Appendicitis, Acute

Synonyms and related keywords: acute inflammation of the appendix

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Background:
Appendicitis is a common and urgent surgical illness with variable manifestations, generous overlap with other clinical syndromes, and significant morbidity, which increases with diagnostic delay. No single sign, symptom, or diagnostic test accurately makes the diagnosis of appendiceal inflammation in all cases. The surgeon’s goals are to evaluate a relatively small population of patients referred for suspected appendicitis and to minimize the negative appendectomy rate without increasing the incidence of perforation.

Pathophysiology:
Obstruction of the appendiceal lumen is the primary cause of appendicitis. Obstruction of the lumen leads to distension of the appendix due to accumulated intraluminal fluid. Ineffective lymphatic and venous drainage allows bacterial invasion of the appendiceal wall and, in advanced cases, perforation and spillage of pus into the peritoneal cavity.

Mortality/Morbidity:
Overall mortality rate of 0.2-0.8% is attributable to complications of the disease rather than to surgical intervention.
Mortality rate rises above 20% in patients older than 70 years, primarily because of diagnostic and therapeutic delay.
Perforation rates are higher in patients younger than 18 years and in patients older than 50 years, possibly because of delays in diagnosis. Appendiceal perforation is associated with an increase in morbidity and mortality rates.

Sex:
Incidence of appendicitis is approximately 1.4 times greater in men than in women. The incidence of primary appendectomy is approximately equal in both sexes.

Age:
Incidence of appendicitis gradually rises from birth, peaks in the late teen years, and gradually declines in the geriatric years.
Although rare, cases of neonatal and even prenatal appendicitis have been reported.

History:
Variations in the position of the appendix, age of the patient, and degree of inflammation make the clinical presentation of appendicitis notoriously inconsistent. In addition, many other disorders present with symptoms similar to those of appendicitis. These include pelvic inflammatory disease (PID), tubo-ovarian abscess, endometriosis, ovarian cyst or torsion, degenerating uterine leiomyomata, diverticulitis, Crohn disease, colonic carcinoma, rectus sheath hematoma, cholecystitis, bacterial enteritis, mesenteric adenitis, and omental torsion.
The classic history of anorexia and periumbilical pain followed by nausea, right lower quadrant (RLQ) pain, and vomiting occurs in only 50% of cases.
Migration of pain from the periumbilical area to the RLQ is the most discriminating historical feature, with sensitivity and specificity of approximately 80%.
When vomiting occurs, it nearly always follows the onset of pain. Vomiting that precedes pain is suggestive of intestinal obstruction, and the diagnosis of appendicitis should be reconsidered.

Nausea is present in 61-92% of cases; anorexia is present in 74-78% of cases. Neither finding is statistically different from findings in ED patients with other etiologies of abdominal pain.

Diarrhea or constipation is noted in as many as 18% of patients and should not be used to discard the possibility of appendicitis.

Duration of symptoms is less than 48 hours in approximately 80% of adults but tends to be longer in the elderly and in those with perforation. Approximately 2% of patients report duration of pain in excess of 2 weeks.

History of prior similar pain is reported in as many as 23% of cases. History of similar pain should not, in and of itself, be used to discard the possibility of appendicitis.

An inflamed appendix located in proximity to the urinary bladder or ureter can give rise to irritative voiding symptoms and hematuria or pyuria. Remember that cystitis in males is rare in the absence of instrumentation. Consider the possibility of an inflamed pelvic appendix in males with apparent cystitis.

**Physical:**

RLQ (Right lower quadrant) tenderness is present in 96% of patients but is a very nonspecific finding.

The most specific physical findings are rebound tenderness, pain on percussion, rigidity, and guarding.

Rovsing sign (ie, RLQ pain with palpation of the LLQ), obturator sign (ie, RLQ pain with internal rotation of the flexed right hip), and psoas sign (ie, RLQ pain with hyperextension of the right hip) are present in a minority of patients with acute appendicitis. Their absence never should be used to rule out appendiceal inflammation.

