REVIEW ARTICLES

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Acute appendicitis

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Abstract

Background: It has been more than 130 years since Reginald Fitz described for the first time the pathomorphological changes of the acute appendicitis and after the first appendectomy that was performed by H. Hancock, in the case of acute appendicitis, but the problem remains to be actual till now. Despite of the acute appendicitis is the most common abdominal emergency, there still are some compartments of this problem that need to be studied, starting with particularities of etiology of acute appendicitis and ending with particularities of clinical picture, differential diagnosis, and treatment. The article describes anatomy and physiology of the appendix. Authors presented data on history, epidemiology, etiology, pathophysiology, classifications, complications, management, treatment and prognosis of acute appendicitis. Also the article reflects characteristics of acute appendicitis in children, elderly patients and pregnancy and clinical signs depending on anatomical position of appendix.

Conclusions: Earlier diagnostics and an early surgery performance in patients with acute appendicitis are the key to success, and lead to significant reduction in number of postoperative complications. We hope that our article will be useful for medical students, family doctors, and for young surgeons.

Key words: appendix, acute appendicitis.

Appendix, definition

The vermiform appendix is a narrow blind tube structure attached to the cecum and is named after the Latin word "vermiform" which means 'worm-shaped'. The appendix is a true diverticulum of the cecum. In contrast to acquired diverticular disease, which consists of a protuberance of a subset of the enteric wall layers, the appendiceal wall contains all of the layers of the colonic wall.

Anatomy of appendix

It varies essentially in length from 1 to 25 cm; but mostly it varies between 5-10 cm [16]. The histological features of the appendix include the following: serosa, the muscularis layers, the submucosa and mucosa. The three taenia coli converge at the junction of the cecum with the appendix and can be a useful landmark to identify the appendix.

The appendix receives its arterial supply from the appendicular branch of the ileocolic artery. Findings in literature show that the retrocecal appendix position can be found in 26-70% of cases, followed by paracecal and then the other positions of the appendix in different percentage. Retrocecal position – when appendix lies behind the cecum although in majority of cases in an intraperitoneal location. Only in case of a long retrocecal appendix the tip of the appendix remains in the retroperitoneal tissue close to the ureter [24]. Pelvic position of the appendix is the second most common irregular position –25% [24]. Subcecal position of the appendix (2%) – that means position of the appendix behind the cecum. Subhepatic position of the appendix (3%) – it means that the tip of the appendix is towards the liver [24]. Absent appendix is too rare a condition and until this date only 68 cases have been reported in the literature [22]. Similarly duplication of appendix is also a rare anomaly and fewer than 100 cases have been reported [19]. The peculiarity of the musculature of the appendix is that there are a few gaps in the muscular layer called "hiatus muscularis". Through this infection from the submucosal coat directly comes to peritoneum and regional peritonitis occurs [24]. The appendix is fixed retrocecally in 16% of adults and is freely mobile in the remainder [24]. The function of the appendix is not clearly understood, although the presence of lymphatic tissue on it suggests a role in the immune system.

Physiology of the appendix

- Secretion function, the appendix mucosa makes and releases the special fluid that contents mucus and proteolytic enzymes.
- Hemopoetic function – limphopoetic and immune.

Acute appendicitis is one of the more common causes of acute abdominal pain and is the most common emergency surgical presentation requiring operation.

Acute appendicitis is an inflammation of vermiform appendix caused by nonspecific purulent infection [17].

History

Appendix was first depicted in anatomic drawings in 1492 by Leonardo da Vinci. Appendix was described in 1521 by Berengar Carpi, a famous surgeon and anatomist from Bologna and in 1543 was remarked in "The humanus corporis factory" of Vesalius. The first report of an appendectomy came from Amyan, a surgeon of the English army that performed an appendectomy in 1735 without anesthesia to remove a perforated appendix [24]. Reginald Fitz, an anatomopathologist at Harvard, first described acute and chronic appendicitis in 1886 and it has been recognized as one of the most common causes of severe acute abdominal pain worldwide [11]. The greatest contributor to the advancement in the treatment of appendicitis was an American surgeon from York, Charles McBurney. In 1889 he described some symptoms, anatomical point projection of inflamed appendix, and described the classic oblique incision that nowadays is used for appendectomy, and in the same year, he published his landmark paper in the *New York State Medical Journal* describing the indications for early laparotomy for the treatment of acute appendicitis.

Then, at the end of the 19th century, the English surgeon H. Hancock successfully performed the first appendectomy in a patient with acute appendicitis.

Semm is widely credited with performing the first successful laparoscopic appendectomy in 1982 [25].

Epidemiology

Approximately 7% of people in western countries have appendicitis at some time during their lives, and about 200,000 appendectomies for acute appendicitis are performed annually in the United States [14]. About 10% of the population will develop acute appendicitis during their lifetime [23]. Between 15 and 30 years of age there is an increase of 230 cases per 100,000 population/year, and then a decline of cases with aging. The frequency of acute appendicitis is different in each country. The current incidence of appendicitis is about 100 per 100,000 person-years in Europe/America and 220 cases per 100.000 in the Republic of Moldova (2007). In Asian and African countries, the incidence is probably lower because of the dietary habits. The incidence is lower in populations where a high-fiber diet is consumed [4, 12]. Appendicitis occurs more frequently in males than in females, with a male-to-female ratio of 1.7:1 [24] although some authors described the prevalence in women. Appendicitis is a disease of the young, with 40% of cases occurring in patients between the ages of 10 and 29 years. According to Yui-Rwei Y 90% of the cases of appendix infection occur in patients under 60 years old [35]. The lower number was in the age from 70 to 80 years of life. It is unusual under the age of 1 year. Incidence of acute appendicitis decreases with age, because lumen of the appendix enlarges after lymphoid tissue atrophies. Petroianu A. mentioned that the most of patients are whites (74 %), and it is very rare in patients with black skin (5 %) [21]. Some authors have described a seasonal variation in the incidence of appendicitis, a higher incidence occurring at summer time, or at spring and autumn, or even in raining weather [5]. The cost per patient for the surgical treatment of appendicitis in the United States ranges from $11,577 to $13,965.

