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PRACTICE

CLINICAL UPDATES

Acute appendicitis

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Acute appendicitis is the most common abdominal surgical emergency in the world, with around 50 000 and 300 000 acute appendicectomies performed annually in the UK and in the US respectively.[1 2] However, its incidence is falling for unknown reasons.[3 4]

This clinical update provides information on how patients may present and what investigations and treatments are available.

Who is affected?

Acute appendicitis can affect people of any age but is most common between the ages of 10 and 20 years.[4 5] It is more common in males, although females are twice as likely to undergo an appendicectomy.[6 7] The lifetime risk of acute appendicitis is 8.6% in males and 6.9% in females; the lifetime appendicectomy rate is 12% in males and 23% in females.[6 7] Perforation is found in 13-20% of patients with acute appendicitis.[8 9]

What causes appendicitis?

The aetiology remains uncertain,[7-10] but possible causes include luminal obstruction blocking the escape of mucosal secretions and leading to an increase in pressure, causing engorgement and stasis that can lead to necrosis and eventually perforation.[7 9] Faecoliths, foreign bodies, malignancy, and lymphoid hyperplasia during an infection are described as possible causes of luminal obstruction.[9-12] There is no known genetic cause of acute appendicitis, but increased risk has been observed in twin studies and in those with a positive family history.[13 14]

How do patients present with acute appendicitis?

Untreated appendicitis can cause significant morbidity and mortality, as can an appendicectomy with a normal appendix.[15-18] Individually, the patient history, examination, and laboratory findings are of poor predicative value, but in combination their diagnostic value is much greater.[19-21] The differential diagnoses are broadest in pre-menopausal women, as symptoms of acute appendicitis can be similar to the pain some women experience during normal menstruation, dysmenorrhoea, or ovulation and pathology such as ovarian torsion, ectopic pregnancy, and pelvic inflammatory disease.[15] Diagnosis is harder if communication is limited—for example, where there is a language barrier or in patients who are very young, have dementia, a mental health diagnosis or a learning difficulty.[20] In these patients, a collateral history of becoming withdrawn, less active, or having a reduced oral intake will raise the index of suspicion.[5]

Clinical assessment

The classic picture of central pain migrating to the right iliac fossa associated with nausea, vomiting, and anorexia occurs in less than half of presentations.[5-21] Abdominal pain is the most common feature.[5] Movement such as coughing and driving over uneven roads can exacerbate the pain of localised peritonism.[3-22] Patients may also give a history of feeling generally unwell, weak, cold, and clammy, or describe any symptom in keeping with sepsis.[5] A meta-analysis of clinical presentations in appendicitis showed that migratory pain was the strongest symptom associated with a diagnosis of acute appendicitis.[19]

Examine the patient for tenderness specifically in the right iliac fossa. Guarding, rebound, or percussion tenderness suggests local peritonism. If signs of peritoneal irritation are absent, then the likelihood of acute appendicitis is reduced (likelihood ratio 0.24-0.39).[19] Rovsing's sign (palpation in the left iliac fossa giving rise to pain in the right iliac fossa) and the psoas sign (passive hip extension with the patient in left lateral position causing pain) are of limited diagnostic value for acute appendicitis.[19] In the event that a patient has right iliac fossa

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What you need to know

- Around half of patients with acute appendicitis will display the typical clinical features
- Diagnosis is made on the basis of history and examination supported by blood tests and imaging in hospital
- Appendicitis is more likely if there is an elevated white cell count, C reactive protein concentration, granulocyte count, or proportion of polymorphonuclear cells
- Laparoscopic appendicectomy offers a reduced risk of wound infection, reduced rate of negative appendicectomy, less postoperative pain, shorter length of hospital stay, and quicker return to work and full function
- 1% of appendicectomies reveal a neoplasm

pain with no signs of peritonism, normal blood test results, and a normal ultrasound scan, the risk of appendicitis is very low.[19 23]

What investigations?

Investigations serve two purposes: to exclude other pathology and to support the diagnosis of acute appendicitis.