A positive cough sign (ie, sharp pain in the RLQ elicited by a voluntary cough) may be helpful in making the clinical diagnosis of localized peritonitis. Similarly, RLQ pain in response to percussion of a remote quadrant of the abdomen, or to firm percussion of the patient’s heel, suggests peritoneal inflammation.

Literature is inconsistent as to whether rectal examination is helpful in making the diagnosis; however, failure to perform a rectal examination is cited frequently in successful malpractice claims.

**Causes:**

Appendicitis is usually precipitated by obstruction of the appendiceal lumen. Causes of luminal obstruction include fecoliths, lymphoid follicle hyperplasia, foreign bodies (eg, shotgun pellet, intrauterine device), and tumors.

Fecoliths form when calcium salts and fecal debris become layered around a nidus of inspissated fecal material located within the appendix.

Lymphoid hyperplasia is associated with a variety of inflammatory and infectious disorders including Crohn disease, gastroenteritis, amebiasis, respiratory infections, measles, and mononucleosis.

**DIFFERENTIALS**

- Cholecystitis and Biliary Colic
- Constipation
- Diverticular Disease
- Endometriosis
- Gastroenteritis
- Inflammatory Bowel Disease
- Mesenteric Ischemia
- Ovarian Cysts
- Ovarian Torsion
- Pediatrics, Intussusception
- Pelvic Inflammatory Disease
- Spider Envenomations, Widow

**Other Problems to be Considered:**

- Typhilitis
- Epiploic appendagitis
Mesenteric adenitis

**Lab Studies:**

**Complete blood count**

Studies consistently show that 80-85% of adults with appendicitis have a WBC count greater than 10,000. Neutrophilia greater than 75% occurs in 78% of patients. Fewer than 4% of patients with appendicitis have a WBC count less than 10,000 and neutrophilia less than 75%.

CBC is inexpensive, rapid, and widely available; however, it is nonspecific and misses 4% of cases. It costs approximately $50.

Literature is inconsistent with regard to WBC count parameters in children and elderly patients with appendicitis.

**C-reactive protein test**

C-reactive protein (CRP) is an acute-phase reactant synthesized by the liver in response to bacterial infection. Serum levels begin to rise within 6-12 hours of acute tissue inflammation. A rapid assay is widely available.

Several prospective studies have concluded that in adult patients who have had symptoms for longer than 24 hours, a normal CRP has a negative predictive value of approximately 100% for the presence of appendicitis. Specificity has ranged from 50-87% in several series. Two other studies in adults found that a combination of a WBC count of less than 10,500, neutrophilia less than 75%, and a normal CRP had 100% negative predictive value for the diagnosis of acute appendicitis. In 1989, Thimsen et al noted that a normal CRP after 12 hours of symptoms was 100% predictive of benign, self-limited illness.

CRP does not distinguish between various types of bacterial infection.

**Imaging Studies:**

**Computed tomography**

Abdominal CT has become the most important imaging study in the evaluation of patients with atypical presentations of appendicitis. Several studies have shown a decrease in negative laparotomy rate and appendiceal perforation rate when abdominal CT is used in selected patients with suspected appendicitis. Advantages of CT scanning include superior sensitivity and accuracy compared with other imaging techniques, ready availability, noninvasiveness, and potential to reveal alternative diagnoses. Disadvantages include radiation exposure, potential for anaphylactoid reaction if intravenous (IV) contrast is used, lengthy acquisition time if oral contrast is used, and patient discomfort if rectal contrast is used. A variety of CT techniques have been studied.

**Ultrasonography**

A 5-MHz transducer is used, applying gentle but firm pressure in the RLQ to displace intervening bowel gas and to decrease the distance between the transducer and the appendix, thereby improving image quality. An outer diameter of greater than 6 mm, noncompressibility, lack of peristalsis, or presence of a periappendiceal fluid collection characterizes an inflamed appendix. The normal appendix is not visualized in most cases. A posterolateral approach is suggested to evaluate the retrocecal area. Scattered case reports endorse transvaginal ultrasonography for women with low pelvic tenderness if the appendix is not visualized on transabdominal sonography.

