

Appendicitis and non-specific abdominal pain in childhood

Sumita Chhabra

Simon E Kenny

Abstract

Abdominal pain is a common experience during childhood and frequently presents to secondary healthcare facilities. Although non-specific abdominal pain and appendicitis are the most common causes, the clinician should also be aware of the diagnosis and management of all causes of abdominal pain in children. This article provides an overview of abdominal pain in children, including history and examination, initial management, diagnostic categories, modes of investigation, and definitive treatment.

Keywords Acute abdomen; appendicitis; children; non-specific abdominal pain; peritonitis

Overall assessment

History and examination

The evaluation of the child with non-specific abdominal pain remains challenging and good communication between the clinician, child and parents is essential. Successful evaluation requires patience and a careful and meticulous approach to history taking and physical examination. General principles include addressing the child directly whenever possible and allowing them time to answer questions; these should give the child several options without biasing their choice of answer: e.g. 'is the pain getting better, worse, or staying the same?', 'is the pain bad all the time or does it come and go?'. A calm demeanour is essential and the surgeon should try to sit or kneel at the same level or lower than the child to reduce anxiety. With extremely anxious children, often initiating with time spent talking to siblings and 'ignoring' the unwell child can help them to relax and even want to interact. History taking should be tailored to the age of the child; for instance in older children tactful enquiry into gynaecological matters and sexual history should be made where appropriate, the latter is best achieved when the parents are absent. Perhaps the most important aspect to ascertain in the history is whether the pain is accompanied by vomiting. In particular, bilious vomiting should be regarded as having a surgical cause until proven otherwise. On this note, care should be taken to characterize the nature of 'bilious vomiting'. The term 'bilious' means different

things to different people and careful enquiries should be made as to whether the vomit was truly green. The presence of bloody mucus in the stool can be suggestive of a surgical cause but can also be found in bacterial gastroenteritis.

Little diagnostic information can be gleaned by attempting to examine the abdomen of a crying child who is being pinned to the examination couch by his/her parents. Often the child picks up on the anxiety of his/her parents and attempts should be made to calm their fears. It is important to be adaptable and sometimes abdominal examination is best performed in an unorthodox manner. Examination of the child on a parent's lap or when they are standing up, often makes the child feel safer and can allow relevant clinical signs to be detected. If the clinical condition allows, a useful strategy in the case of the uncooperative child is to defer examination. Indeed, the fretful tearful child in the emergency room often becomes more cooperative when in the calmer environment of a children's ward. Play specialists can also be invaluable when children are being examined and when any invasive procedures need to be performed. Rebound tenderness should not be sought in the presence of localized tenderness and guarding. Getting the child to hop on one leg can help elicit peritonism in a way that fully engages the child in the examination process (clearly this should not be attempted in the unwell child). It is mandatory to examine the inguinal region in all children with abdominal pain and the testes in males to avoid missing the diagnoses of strangulated herniae and testicular torsion, respectively. The issue of digital rectal examination is a contentious one; the balance between clinical information gained versus emotional trauma caused and potential trust lost is such that the authors do not practise this procedure in the evaluation of children with abdominal pain and have not been aware of diagnostic lapses that would have been avoided had this examination been performed. In addition to the abdominal examination, an ENT and respiratory examination should be performed, as pathology in these sites can commonly cause pain referred to the abdomen.

Common and serious causes of abdominal pain in children are listed in [Box 1](#). The clinical skills required to differentiate between them should not be underestimated.

Initial management

Initial evaluation should incorporate assessment of Airway, Breathing, Circulation. In the shocked or listless child, 100% oxygen via a rebreathing circuit should be administered and continuous pulse oximetry readings taken. Intravenous or intraosseous access should be obtained where there is evidence of shock or dehydration: initial crystalloid infusions should be administered as a bolus of 20 ml/kg. It is not uncommon for children to require over 40 ml/kg of intravenous fluids: establishing an adequate capillary refill time (<5 seconds) should be used as an end-point. Oral, rectal or intravenous analgesics should be administered as appropriate: intramuscular morphine should be avoided especially in the presence of shock. Physical signs of peritonitis are *not* masked by the administration of opiate analgesia and analgesia should not be withheld pending surgical assessment.