Etiology

Although it was originally described more than 125 years ago, the etiology of acute appendicitis continues to be debated. Obstruction of the lumen is the dominant etiologic factor in acute appendicitis. Obstruction of the proximal lumen by fibrous bands, submucosal lymphoid hyperplasia, fecaliths, inspissated barium, calculi, vegetable/fruit seeds, worms, tumors of cecum/appendix has long been considered to be the major cause of acute appendicitis, though that theory is doubted by many experts. Fecalith or calculus is found in only 10% of acutely inflamed appendices [10,14]. Fecalith alone causes simple appendicitis in 40%, gangrenous non-perforated appendicitis in 65%, and perforated appendicitis in 90% of cases [6]. Although it is widely accepted that obstruction is the inciting event in most cases of acute appendicitis, it is worth pointing out some observations that are not consistent with this hypothesis [16]. The first observation is that impacted fecaliths have been observed with no accompanying local inflammation or syndrome of appendicitis. In addition, fecalith impaction or functional evidence of obstruction cannot be demonstrated in a substantial number, up to half, of cases. Thus obstruction may be just one of many factors involved in the etiology and pathogenesis of acute appendicitis [16].

Some researchers suggest that the forms of uncomplicated and complicated appendicitis are two distinct diseases, with different etiologies, each of which leads to the final pathway of invasion of the appendiceal wall by intraluminal bacteria.

One of the theories of acute appendicitis is *Aschoff infectious theory.* Advocates of infectious theory consider that the main cause of acute appendicitis is a polymicrobial infection that occurs in a healthy intestine (E. coli, Staphylococcus, Streptococcus).The significant place has had the predisposing factors, that lead to the trauma of the mucous membrane of the appendix, like: foreign bodies, pieces of solid food, intestinal parasites, as well as intestinal atony, changes in the reactivity of the organism, etc. That leads to violations of the barrier function of the epithelium of appendix and penetration of the bacteria inside appendix wall. As in other intra-abdominal infections, such as salpingitis, diverticulitis and enterocolitis, which are often treated only with antibiotics, the infectious etiology of acute appendicitis is advocated by some scholars [26].

Hematogenous theory. Bacteria reach the appendix by blood, from an infection source. This theory is especially true in children after infectious disease. The infection can occur in outbreaks. Nearby situation occurs frequently in women, the inflamed ovaries may be the source of infection. Advocates of *neurovascular theory* consider that the most important moment in acute appendicitis pathogenesis is a reflex abrupt violation of the regional blood flow inside the appendix (vasospasm, ischemia), which leads to the thrombosis of the blood vessels of the appendix and development

of trophic disorders and necrosis inside the appendix wall.

Some researchers attach importance to the *allergic factor* endpoint to significant amount of mucus and Charcot-Leiden crystals in the lumen of the appendix.

Recently, with the advent of *neurogastroenterology*, the concept of neuroimmune appendicitis has evolved [40].

Pathophysiology

The lumen distal to the obstruction starts to fill with mucus and acts as a closed-loop obstruction. This leads to distension and an increase in intraluminal and intramural pressure [6]. As the pressure of the lumen exceeds the venous pressure, the small venules and capillaries become thrombosed, but arterioles remain open, which leads to engorgement and congestion of the appendix. With vascular compromise, epithelial mucosa breaks down and bacterial invasion by bowel flora occurs. The inflammatory process soon involves the serosa of the appendix, hence the parietal peritoneum in the region, which causes classical right lower quadrant pain [6]. Once the small arterioles are thrombosed, the area at the antimesenteric border becomes ischemic, and infarction and perforation ensue. Bacteria leak out through the dying walls and pus forms (suppuration) within and around the appendix. Perforations are usually seen just beyond the obstruction rather than at the tip of the appendix [6].

Kolesov's classification of acute appendicitis (1952)

1. Appendicular colic.
2. Simple superficial appendicitis.
3. Destructive appendicitis:
   a) phlegmonous;
   b) gangrenous;
   c) perforated.
4. Complicated appendicitis:
   a) appendicular mass;
   b) appendicular abscess;
   c) diffuse purulent peritonitis.
5. Other complications of acute appendicitis (pylephlebitis, sepsis, retroperitoneal phlegmon, local abscesses of abdominal cavity) [38, 39].

L. Kovalchuk remarked that [17] four phases are distinguished according to clinical features of acute appendicitis: 1) epigastric; 2) local symptoms; 3) calming down; 4) complications [17].

During the last World Society of Emergency Surgery Congress in Israel (July 6th, 2015), the authors submitted a new comprehensive disease grading system, based on three aspects of the disease (clinical and imaging presentation and laparoscopic findings).

Acute appendicitis grading system

Grade-0 (normal looking) – the patient has a clinical diagnosis of acute appendicitis and laparoscopy shows a macroscopically "normal looking appendix", the histopathological study shows intraluminal inflammation.

Grade-1 (inflamed) – the image shows hyperemia and edema of appendix.

Grade-2A and 2B (necrosis)

Grade 2A – the necrosis was an isolated phenomenon, restricted to the appendix, without or with minimal local exudation.

Grade 2B – presence of necrosis involving the appendicular base, at the level of its insertion on cecal wall.

Grade-3A -3B -3C (perforated – inflammatory tumor)

Grade 3A – the CT scan of abdomen showing an inflammatory tumor in the lower right quadrant. The patient was managed with antibiotics only; non-operative treatment.

Grade 3B – acute appendicitis complicated with inflammatory tumor and an abscess less than 5 cm, managed by laparoscopic approach.