Advantages include noninvasiveness, short acquisition time, lack of radiation exposure, and potential for diagnosis of other causes of abdominal pain, particularly in the subset of females of childbearing age. Many authorities feel that ultrasonography should be the initial imaging test in pregnant women and in pediatric patients because radiation exposure is particularly undesirable in those groups.

The principal disadvantage is that ultrasonographic examination is operator dependent. Because nonvisualization is interpreted as a noninflamed appendix, technical expertise and commitment to a thorough examination are essential in obtaining maximum sensitivity.

If graded compression ultrasonography of the right lower quadrant is positive for appendicitis, appendectomy should be performed. If negative, this finding is not sufficiently sensitive to rule out the possibility of appendicitis. Consideration should be given to further observation and focused helical CT with rectal contrast.
**Abdominal radiography**
Kidneys-ureters-bladder (KUB) view used typically. Visualization of an appendicolith in a patient with symptoms consistent with appendicitis is highly suggestive of appendicitis, but this occurs in fewer than 10% of cases.

The consensus in the literature is that plain radiography is insensitive, nonspecific, and not cost-effective.

**Barium enema**
A single contrast study can be performed on an unprepared bowel. Nonfilling or incomplete filling of the appendix coupled with pressure effect or spasm in the cecum suggests appendicitis.

Advantages of barium enema are its wide availability, use of simple equipment, and potential for diagnosis of other diseases (eg, Crohn disease, colon cancer, ischemic colitis) that may mimic appendicitis.

Disadvantages include its high incidence of nondiagnostic examination, radiation exposure, insufficient sensitivity, and invasiveness. These disadvantages make barium enema a poor screening examination for use by emergency physicians. Barium enema has essentially no role in the diagnosis of acute appendicitis in the era of ultrasonography and CT.

**Radionuclide scanning**
Whole blood is withdrawn. Neutrophils and macrophages are labeled with technetium 99m albumin and administered intravenously. Images of the abdomen and pelvis are obtained serially over 4 hours. Localized uptake of tracer in the RLQ suggests appendiceal inflammation.

While future studies may confirm sensitivity as high as 98%, the acquisition time of 5 hours and the lack of availability are disadvantages to its use as a high-sensitivity ED screen for appendicitis.

**Other Tests:**

**Clinical diagnostic scores**
Several investigators have created diagnostic scoring systems in which a finite number of clinical variables is elicited from the patient and each is given a numerical value. The sum of these values is used to predict the likelihood of acute appendicitis.

The best known of these is the MANTRELS score, which tabulates presence or absence of migration of pain, anorexia, nausea/vomiting, tenderness in the RLQ, rebound tenderness, elevated temperature, leukocytosis, and shift to the left.

Clinical scoring systems are attractive because of their simplicity; however, none has been shown prospectively to improve upon physician judgment in the subset of patients evaluated in the ED for abdominal pain suggestive of appendicitis. The MANTRELS score, in fact, was based on a population of patients hospitalized for suspected appendicitis, which differs markedly from the population seen in the ED.

**Computer-aided diagnosis**
A retrospective database of clinical features of patients with appendicitis and other causes of abdominal pain is entered into a computer. It is then utilized in prospectively assessing the risk of appendicitis.

Computer-aided diagnosis can achieve sensitivity greater than 90% while reducing rates of perforation and negative laparotomy by as much as 50%.

The principle disadvantages are that each institution must generate its own unique database to reflect local population characteristics. Specialized equipment and significant initiation time are required.
TREATMENT

**Emergency Department Care:**
Treatment guidelines for patients with suspected acute appendicitis include the following:

Establish IV access and administer aggressive crystalloid therapy to patients with clinical signs of dehydration or septicemia.

Do not give anything by mouth to patients with suspected appendicitis.

Consider ectopic pregnancy in women of childbearing age and obtain a qualitative beta-hCG in all cases.