Urine analysis

Explain to premenopausal women that it is important to perform a urine pregnancy test (β-human chorionic gonadotropin level) to rule out pregnancy as a cause of the symptoms. Urine analysis can also suggest an alternative diagnosis such as renal colic or urinary tract infection. However, as the appendix often lies in close proximity to the urinary tract, 40% of patients with acute appendicitis will have leucocytes in their urine.[5]

Blood tests

There are no specific bloods tests for appendicitis. However, if there is an elevated white cell count, C reactive protein level, granulocyte count, or proportion of polymorphonuclear cells, then appendicitis is more likely (likelihood ratio 2.39-7.09). If these parameters are normal, then it is less likely to be acute appendicitis (likelihood ratio 0.24-0.39).[19]

Imaging

Computed tomography (CT) with intravenous contrast offers the best chance of diagnosis, at the cost of using ionising radiation. It is contraindicated in pregnancy and relatively contraindicated in young patients.[2-25] In these populations, other options are ultrasonography and magnetic resonance imaging (MRI) (table 1⇓). Imaging relies on the physical appearance of the area. The more advanced the inflammatory process, the more obvious appendicitis will be on any of the modalities.[28 29]

Ultrasonography is safe in children and pregnant patients. In a sexually active female a transvaginal ultrasound scan may be of value in imaging the gynaecological organs. Results are operator dependent, and an expert such as a consultant radiologist is shown to be more likely to deliver a correct diagnosis.[5-28]

MRI scans are mainly reserved for pregnant patients when ultrasound is non-diagnostic. A meta-analysis showed that MRI scans are of high diagnostic value in appendicitis, with slightly better results in non-pregnant patients.[26 27] Furthermore, non-visualisation of the appendix on MRI was associated with a reduction in the risk of appendicitis being present.[29]

Access to imaging varies widely. It is estimated that in the US universal imaging with CT would avoid 12 unnecessary appendicectomies but could result in one additional cancer death.[25] In the US, it is reported that 50% of patients who undergo appendicectomies in childhood and 95-99% in adulthood have a CT scan before surgery,[1-20] with scans commonly being performed in an emergency department before assessment by a surgeon.[2] In the EU in 2013, 12.9% of patients undergoing appendicectomy had a CT scan during the diagnostic workup.[1] This discrepancy is large: the use of CT scanning is shown to reduce the negative appendicectomy rate,[1] but the use of CT needs to be judicious, especially in children.[20] Low radiation dose CT has been trialled for the diagnosis of appendicitis, and it showed non-inferiority to a standard CT.[30] However, twice as many participants in the low radiation group went on to have further scans, including a standard abdominal CT scan.[30]

What are the treatment options?

Surgery

Current standard treatment for appendicitis is an appendicectomy, which can be performed open or laparoscopically. Open appendicectomy was described by McBurney in 1891,[31] and the technique has remained largely unchanged. Other surgical approaches exist, however, and the most common are McBurney's incision (also known as grid iron incision) and the Lanz incision.[31] Semm described a laparoscopic appendicectomy in 1983,[32] and more recently this operation has become widespread.

Which approach?

A 2013 study looking at 95 centres and 3326 patients noted that 66.3% of appendicectomies start laparoscopically in the UK.[1] Laparoscopy is also a diagnostic tool shown to reduce the rate of a negative appendicectomy. A Cochrane review including 67 studies, mostly in adults, found that a wound infection was around half as likely in laparoscopic appendectomy, but the intra-abdominal abscess rate was three times higher.[33] Laparoscopic appendicectomy was associated with a statistically significantly shorter hospital stay (1.1 days) and quicker return to full function by five days.[33] The authors felt that laparoscopic appendicectomy had various advantages and that the patients most likely to benefit were young, female, obese, or employed.[33]Table 2⇓ includes the practical information on each procedure to discuss with patients when deciding on the appropriate approach.

Support for day case appendicectomy is growing. A recent study treated a total of 563 patients with an acute appendicectomy: 86% (484) were treated as outpatients in a day case setting with a 1.3% (7) readmission rate.[34]

What if the appendix is normal at laparoscopy?

The decision of whether to proceed with appendicectomy is made on a case by case basis as the evidence is contradictory.[16-18] In practice, the decision is based on the following considerations for the individual patient:

- The risk of causing harm by leaving the appendix in situ after incorrectly considering it as normal
- The patient's lifetime risk of subsequently developing appendicitis

- The patient's lifetime risk of subsequently developing an appendicular malignancy
- The risk of surgical complications from removing a histologically normal appendix.

The evidence is contradictory, leading to a variation in practice.

When to operate?