Grade-4 (perforate – diffuse peritonitis)

Clinical diagnostics of acute appendicitis. Complaints

Only half of the patients present the classical clinical diagnosis of appendix infection.

Pain localization

Typically begins as epigastric pain or periumbilical (in 70% of patients) followed by brief nausea, vomiting, and anorexia [23]. After a few hours, the pain shifts to the right lower quadrant (the Kocher's and Kiumeli's symptoms).

Patients may present with localized pain in the right upper quadrant from a long appendix, in the left lower quadrant if malrotation is present, and in the anterior wall of the rectum if the appendix is located in the pelvis [8,42,43]. The most common location of 'atypical' somatic pain is the right flank in patients with a rectrocecal appendix [8].

The typical patient will therefore present with an initial central colicky abdominal pain, which after a few hours progresses into a constant right iliac fossa pain (the pain moves; it does not radiate) [2]. As the response to luminal obstruction evolves to include luminal distension, intramural edema, and ischemia, the pain becomes constant [16]. The disease begins with a sudden pain in the abdomen. It is localized in the right iliac region, has moderate intensity, permanent character and does not irradiate [17, 24].

The second characteristic feature of the pain in appendicitis is its permanence. Pain remains while the inflammatory process is present, may increase and wane, but not completely stopped. The intensity of pain depends from the location and extension of the process of inflammation. For the vast majority of patients moderate, constant aching pain is typical, but sometimes (4-19%) cramping occurs. Pain may be very acute, especially in perforation appendicitis and in the cases of peritonitis, but it does not reach such a force as in patients with perforated gastric ulcer, acute intestinal obstruction, acute pancreatitis or renal colic. Pain intensity does not always correspond to the degree of pathological anatomical changes. Sometimes intense pain before operation has had slight morphological changes inside the appendix, and, conversely, the presence of even gangrenous and perforated appendicitis sometimes do not complain of severe pain [36].

Pain increases with cough and motion that is caused by movement of the inflamed appendix against the peritoneum. Patients usually lie down, flex their hips, and draw their knees up to reduce movements and to avoid worsening their pain.

The duration of symptoms is less than 48 hours in approximately 80% of adults but tends to be longer in elderly persons and in those with perforation.

Anorexia is the most constant symptom of appendicitis. If it is absent, the diagnosis should be questioned [8]. A patient reporting a normal appetite is very uncommon [16]. Vomiting occurs in the first hours of the disease and more often is single. In catarrhal appendicitis vomiting is absent in 90% of all cases. Repeated vomiting is observed in acute appendicitis complicated by peritonitis. Vomiting does not bring relief to the patient. With involvement of the peritoneum inflammation some patients have constipation due to intestinal paresis.

Temperature elevation is rarely >1°C. Fever above 100°F or 38.2°C rarely occurs early in the appendicitis syndrome and usually appears after the time when local tenderness appears [16].

Less common symptoms include diarrhea, which may occur early or late in the course of appendicitis. Early in the course, patients may have one or two loose bowel movements, or they may have an episode of massive evacuation of normal stool. This sequence represents a response to visceral pain and is usually limited to one or two episodes, rather than the persistent diarrhea caused by viral or bacterial infection. Later in the course of appendicitis, diarrhea may return because of irritation of the rectum by an inflamed pelvic appendix [8].

Diarrhea, urinary frequency, pyuria, or microscopic hematuria may suggest a retrocecal appendix, causing irritation of adjacent structures [23]. Mild fever and tachycardia are common in appendicitis [23].

Clinical examination

The general condition of patients is usually normal and gets worse only in case of growth of destructive changes in appendix [24]. Pulse rate is normal or slightly elevated.

Do not administer analgesics and antipyretics to patients with suspected appendicitis who have not been evaluated by the surgeon.

Painfulness is the basic and decisive sign of acute appendicitis during the examination by palpation in a right iliac region. Tension of muscle of abdominal wall is a positive symptom of peritoneum irritation [9, 24]. Tenderness over the site of the appendix is the hallmark of appendicitis. However, tenderness may be absent early in the course of the illness or unelicitable in obese individuals. Patients with a retrocecal appendix may experience some mild right-sided or right-flank tenderness [9]. Classically, the area of maximal tenderness will be one-third of the way from the anterior superior iliac spine to the umbilicus, but in fact it will be wherever the appendix is in the individual patient [8]. Cutaneous hyperesthesia often overlies the region of maximal tenderness [23].

Dieulafoy triade – cutaneous hyperesthesia often overlies the region of maximal tenderness and pain.

Kocher (Kosher)'s sign. The classic history – the appearance of pain in the epigastric region and migrating or subsequent shift to the right iliac region occurs in only 50 percent of patients.

Kiummel sign. The appearance of pain in the umbilical region and migrating or subsequent shift to the right iliac region.

The Rovsing's sign. Continuous deep palpation starting from the left iliac fossa upwards (anti-clockwise along the colon) may cause pain in the right iliac fossa, by pushing bowel contents towards the ileocecal valve and thus increasing pressure around the appendix.

Psoas sign or Coupe 1 sign. With the patient lying on the left side, slow extension of the right hip causes local irritation and pain**.** This indicates presence of irritative inflamed appendix in close proximity to the psoas muscle. This is possible in retrocecal appendicitis [23, 24].

Obturator sign or Coupe 2 sign. With the patient supine, passive internal rotation of the flexed right hip causes hypogastric pain [23].

Shake test. Another useful sign in establishing the presence of local peritonitis. Most surgeons perform this by grasping the iliac wings and shaking the pelvis from side to side. The patient complains of pain at the site of the appendix if local peritonitis is present [8].

Blumberg's sign. After gradual pressing by fingers on a front abdominal wall from the place of pain quickly, but not acutely, the hand is taken away. Strengthening of pain is considered as a positive symptom in that place. Tension of muscles of front abdominal wall is obligatory here.