**Nonsurgical treatment of appendicitis**
This may be useful when appendectomy is not accessible or when it is temporarily a high-risk procedure.

Preoperative antibiotics

**Consultations:**
General surgeon

**MEDICATION**
The goals of therapy are to eradicate the infection and prevent complications.

**Belladonna**

*TYLER* - *Medicine acute intest. conditions, colic* - Abdominal pains, violent; come and disappear suddenly. Are squeezing; clawing; as if griped by nails; violent pinchings. "Violent colic, intense cramping pain, face red as fire." Tenderness of abdomen, worst least jar. Frequent urging to stool, little or no result (Nux). Spasmodic contraction of sphincter ani. Great pain in ileo-caecal region: cannot bear slightest touch, even of bedclothes (early appendicitis. Local external applications to abort). Typical Bell. has red, hot face; big pupils: is sensitive to pressure draughts, jar.

*TYLER - Special remedies of appendix and caecum* - Years ago, when making diagrams to show the action of remedies on parts of the body, one grasped the fact that two drugs seemed to share the honours in this area- Belladonna and Mercurius corrosivus. And one knows that Bell. has earned a great reputation for early, simple inflammation of appendix. Among its symptoms are : Great pain in right ileo-caecal region. Cannot bear the slightest touch, not even of bed covers. Tenderness aggravated by least jar.(KENT says, "The jar of the bed will often reveal to you the remedy"). Bell. has much swelling. Its inflammations throb : feel bursting. Kent also says, "There are instances where Bell. is the remedy of all remedies in appendicitis".

*KENT* - There are instances where Bell. is the remedy in appendicitis. Belladonna has dysenteric troubles.

Pain in the region of the caecum.

**Mercurius corrosivus**

*TYLER - Medicine acute intest. conditions, colic. -* Peculiar bruised sensation about caecum and along transverse colon. Tender to pressure. Appendicitis. (Bell). Painful bloody discharges (from rectum) with vomiting. Tenesmus, persistent, incessant, with insupportable cutting, colicky pains. Diarrhoea dysentery with terrible straining before, with, and after stool. Merc. cor. is almost specific for dysentery. Very distressing tenesmus, getting worse and worse: nothing blood.

*TYLER - Special remedies of appendix and caecum* - Kent has this drug down in black type for appendicitis. Merc. corr. is violent and active. Has far more activity, excitement and burning. Caecal region and transverse colon painful. Bloated abdomen. Characteristic : Great tenesmus of rectum, the "never-get-done" remedy. Abdomen bruised, bloated, tender to least touch. Tenesmus of bladder, also. Hot urine passed drop by drop.

*CLARKE - Clinical. -* Appendicitis.
A girl, 16, had perforating appendicitis, operation having been delayed too long in consequence of opposition of friends.

**Bryonia alba**

*TYLER - Special remedies of appendix and caecum - Appendixitis: peritonitis. Must keep very still; stools hard, dry, as if burnt. Pain in a limited spot: dull, throbbing or sticking. Bry. is better lying on painful side, for pressure and to limit movement. Lies knees drawn up. Better for heat to inflamed part.*

*SAMUEL - Sensitive abdomen; appendicitis. Constipation; hard, dry stool.*

**Echinacea purpurea**

*TYLER - Special remedies of appendix and caecum - (In Repertory for Appendicitis). Boericke says: "It acts on appendix and has been used for appendicitis. But remember, it promotes suppuration, and a neglected appendix with pus formation would probably rupture sooner under its use". -Another condition to which Natrum sulph. patients are prone is a fairly acute attack of appendicitis, with extreme pains in the cecal region.*

*BOERICKE - Lymphatic inflammation; crushing injuries. Compare: Iris florentina-Orris-root-(delirium, convulsions, and paralysis); Iris factissima (headache and hernia); Iris germanica-Blue Garden Iris-(dropsy and freckles); Iris tenax -1.minor-(dry mouth; deathly sensation at point of stomach, pain in ileo-caecal region; appendicitis. Pain from adhesions after).*