Patients with appendicitis and evidence of sepsis require urgent surgery. The contradictory evidence regarding the consequence of delays to surgery in cases of acute appendicitis means that decisions whether to operate overnight on a non-septic patient with suspected appendicitis must be taken on an individual basis. In some studies, delays of less than 24 hours have found no increase in the rates of complications.[35-38] However, Busch et al showed that a delay of >12 hours was an independent risk factor for perforation (29.7% *v* 22.7%, P=0.01).[39] Kim et al showed a delay of >36 hours after the onset of symptoms was associated with an increased rate of postoperative ileus (0% *v* 5.9%, P=0.0024) and a longer hospital stay (3.8 (SD 1.5) *v* 4.7 (1.7) days, P<0.001).[40] They also reported that the duration of symptoms before hospital attendance of 12, 24, and 36 hours had relative risks of 1.626 (95% CI 1.225 to 2.160), 2.328 (1.576 to 3.438), and 1.912 (1.251 to 2.923) respectively for complicated appendicitis.[39-42]

Antibiotics

It is unclear whether antibiotics alone are a suitable treatment for non-complicated appendicitis as an alternative to surgery.[2-45] In practice, antibiotics are reserved for appendicitis in patients who are considered high risk or unfit for surgery, or for a patient who declines surgery.

First line treatment with antibiotics is associated with an increased length of stay, a lower risk of complications, and a lower rate of cure at one year.[43-46] If primary antibiotic treatment is initiated, a fifth of patients can expect a readmission, with recurrent symptoms within a year; most will undergo an appendicectomy that is not more complicated.[10-46] The data for use of antibiotics have short follow-up times, so the lifetime recurrence risk and the risk of missing a subclinical incidental neoplasm are unknown.[43]

A Cochrane review of five randomised controlled trials including 901 patients found that 97.4% of patients who underwent open or laparoscopic surgery, compared with 73.4% of patients who received antibiotics, were cured at two weeks, with no major complications, including recurrence at one year, in either group.[43] Those who had surgery had a shorter hospital stay. A higher complication rate of treatment would be expected with surgery, and this was 6.9% compared with 2.9% in the antibiotic group.[43] A more recent meta-analysis of randomised controlled trials of patients followed for one year showed that, after open or laparoscopic surgery, 88.1% were cured, compared with 62.6% of those treated with antibiotics.[44] Furthermore, 20% of those treated with antibiotics were readmitted within a year with similar symptoms, and most (97.3%) went on to have an appendicectomy. At the time of the procedure 10.9% had complicated appendicitis (gangrene or perforation), compared with 17.9% of the patients randomised to primary surgery.[44]

How to manage appendicitis in pregnancy?

An appendicectomy is the most common non-obstetric operation in pregnancy, with appendicitis occurring in one in 500-600 pregnancies, and it most commonly presents in the second trimester.[47 48] The risks and impact of fetal loss and premature labour add complexity. The history and clinical assessment are the same as in non-pregnant patients. Ultrasonography and MRI are the imaging tests of choice as computed tomography is contraindicated.[48]

Appendicectomy is the optimal treatment, but a negative appendicectomy will place the pregnancy at risk.[48 49] A meta-analysis found no statistically significant difference between open and laparoscopic surgery, although questions have been raised about the risk to pregnancy by raising the intra-abdominal pressure during insufflation.[48] A series published in China found that the greater the time between onset of symptoms and surgery, the greater the risk of appendix perforation, premature labour, and fetal death.[49] Care of pregnant women with suspected appendicitis is best led jointly by senior members of the obstetric and surgical teams.

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Patient involvement

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Tables

Table 1| Pros and cons of different imaging modalities for diagnosis of appendicitis

	Advantages	Disadvantages	Sensitivity and specificity
Ultrasonography	• Safe in children and pregnancy (no ionising radiation) • No contrast required	• Diagnostic accuracy is operator dependent • Usually not accessible out of hours	• 86% and 81%[10 23]
Computed tomography	• Widely accessible in most healthcare systems including out of hours	• Contraindicated in pregnancy (ionising radiation) • Relatively contraindicated in children • Requires intravenous contrast, relatively contraindicated in renal failure	• 95-100% and 98-99.5%[24 25]
Magnetic resonance imaging	• Safe in children and pregnancy (non-ionising radiation)	• Limited access, especially out of hours • Unsuitable for claustrophobic patients • Long scanning time • Requires patient cooperation	• 94% and 96% in pregnant patients • 96% and 97% in non-pregnant patients[26 27]

Table 2| **Summary of results for laparoscopic versus open appendicectomy from a Cochrane review33**

Laparoscopic appendicectomy	Open appendicectomy
Statistically significant results	
Three incisions, with an improved cosmetic result	Single incision
Reduced risk of wound infection (by half)	Reduced risk of intra-abdominal abscess (by a third)
Less postoperative pain	Reduced intraoperative costs
Shorter length of hospital stay (by 1.1 days)	
Borderline significant results	
Reduced the negative appendicectomy rate	
Bowels working sooner	
Non-significant results	
Quicker return to work (by 2 days)	Reduced operating time (by 10 minutes)
Quicker return to full function (by 5 days)	