Voskresensky's sign. By left hand the shirt of patient is drawn downward and fixed on pubis. By the taps of 2–4 fingers of right hand epigastric region is pressed, the hand slides in the direction of right iliac region, without taking the hand away. Thus there is an acute strengthening of pain.

Sitkovsky's sign. A patient, that lies on the left, feels the pain which arises or increases in the right iliac region. The mechanism of intensification of pain is explained by displacement of blind gut to the left, by drawing of mesentery of the inflamed appendix.

The Obrazcov's sign. With the position of patient on the back by index and middle fingers the right iliac region of most painful place is pressed and the patient is asked to heave up the straightened right leg. At appendicitis pain increases acutely.

Bartomier's sign. The increase of pain intensity during the palpation in right iliac region of patient in position on the left side. At such position an omentum and loops of small intestine are displaced to the left, and appendix becomes accessible for palpation.

Rosdolsky's sign. At percussion of the anterior abdominal wall the pain increases in a right iliac region.

Krimov symptom. Pain during peritoneum palpation throws right external inguinal orifice.

Iaure–Rozanov sign. Palpation in the projection of Pti triangle is painful.

Laboratory evaluation

Although the diagnosis is clinical, the complementary tests may be useful in doubt. What are the main alterations of laboratory tests in patients with acute appendicitis?

Leukocyte count greater than 11,000 cells/ul with polymorphonuclear cell predominance is common in children and young adults [23]. An elevated white blood cell count cannot be used alone as a sign of appendicitis [24]. A leukocytosis of over 20 000 mm^3 suggests perforation of the appendix or another diagnosis [8]. Neutrophilia with deviation to the left is frequently associated to lymphopenia and can be presented along with monocytosis. They are predictive for the diagnosis of acute appendicitis, whereas elevated levels of fibrinogen, high lymphocyte and PLT count are predictive for non-appendiceal pathology with low diagnostic accuracies [41]. In 20-30% of acute appendicitis, the number of white blood cells is normal or only slightly increased. Some studies mention that the ratio neutrophils / lymphocytes of greater value than 3.5 would indicate for diagnosis of acute appendicitis and would be more sensitive diagnostic test if compared to the WBC account [15].

The advanced stages related to the initial ones, show lower quantities of lymphocytes (9,3% e 14,8%, respectively), with value of $p<0,05$ [3]. C reactive protein levels are also related to the evolution stage of appendicitis, according to literature. Values above 50 mg/dl are related to appendix necrosis and perforation.

Urine analysis is abnormal in 25% of patients with appendicitis. Pyuria, albuminuria, and hematuria are common. Bacteria suggest urinary tract infection. Hematuria suggests urolithiasis [23]. The urinalysis also may be abnormal with appendicitis because the appendix lies near the ureter and bladder. Most patients with appendicitis, however, have a normal urinalysis [24].

Serum pregnancy test should be performed in women of childbearing age. A positive test suggests an ectopic pregnancy [23].

Abdominal X-rays. Plain radiography is infrequently able to give the diagnosis, however, it is useful for identifying free gas, and may show an appendicolith in 7-15% of cases [8].

An appendicolith can be seen in only one-third of children and one-fifth of adults with appendicitis [23].

Plain abdominal films may reveal localized ileus and soft-tissue density in the right lower quadrant, or free intraperitoneal air (0-7%). These are so non-specific as to be of no value in the diagnosis of appendicitis [8].

Ultrasonography showed the highest diagnostic accuracy (92.9%). Sonographically, the appendix is identified as a blind-ending, nonperistaltic bowel loop originating from the cecum. Findings associated with appendicitis include wall thickening, luminal distention, lack of compressibility, abscess formation, and free intraperitoneal fluid [32]. Nevertheless, during appendicitis, the appendix can be seen in only 50% of patients. Therefore, not seeing the appendix during an Ultrasonic test does not exclude appendicitis [24]. Ultrasonographic criteria for the diagnosis of appendicitis are: a threshold 6-mm diameter of the appendix under compression surrounded by a hypoechoic, thickened wall more than 2 mm in diameter [8]. Remark that a sensitivity of only 75 per cent is too low to be acceptable in a diagnostic test.

CT scan of the appendix region is useful in acute appendicitis and periappendicular abscesses diagnosis as well as in excluding other diseases inside the abdomen and pelvis that can mimic appendicitis [24]. CT is highly sensitive (94-98%) and specific (up to 97%) for the diagnosis of acute appendicitis and allows for alternative causes of abdominal pain also to be diagnosed.

CT findings include: dilated appendix with distended lumen (>6 mm diameter), thickening of the cecal apex (up to 80%): pericecal adenopathy, including stranding of the adjacent fat and thickening of the lateroconal fascia or mesoappendix, pericecal collections of fluid, inflammatory phlegmon, abscess formation, appendicolith may also be identified [8].

Laparoscopy can be used in the diagnosis and treatment of patients with suspected acute abdomen that imitates acute appendicitis and cannot be differentiated with physical examination and laboratory methods. Delays in diagnosis and unnecessary appendectomy will be prevented in this way.

Scoring Systems

The diagnosis of acute appendicitis can be difficult and any delay in definitive treatment with surgery can lead to an increase in mortality and morbidity as the disease progresses to appendiceal perforation.

The most widely cited score in the diagnosis of adults with acute appendicitis is the Alvarado score (Alvarado, 1986) [1]. Whereas, in children the pediatric appendicitis score or Samuel score is most widely used (Samuel, 2002) [23].

Alvarado score resulted in the formation of a simple score, from 0 to 10, consisting of three symptoms (Migration of pain to right iliac fossa – 1 point, anorexia or acetone in urine – 1 point, nausea-vomiting – 1 point, three signs (tenderness over right iliac fossa – 2 points, rebound tenderness over right iliac fossa – 1 point, elevation of temperature 37.3C – 1 point,) and two laboratory markers of inflammation (leukocytosis more than 10000 – 2 points, shift to the left more than 75% – 1point).