Serum biochemistry should be obtained if there has been significant vomiting, and liver function tests and serum amylase if there are clinical indications of hepatobiliary disorders or pancreatitis. Capillary or arterial blood gases are useful in

Sumita Chhabra *BMBS BMedSci(Hons) MRCS DCH is a Specialist Registrar in Paediatric Surgery at Royal Manchester Children's Hospital, Manchester, UK. Conflicts of interest: none declared.*

Simon E Kenny *BSc MBChB(Hons) MD FRCS(Paed Surg) FAAP(Hons) is a Consultant Paediatric Surgeon at Alder Hey Children's NHS Foundation Trust, Liverpool, UK. Conflicts of interest: none declared.*

Common and serious abdominal emergencies in children

Common causes of abdominal pain in childhood

- Appendicitis
- Gastroenteritis
- Urinary tract infection
- Constipation
- Mesenteric adenitis
- Ovulatory/perimenstrual pain
- Non-specific abdominal pain

Serious causes of abdominal emergencies in childhood

- Appendicitis
- Intussusception
- Malrotation/volvulus
- Bleeding Meckel's diverticulum
- Bacterial enterocolitis
- Ovarian/testicular torsion
- Pancreatitis
- Obstruction/strangulated hernia
- Perforated duodenal ulcer

Box 1

assessment of associated acid–base disorders and response to treatment. Metabolic acidosis is a common finding in hypovolaemic shock; failure of the acidosis to respond to fluid resuscitation and supportive measures is suspicious of ischaemic or infarcted bowel (especially in the presence of a raised serum lactate levels). Serial C-reactive protein (CRP) levels and white cell count with differential can be of use as discriminatory factors in cases where the diagnosis is uncertain when taken together with the history and examination findings. Intravenous broad-spectrum antibiotics should be administered in children with obvious peritonitis who are being prepared for theatre; a more circumspect approach should be adopted in children where the diagnosis is less clear. It is mandatory for all post-menarchal girls to have a pregnancy test.

Appendicitis

Appendicitis is inflammation of the appendix. Typically this is caused by luminal obstruction, usually by a faecolith (impacted faeces) but other causes of obstruction are listed in [Box 2](#). The clinical and pathological course of appendicitis is variable and dependent on the anatomical location of the appendix and the host response to infection. Pathologically, luminal obstruction is

Causes of appendicitis

- Faecolith (impacted calcified faeces)
- Lymphoid hyperplasia (viral)
- Parasitic infestation (typically threadworm)
- Gallstone
- Tumours – typically carcinoid

Box 2

followed by localized infection and inflammation confined to the wall of the appendix. If left untreated then ischaemia and infarction may supervene with localized bacterial translocation potentially followed by appendicular perforation and peritonitis, which may be generalized or localized depending on (1) the location of the appendix (if retrocaecal then will remain localized) and (2) the omental response (if the omentum is able to contain the perforation then a localized inflammatory mass/abscess will form).

Clearly generalized peritonitis is the most severe inflammatory reaction and death can result from generalized sepsis if sepsis is not promptly treated.

Symptoms

The clinical history in 'classic' appendicitis is of abdominal pain associated with nausea and anorexia, followed by vomiting and in some instances, diarrhoea, particularly with pelvic appendicitis. Some children may also experience lower abdominal pain on micturition. Whereas during the early stages the pain is located in the periumbilical region due to referred midgut pain, the pain classically migrates to the right iliac fossa due to local peritoneal irritation. The pain is usually worse on walking or when coughing and is relieved by flexing the right hip and bringing the knee upwards to decrease psoas irritation. In cases of perforated appendicitis with generalized peritonitis, the pain is generalized and severe. When spontaneously recounted without prompting, exacerbation of pain when the car or ambulance went over speed-humps during transit to hospital, is strongly suggestive of peritonitis!