*CLARKE -Echinacea angustifolia - Clinical - Appendicitis.*

**Natrium sulphuricum**

*BORLAND - Digestive drugs - Apparently, it is a retro-cecal appendix, because they always complain of extreme pain going right round to the back, rather than of pain ore McBurney's Point. It is the type of appendix which is associated with a degree of jaundice. Some of the most striking results from Natrum sulph. have been in cases of appendix abscesses, where there has been a retro-cecal appendix and a tendency for the inflammation to track up and conditions suggesting a sub-phrenic. There is one other rather interesting point about this remedy, and it has no connection with the digestive system. Natrum sulph. is sometimes very well indicated in acute his joints, particularly when it is the right hip which is affected. The pain is very similar in character to that experienced in cases of appendicitis, and if there are any Natrum sulph. indications, it is worthwhile to consider its use. Two cases in hospital cleared up remarkably well on Natrum sulph., and it is apt to be forgotten for this condition.*

*KENT - Natrium sulphuricum - It has cured many cases resembling the first stage of appendicitis. Pain and tenderness in the whole abdomen. Flatulence; colic; rending, tearing, cutting pains throughout the abdomen; stitching pains in the abdomen; violent neuralgic pains in the abdomen; inflammation of the bowels, of the peritoneum; appendicitis.*

**Alfalfa**

*BOERICKE - Abdomen - Flatulence with distention. Shifting, flatulent pain along colon several hours after meals. Frequent, loose, yellow, painful stools, with burning of flatulence. Chronic appendicitis.*

**Cascara sagrada**

*BOERICKE - Relationship - Compare: Hyd.; Nux.; Rhamnus Californica (tincture for constipation; tympanites and appendicitis and especially rheumatism).*

* Acts on vermiform appendix thus has been used for appendicitis, but remember it promotes suppuration and a neglected appendicitis with pus formation would probably rupture sooner under its use.*

**Ammoniacum gummi**
CLARKE - Clinical - Appendicitis. Stitches in the caecum at 7 p.m., alternating with pains elsewhere.

Characteristics - This should make it appropriate in some cases of appendicitis. Appendicitis. As an external application in the form of compresses, Lime-water has an ancient repute in allaying inflammation of many kinds.

Calcarea caustica

CLARKE - Characteristics - It has rapidly dispelled all inflammatory action in cases of appendicitis; and has removed all suffering in an aggravated case of phagedaenic piles.

Colchicum autumnale

CLARKE - Clinical - Appendicitis.

Crotalus horridus

CLARKE - Clinical - Apoplexy. Appendicitis.

Ginseng quinquefolium

CLARKE - Clinical - Appendicitis.

Iris tenax

CLARKE - Clinical - Appendicitis.

Lac vaccinum defloratum

CLARKE - Clinical - Anaemia. Appendicitis.

Lachesis mutus

CLARKE - Clinical - Appendicitis. Acute pain in liver extending towards stomach," though contrary to the general "left to right" direction, is characteristic, as I can testify. Lach. is also one of the most prominent remedies in appendicitis.

Mercurius solubilis

CLARKE - Clinical - Appendicitis.

Phosphorus

CLARKE - Characteristics - Although he deemed it useless he was persuaded to operate, and found a large abscess behind the colon, freely communicating with the peritoneal cavity.

Plumbum metallicum

CLARKE - Clinical - Appendicitis.

Rhamnus cathartica

Rhamnus frangula

*CLARKE - Clinical.* - Anus, itching of. Appendicitis.

**Rhus radicans**

*CLARKE - Clinical.* - Appendicitis. Appetite, lost.

Sabal serrulata

*CLARKE - Clinical.* - Appendicitis.

Scrophularia marylandica


Tuberculinum bovinum kent

*CLARKE - Clinical.* - Appendicitis. "Sensitive to music" was observed in one of Nebel's patients; another had pains in the region of the appendix vermiformis, which should lead to serviceable action in appendicitis cases.

