesadenitis.

С. Diverticulitis

D. Acute appendicitis.

Е. Primary peritonitis.

**Keys for tests:**

1. A
2. A, E
3. B
4. A
5. A
6. B
7. A
8. E

Tasks for final level of knowledge

Task 1. You are called to the emergency department to see a 12 year old boy. He presented with abdominal pain and a two day history of vomiting and anorexia. Based on clinical examination and laboratory studies (demonstrating a WBC count increasing), your working diagnosis is acute appendicitis.

* 1. What is your management of this patient?
  2. What is the best time of operation in child with acute appendicitis?

Key Answer

1. Appendectomy, preferably laparocopical
2. Timing to surgery has not been shown to greatly affect outcome within the first 24 hours; however, because a risk of rupture theoretically increases over time, an appendectomy should not be delayed if possible.

Task 2. 9 yo girl presents with sever right-sided abdominal pain and vomiting. Pain came on last night and has steadily worsened. Emesis began in morning. ABD exam displays guarding, rebounding and positive Rovsing's signs. WBC 12000, HCT 41, PLT 366000.

1. What is the most likely diagnosis?
2. What should you do next?

Key Answer

1. Acute appendicitis
2. Hospitalization in surgical department

Task 3. You see a 3 year old girl in the emergency department. Her parents have noticed that she has become weakened last three days. Her temperature is 37°C. On examination his abdomen is painful but soft and non-tender with no guarding. You perform the blood and urine tests that are normal. What should you do next?

Key Answer

Observe her for the next 24 hours to exclude surgical cause of abdominal pain.

**Materials for self-study of the students**

|  |  |
| --- | --- |
| Main tasks | Notes (instruction) |
| **Repeat:**  Anatomy of intestine, appendix vermiformis  Physiology of appendical frolics, peritoneum  Pathogenesis of inflammation | To sketch out the anatomy of peritoneal cavity  Top represent the methods of diagnosis of acute appendicitis and peritonitis in children |
| **Study:**  Pathogenesis of appendicitis, primary and secondary peritonitis  Features of appendicitis and peritonitis in children  The diagnostic possibilities of ultrasound examination, CT, MRI in children | To make differential diagnosis of acute appendicitis and nonsurgical diseases in children  To make the indications to surgical treatment in children with abdominal pain  To know modern diagnostically methods  To know the advantages and disadvantages of classic and laparoscopic appenectomy |