The maximum total score achievable is, therefore, 10. Group-I with total score 1-4 diagnosis of acute appendicitis unlikely. A score of 5 or 6 is compatible with a diagnosis of possible acute appendicitis. Score of 7 or 8 indicating probable appendicitis and a score of 9 or 10 indicating a very probable acute appendicitis. It has been suggested that score can be used as a guide to determine which patients require further observation and which patients require surgery. Those with a score of 5 or 6 required observation while those with a score of 7 or above needed to proceed to surgery as it was likely that they had appendicitis.

Differential diagnosis. Acute surgical diseases

Acute cholecystitis. The attack of pain can arise after the reception of spicy food and, is accompanied by nausea and frequent vomiting by bile. In anamnesis patients often have information about a gallstone disease. During examination intensive painfulness is observed in right hypochondrium,

increased gall-bladder and positive symptoms Murphy's and Ortner's.

Perforated peptic ulcer disease. The pain in the right ileac area is caused by gastric and duodenal fluids that tend to settle in the right paracolic gutter causing peritonitis and RLQ pain. The syndrome carries its name after Rudolph Valentino, a famous American film actor, who died in 1926 due to complication related to the perforated peptic ulcer. He presented with pain in right lower abdomen and was diagnosed and treated as a case of acute appendicitis and later on autopsy, he was found to have perforated peptic ulcer [34].

The pain in right ileac area usually is moderate in acute appendicitis and is usually dramatic, sudden, severe, midepigastric pain, like a knife stab, which spreads rapidly to involve the entire abdomen. Both pathologies need an emergency surgery. At surgery, the appendix was found to be normal but with surrounding turbid fluid in the right paracolic gutter and subhepatic space.

An strangulated right inguinal or femoral hernia may present with right ileo-inghinal pain. There will be tenderness and an irreducible swelling over the hernial orifice, and symptoms and signs of bowel obstruction. Cough impulse is lost if hernia is strangulated.

Acute intestinal obstruction

In acute intestinal obstruction the patient has the cramp abdominal pain, distended abdomen; constipation progressing to obstipation, vomiting. In acute appendicitis the patient has permanent, moderate pain usually in the right ileac area, non-distending abdomen, rare vomiting.

Gastrointestinal diseases

Gastroenteritis is characterized by nausea, emesis prior to the onset of abdominal pain, malaise, fever, and poorly localized abdominal pain and tenderness. The WBC count is less frequently elevated. Salmonella typhimurium infection causes mesenteric adenitis and paralytic ileus with symptoms similar to those of appendicitis. The diagnosis can be established by serologic testing. *Campylobacter jejuni* causes diarrhea and pain that mimics that of appendicitis. The organism can be cultured from stool.

Meckel's diverticulitis may mimic appendicitis, and practically is impossible to put correct diagnosis before surgery, because clinical signs are the same.

Meckel's diverticulitis is associated with the same complications as appendicitis and requires the same treatment – prompt surgical intervention. Resection of the diverticulum or resection of the segment of ileum bearing the diverticulum with end-to-end anastomosis can nearly always be done through a McBurney incision, extended if necessary, or laparoscopically.

Mesenteric lymphadenitis is characterized by alarming discrepancy between general symptoms (headache, cough, fever, diffuse muscle aches) and slight pain in the right iliac area; white blood cell count is normal or even low, and a relative lymphocytosis will be present. During surgery the surgeon finds a normal appendix and mesenteric lymph, increased in size. Acute mesenteric adenitis is the disease most often confused with acute appendicitis in children. The pain usually is diffuse, and tenderness is not as sharply localized as in appendicitis. Voluntary guarding is sometimes present, but true rigidity is rare. Generalized lymphadenopathy may be noted.

Crohn's disease. The manifestations of acute regional enteritis – fever, right lower quadrant pain and tenderness, and leukocytosis – often simulate acute appendicitis. The presence of diarrhea and the absence of anorexia, nausea, and vomiting favor a diagnosis of enteritis, but this is not sufficient to exclude acute appendicitis. In an appreciable percentage of patients with chronic regional enteritis, the diagnosis is first made at the time of surgery for presumed acute appendicitis. In cases of an acutely inflamed distal ileum with no cecal involvement and a normal appendix, appendectomy is indicated. Progression to chronic Crohn's ileitis is uncommon.

Perforating carcinoma of the cecum, or of that portion of the sigmoid that lies in the right side, may be impossible to distinguish from appendicitis. These entities should be considered in older patients. CT scanning is often helpful in making a diagnosis in older patients with right lower quadrant pain and atypical clinical presentations.

Urologic diseases

Pyelonephritis is associated with high fever, rigors, and costovertebral pain and tenderness. Diagnosis is confirmed by urine analysis.

Ureteral colic. Intensity of pain in kidney colic is one of the basic differences from acute appendicitis. Pain at first appears in right lumbar region and irradiates downward after passing of ureter in genital organs. Tenderness is usually minimal and hematuria is present. The excretory urography will be very useful to exclude the ureteral stone. Absence of function of right kidney allows to eliminate the diagnosis of acute appendicitis.

Gynecologic diseases

Pelvic inflammatory disease. In pelvic inflammatory disease the infection usually is bilateral but, if confined to the right tube, may mimic acute appendicitis. Nausea and vomiting are present in patients with appendicitis, but in only approximately 50% of those with pelvic inflammatory disease. Pain and tenderness are usually lower, and motion of the cervix is exquisitely painful. Intracellular diplococci may be demonstrable on smear of the purulent vaginal discharge.

Ultrasound can help distinguish PID from appendicitis.