Bleeding per rectum is not characteristic of appendicitis and alternative diagnoses such as intussusception ([Figure 1](#)), Meckel's diverticulum ([Figure 2](#)) or inflammatory bowel disease should be sought.

Signs and examination findings

Classically, children with appendicitis have a low-grade pyrexia with or without tachycardia and prolonged capillary refill depending on the degree of dehydration. If the child has a high temperature, this either suggests that the appendix is perforated or suggests a different pathology (e.g. urinary tract infection or viral mesenteric adenitis). Children with appendicitis usually appear flushed and may have fetor oris. On examination of the abdomen there is maximal tenderness in the right lower quadrant with guarding. It is important to distinguish between actual guarding and voluntary guarding which can be misleading in children. Distraction techniques such as using the diaphragm of a stethoscope to 'listen' for bowel sounds or conversing with the child during examination can be very useful to differentiate between these. Generalized tenderness and guarding or a 'rigid' abdomen point towards perforated appendicitis with generalized peritonitis. In some instances, an inflammatory mass may be palpable in the right lower quadrant if the appendix is walled off or an abscess has formed, particularly if the history is suggestive of a prolonged course of illness. This is not always picked up preoperatively, however, and the child should always be examined on the operating table following induction of general anaesthetic in order to determine whether conservative management is more appropriate in cases of 'appendix mass'.

Appendicitis can be difficult to diagnose in the very young and neurologically impaired. Young children invariably present late with appendicitis and nearly all children under the age of 5 will

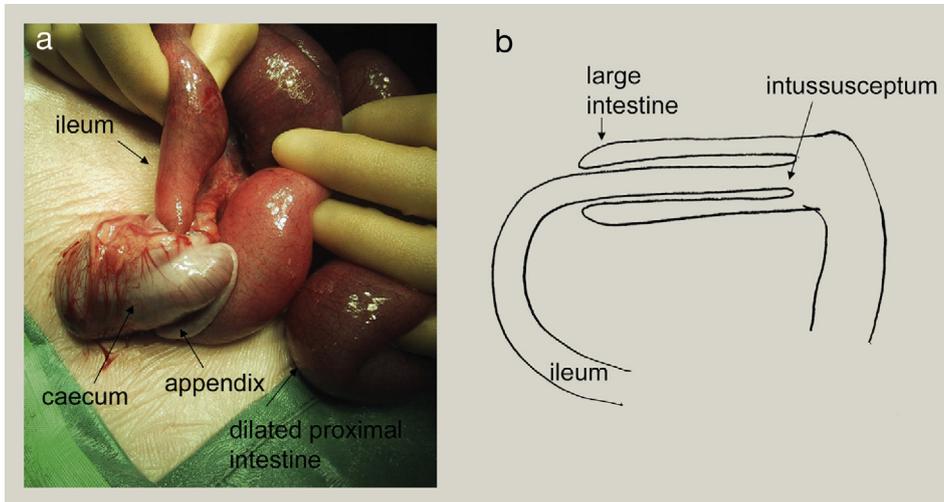


Figure 1 (a) Operative findings of intussusception where the ileum is telescoped into large bowel. In this case the caecum and appendix are visible following partial pneumatic reduction. (b) Cross-section through intussusception.

have perforated at the time of presentation. Abdominal signs can be subtle and true peritonism may be absent. Abdominal distension is a common finding and is usually associated with ileus secondary to perforated appendicitis. A similar situation may occur in the neurologically impaired.