Radium bromatum

*CLARKE - Clinical.* - Albuminuria. Appendicitis.

Arnica montana

*KENT* - Do not forget the symptoms of Arnica in appendicitis if you know Bryonia, Rhus tox., Belladonna, Arnica and similar remedies. The homoeopathic remedy will cure these cases, and, if you know it, you need never run after the surgeon in appendicitis except in recurrent attacks.

If you do not know your remedies, you will succumb to the prevailing notion that it is necessary to open the abdomen and remove the appendix. It is only deplorable ignorance that causes appendicitis to be surrendered to the knife.

"Great pain in the ileo-caecal region; cannot bear the slightest touch, even the bed clothes."

Phosphorus

*KENT* - Yellow, brown spots on the abdomen; petechiae over the abdomen during typhoid fever. Pale face in pleura/peritoneum-disease, red face in articular affections.

Complications:

- Wound infection
- Dehiscence
- Bowel obstruction
- Abdominal/pelvic abscess
- Death (rare)

Prognosis:

Excellent
Approximately 10% of adults who develop appendicitis are not diagnosed correctly at the first physician encounter. Failure to diagnose appendicitis is the leading cause of successful malpractice claims and the fifth most expensive source of claims against emergency physicians.

**Special Concerns:**

**Pregnancy**

The incidence of appendicitis is unchanged in pregnancy, but the clinical presentation becomes even more variable. During pregnancy the appendix migrates in a counterclockwise direction toward the right kidney, rising above the iliac crest at about 4.5 months gestation. RLQ pain and tenderness dominate in the first trimester, but in the latter half of pregnancy, right upper quadrant (RUQ) or right flank pain must be looked upon as a possible sign of appendiceal inflammation. Nausea, vomiting, and anorexia are common in uncomplicated first trimester pregnancies, but their reappearance later in gestation should be viewed with suspicion.

Physiologic leukocytosis during pregnancy makes the WBC count less useful in the diagnosis, and no reliable distinguishing WBC parameters are cited in the literature. One study of 22 pregnant women in the first and second trimesters found that graded compression ultrasound had a sensitivity of 66% and specificity of 95%. Diagnostic laparoscopy also has been suggested for pregnant patients in the first trimester with suspected appendicitis.

While negative appendectomy does not appear to affect maternal or fetal health adversely, diagnostic delay with perforation does increase fetal and maternal morbidity. Therefore, aggressive evaluation of the appendix is warranted in this group.

**Nonpregnant women of childbearing age**

Patients in this group who develop appendicitis are misdiagnosed in 33% of cases. The most frequent misdiagnoses are PID, followed by gastroenteritis and urinary tract infection.

In distinguishing appendiceal pain from PID, presence of anorexia and onset of pain more than 14 days after menses favors appendicitis. Previous PID, presence of vaginal discharge, or presence of urinary symptoms indicates the diagnosis of PID.

On physical examination, tenderness outside the RLQ, cervical motion tenderness, vaginal discharge, and positive urinalysis favor the diagnosis of PID.

**Children**

Children with appendicitis are misdiagnosed in 25-30% of cases overall, and the rate of initial misdiagnosis is inversely related to the age of the patient.

The most common misdiagnosis is gastroenteritis, followed by upper respiratory infection and lower respiratory infection.

Misdiagnosed children are more likely than their correctly diagnosed counterparts to have vomiting before pain onset, diarrhea, constipation, dysuria, signs and symptoms of upper respiratory infection, and lethargy or irritability.

Physical findings less likely to be documented in the children who are misdiagnosed include findings of ear, nose, and throat exam; bowel sounds; peritoneal signs; and findings of rectal examination.

**Elderly patients**

Appendicitis in patients older than 60 years accounts for 10% of all appendectomies. The incidence of misdiagnosis is increased in the elderly. In those patients with morbid conditions, diagnostic delay does correlate with increased morbidity and mortality.
Older patients tend to seek medical attention later in the course of illness; therefore, duration of symptoms in excess of 24-48 hours should not dissuade the physician from the diagnosis.