Ectopic pregnancy. A pregnancy test should be performed in all female patients of childbearing age presenting with abdominal pain. Ultrasonography is diagnostic.

Ovarian cysts can cause sudden pain by enlarging or rupturing. The cysts are detected by transvaginal ultrasonography.

Ovarian torsion. The ischemic ovary often can be palpated on bimanual pelvic examination. The diagnosis is confirmed by ultrasonography.

The apoplexy of ovary a more frequent is with young women and, as a rule, on 10-14 day after menstruation. Pain appears suddenly and irradiates in the thigh and perineum. At the beginning of disease there can be a collapse. However, the general condition of patients suffers insignificantly. When not enough blood was passed in the abdominal cav-

ity, all signs of pathology of abdominal cavity organs calm down after some time. Signs, which are characteristic of acute anemia, appear at considerable hemorrhage.

Appendicular mass is necessary to be distinguished with cecum or colon neoplasms, from ileo-cecal tuberculosis, terminal ileitis and from ileal and colonic locations of Crohn's disease, from ileocecal intussusceptions, ovarian cysts torsion, retroperitoneal tumors, etc.

Some rare medical conditions, like Schonlein-Henoch abdominal purple, abdominal saturnine colic, porphyrinuria, anaphylactic abdominal pain can cause clinical pictures of fake acute abdomen and fake clinical sign of acute appendicitis [10].

Treatment

The treatment of acute appendicitis is appendectomy. Appendectomy is the most common nonelective surgery performed by general surgeons. Several methods of performing an appendectomy include open incision method and laparoscopic approach.

The surgery may be performed through a standard small incision in the right lower part of the abdomen, or it may be performed using a laparoscopy, which requires three to four smaller incisions [24].

Management of acute appendicitis

Alvarado score [1] is found to be helpful in the diagnosis and management of acute appendicitis. Diagnosis of acute appendicitis is virtually confirmed with a score of 7-10 especially in males and they should undergo appendectomy. Diagnostic laparoscopy is advised to minimize the unacceptable high false negative rate in women. Patients with score 5-6 must be admitted and scored frequently. Score 1-4 can be discharged unless otherwise indicated.

It should be noted that excessive involvement in the surgery, sometimes a frivolous approach to surveys of acute appendicitis leads to the fact that appendectomy is performed in those cases when it is not clinically justified. In more than 70% of patients suffering from an adhesion disease, the first operation was the removal of the unchanged vermiform appendage [37].

Open appendectomy is indicated when the surgeon or patient prefers an open procedure to a laparoscopic procedure, or when the laparoscopic approach is contraindicated.

An incision is made in the right iliac fossa. The position of the incision is based upon the location of the McBurney point, which is a point one third of the distance from the anterior superior iliac spine to the umbilicus [44]. Place the incision between the first third and the second third of the distance from the anterior superior iliac spine to the umbilicus. An incision is then made down through skin and subcutaneous tissues until the muscle layers are reached. External oblique muscle is split bluntly by using Roux retractors. The external oblique, internal oblique and transverse abdominus muscles are then opened. This is done by a muscle-splitting incision along the lines of the fibers with no fibers actually being cut. The peritoneum is open and the abdominal cavity can be entered. Once the peritoneal cavity is opened, any fluid encountered should be sent for Gram stain and culture. The appendix and cecum are then identified and pulled up through the incision. The appendix can be removed through either an antegrade or a retrograde technique. After exteriorization of the appendix, the mesoappendix is held between clamps, divided, and ligated. The appendix is clamped proximally and is cut above the clamp with a scalpel [24]. Many surgeons then bury the stump of the appendix with a purse-string and z-stitch around the cecum. The cecum is then returned to the abdomen. Any fluid or pus is carefully sucked and swabbed out. If there is severe contamination, a drain may be left [2]. In cases of perforated appendicitis, some surgeons leave the wound open, allowing for secondary closure or a delayed primary closure until the fourth or fifth day after operation. Other surgeons prefer immediate closure in these cases [24]. Although most authors recommend leaving the incisions open when there is gross contamination by pus and fecal material, there is increasing evidence that this may be no more unsafe and less cost-effective than closing all wounds (where it is feasible) and later treating any wound infections that result. This decision should be individualized to each patient [16].

Laparoscopic approaches

Based on the most recent information available, it seems clear that in uncomplicated cases the diagnosis is secure, the laparoscopic approaches may offer a small reduction in pain scores, a mild reduction in hospital stay, and possibly a reduction in wound infection rates. Return to work may also occur earlier [16].

Contraindications to the laparoscopic approach include the lack of surgical expertise and necessary equipment, severe pulmonary disorders, a bleeding diathesis, severe heart failure, portal hypertension, intolerance of Trendelenburg positioning, poor visualization, and severe adhesive disease from previous abdominal surgical procedures.

The operation should be covered with prophylactic antibiotics, usually Metronidazole, given intravenously at induction of the anesthetic [2]. We could sometimes meet the information about the fact that spontaneous resolution of early acute appendicitis can occur. Several authors suggest that antibiotics may be used as primary treatment for selected patients with suspected uncomplicated appendicitis. However, due to the small number of patients included and the lack of the characteristics of the patients, it is very difficult to analyze these studies. I must remark that it is a very dangerous treatment way for acute appendicitis, but sometimes it is possible to try to do it,if facilities for appendectomy are not available. Conservative or unreasonable long-termdynamic observation can lead to a time lost for an optimal surgical treatment of acute appendicitis that will certainly increase the number of postoperative complications and mortality [29].

Acute appendicitis in children

The mean age in the pediatric population is 6-10 years, we can meet only 2% appendicitis in children under 2 years. It is common after age of two years. In infants acute appendicitis can be seen infrequently, but, quite often carries atypical character. Historically, the lack of classic symptoms and delay in presentation make diagnosing acute appendi-

citis more difficult in children, resulting in a higher perforation rate. All this is characterized, mainly, by the features of anatomy of appendix, insufficient of plastic properties of the peritoneum, short omentum and high reactivity of child's organism [17]. The temperature reaction is also expressed considerably acuter. In the blood test there is high leukocytosis [24]. Very often the children do not report pain, because they are afraid, in this situation are very important patient's mimics ("what the word hides, the face betrays").

Acute appendicitis in elderly patients

Appendicitis is known to be the disease of the younger age groups with only 5-10% of cases occurring in the elderly population. It is widely recognized that elderly patients with appendicitis present with less acute symptoms, less impressive clinical signs, and leukocytosis [33]. The triad of right lower abdominal pain and tenderness, fever and leukocytosis is reported to be present in not more than 26% of patients above 60 years [27]. Up to 30% of elderly patients present more than 48 h into the illness, and between 50% and 70% have a perforation at the time of surgery [16]. The reasons behind this high rate were postulated to be due to the late and atypical presentation, delay in diagnosis and surgical intervention, presence of comorbid diseases and to the age-specific physiological changes [13]. The early use of CT scan can cut short the way to the appropriate treatment. Elderly patients have a higher risk for both mortality and morbidity following appendectomy. It was estimated to be around 70% as compared to 1% in the general population [30].

Acute appendicitis in pregnancy

Acute appendicitis can occur at any time during pregnancy, although it occurs most often during the second trimester (45%) and 30% during the first trimester and the remaining 25% in the third trimester. The overall incidence being 0.15 to 2.10 per 1000 pregnancies [7]. In pregnancy, the percentage of perforated appendix can be as high as 43%, compared to 19% in the general population [31]. Appendicitis is associated with a fetal loss risk of 1.5% to 9%, however the risk increases up to 35% after perforation.

The diagnosis of acute appendicitis during pregnancy is one of the most challenging of all clinical problems. Appendicitis occurs at the same rate in pregnant and nonpregnant women, but pregnant women have a higher rate of perforation.

Pregnancy itself, especially in the early stages, is associated with nausea, vomiting, and pain. In the first and early second trimester, the evolution of symptoms and signs is not different from that in nonpregnant women. During pregnancy the appendix is superiorly and laterally displaced by the enlarging uterus, thus, pushing it away from Mc Burney's point. After the fifth month, the cecum and appendix are shifted upward by the expanding uterus. In the last trimester, localized tenderness from the appendix may be found in the upper flank and right upper quadrant of the abdomen. In addition to this, rebound tenderness and guarding of the abdominal wall are less commonly elicited during examination due to the laxity of the abdominal wall muscles during pregnancy. Fever, hypotension, and tachycardia are also unreliable and may not be present during pregnancy [10,15,18]. Leukocytosis is a normal physiological response of pregnancy (up to 12 500 leukocytes/mm^3) and cannot be relied upon to help confirm the diagnosis of appendicitis and bandemia (immature WBC) are normal physiological alterations during pregnancy. Not all pregnant women with appendicitis have leukocytosis [20]. The diagnosis of appendicitis in pregnancy is mainly clinical but ultrasound is very helpful in this setting, as it may provide images of the appendix, gallbladder, uterus, and other pelvic organs [16].

Complication of acute appendicitis

The more serious complications of acute appendicitis usually include: local and genera1 peritonitis, appendicular or periappendicular mass or abscesses, pylephlebitis, liver abscess.

General peritonitis. The diagnosis of acute appendicitis with genera1 peritonitis is not difficult. The patient complains of severe general abdomina1 pain, with nausea and vomiting. The abdomen becomes distended, tense and rigid. There is tenderness throughout, although it remains more marked in the right lower quadrant. Auscultation reveals a silent abdomen. The temperature is considerably higher (39 - 40 C.) than in uncomplicated acute appendicitis, and the pulse rate is increased. The leukocytes count is also high, more than 20,000.

The patient requires an emergency surgery with preoperative preparation during 1 or 2 hours. The meaning of surgery – large laparotomy, appendectomy, toilet and drainage of the peritoneal cavity.

An appendiceal mass is as an inflammatory mass consisting of an inflamed appendix which has become adherent to the omentum and surrounding viscera. This is an attempt of the nature to prevent general peritonitis even if rupture of the appendix occurs [24]. Appendicular mass is a common surgical clinical entity encountered in 2-6% of the patients presenting with acute appendicitis.

It develops, certainly, on 3-5th day from the beginning of disease. Acute pain in the stomach decreases, the general condition of the patient gets better. Dense, not mobile, painful, with unclear contours, mass is palpated in the right iliac area [24].

At reverse development of the mass (when resorption comes) the general condition of the patient gets better, sleep and appetite improve, activity grows, the body temperature and WBC account become normal, pain in the right iliac area decreases, the mass diminishes in size.

Classical management involves initial conservative treatment with broad-spectrum antibiotics and intravenous fluid until the inflammatory mass resolves. Surgery at this stage is difficult and dangerous as it is difficult to find appendix due to adhesions and ultimately faecal fistula may form [28]. In the majority of cases the mass will resolve and an interval appendectomy (usually after 2 months) can be performed.

If the general and local conditions of the patient become worse: increase in general amount of WBC, pulse rate and body temperature, increase of the abdominal pain, and the mass becomes larger in size, that indicates the abscess formation inside the appendicular mass. In this situation the

patient need an emergency surgery – open and drainage of the appendicular abscesses without appendectomy. Enforce appendectomy, in this situation, can lead to possible damage of the inflammated cecum wall with fistula formation or peritonitis.

Patients with an **appendix abscess** present with a swinging pyrexia associated with a tender mass in the right lower quadrant and a leukocytosis. The diagnosis is often confirmed by ultrasound or using computed tomography. The abscess can be drained percutaneously but open drainage allows appendectomy to be performed. In untreated cases lethal form of peritonitis is produced by secondary rupture of appendicular abscess.

Treatment. Immediate drainage under antibiotic cover is the treatment of choice. Appendectomy is not performed.

Pylephlebitis. Pylephlebitis is defined as septic thrombophlebitis of the portal vein, a precursor of liver abscess, is an extremely rare and frequently fatal complication of diverticulitis and rare nowadays in acute appendicitis. Septic clots from involved mesenteric veins produce multiple pyogenic abscesses in the liver. It is more frequent in patients with acute retrocecal appendicitis. It is heralded by chills, hectic fever, right upper quadrant pain and jaundice. In case with rapid passing of disease the icterus appears, the liver is increased, kidney-hepatic failure progresses, and patients die in 7–10 days from the beginning of disease. At gradual subacute development of pathology the liver and spleen are increased in size, and after the septic state ascites arises. The ideal duration of antibiotic therapy for pylephlebitis is unclear [22]. Given frequency of liver abscess as a complication of pylephlebitis, however, a minimum 4 weeks of therapy seems prudent since developing abscesses may not be visualized on CT scans. Patients with demonstrated macroscopic liver abscess complicating pylephlebitis should probably receive at least 6 weeks of antibiotic therapy, with or without drainage. Surgical intervention for pylephlebitis typically involves opening and drainage of the focus of infection.

Postoperative complications after appendectomy are: intestinal obstruction, major wound sepsis, pneumonia, empyema, pulmonary embolism, postoperative hemorrhage and thrombophlebitis, fecal fistula.

Wound infection

The rate of postoperative wound infection is determined by the intraoperative wound contamination. Rates of infection vary from < 5% in simple appendicitis to 20% in cases with perforation and gangrene. The use of perioperative antibiotics has been shown to decrease the rates of postoperative wound infections.

Intra-abdominal abscess

Intra-abdominal or pelvic abscesses may form in the postoperative period after gross contamination of the peritoneal cavity. The patient presents with a swinging pyrexia, and the diagnosis can be confirmed by ultrasonography or computed tomography scanning.Abscesses can be treated radiologically with a pigtail drain, although open or per rectal drainage may be needed for a pelvic abscess. The use of perioperative antibiotics has been shown to decrease the incidence of abscesses.

Intraperitoneal bleeding after appendectomy is rare, but dangerous complication. At the Sklifosovsky Emergency Institute in Moscow, Russia, this complication was observed in 3 patients over a period of 20 years [37].

Mesentery vessels or the adhesions vessels may be the source of bleeding into the abdominal cavity. Causes of bleeding may be diverse: not complete ligation of the mesentery vessels or slugging of ligature after the decrease in mesentery swelling; insufficiently reliable hemostasis from adhesions; increased bleeding due to common diseases (hemophilia, leukemia, scurvy).

Bleeding inside the peritoneal cavity after appendectomy requires relaparotomy. Often during relaparotomy the source of bleeding is not detected and the operation is ended with the removal of blood and clots, tampon application and drainage of the place of bleeding.

The rate of **acute intestinal postoperative obstruction** fluctuates in the limits of 0.1-2.5%. Diagnosis of early acute intestinal obstruction often is difficult, deterioration of patient's condition is explained by postoperative paresis, continuing peritonitis, that lead to time missing. **Fecal fistula** is an uncommon complication of operation for acute appendicitis, either with or without an associated peritonitis. The incidence of fistulas for the total number of operations for acute appendicitis with and without perforation is only 0.8%. The diagnosis of an intestinal fistula ordinarily is not difficult. In the case of most ceca1 fistulas, the discharge is semisolid and is not especially irritating to the skin. The fistulas higher in the small intestine are associated with an irritating discharge and, due to the fluid character of the contents, considerable quantities of fluid, electrolytes and food substances may be lost. The fistulas associated with appendicitis tend to heal spontaneously. This is particularly true of the cecal fistulas. When healing fails to occur in these cases there is usually an outgrowth of the cecal mucous membrane so that it becomes continuous with the skin, producing the direct or lip type of fistula. In such cases, surgical closure is necessary. The ileal fistulas are more apt to be complete and are less likely to heal spontaneously than are those in the cecum.

After hospital discharge, patients must have a light diet and limit their physical activity for a period of 2–6 weeks based on the surgical approach (i. e., laparoscopic or open appendectomy) [24].

Prognosis

The mortality from appendicitis in the United States has steadily decreased from a rate of 9.9 per 100,000 in 1939 to 0.2 per 100,000 today. Among the factors responsible are advances in anesthesia, antibiotics, IV fluids, and blood products. Principal factors influencing mortality are whether rupture occurred before surgical treatment and the age of the patient. The overall mortality rate in acute appendicitis with rupture is approximately 1%. The mortality rate of appendicitis with rupture in the elderly is approximately 5% – a fivefold increase from the overall rate. Death is usually attributable to uncontrolled sepsis peritonitis, intra-abdominal abscesses, or gram-negative septicemia. Pulmonary embolism continues to account for some deaths.

Conclusions

1. The diagnosis of acute appendicitis is determined by the combination of clinical and instrumental methods.

2. When additional methods of research have exhausted themselves and the diagnosis is not yet clear, the preference will go to the clinical method of examination.

3. Instrumental methods of research play a great and sometimes decisive role in the differential diagnosis of acute appendicitis.

4. The method of treatment of the established diagnosis of acute appendicitis is appendectomy by an open or laparoscopic method.

5. The best method of surgical treatment (open or laparoscopic) is the one that is optimal for this patient.

6. Conservative treatment of acute appendicitis only with antibiotics is dangerous, and cannot be taken as a basis for treatment.

7. The earlier diagnosing and an early surgery performance in patients with acute appendicitis are the key to success, and lead to significant reduction in number of postoperative complications.

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