Investigations

Ultrasound and/or CT are not indicated in children where the signs of appendicitis are clear. However, they may provide useful diagnostic information in equivocal cases and save unnecessary surgery. Ultrasound can be difficult in obese children and is

generally operator dependant. Although the sensitivity and specificity of ultrasound for appendicitis is lower than CT, exposure to radiation can be avoided, it is relatively easier to perform and it is useful for identifying any ovarian pathology in females. CT with dose reduction should be considered if CT is to be performed.

Serum tests may also be used as an adjunct to clinical findings. A raised C-reactive protein and leucocytosis are more likely to be correlated with ongoing appendicitis or bacterial infection. Urine dipstick may show leucocytes secondary to inflammation of the bladder.

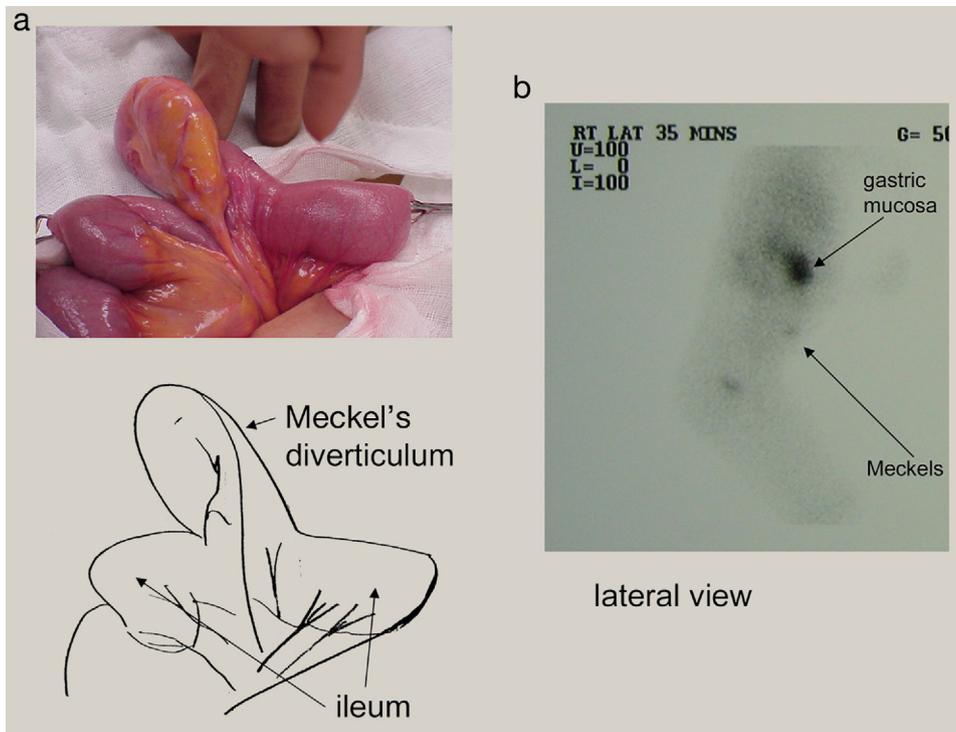


Figure 2 (a) Operative findings of Meckel's diverticulum and (b) positive ^{99m}Tc scan demonstrating Meckel's diverticulum.

Treatment

Careful assessment of dehydration or shock is essential and vigorous intravenous fluid resuscitation and intravenous antibiotics should be instituted when necessary. In addition, adequate intravenous opiate analgesia should be given.

Antibiotic prophylaxis is effective in the prevention of postoperative complications following appendicectomy whether administered pre-, peri- or postoperatively. Generally, less than 24 hours of antibiotics are administered for uncomplicated appendicitis; however, a single dose is effective if the appendix is normal or simply inflamed. The general consensus on the duration of treatment for complicated (perforated or gangrenous) appendicitis is 3–5 days of broad-spectrum intravenous antibiotic such as a third generation cephalosporin in addition to Gram negative cover. Antibiotic treatment and duration should be tailored to the individual patient depending on the child's clinical course. There is no clear evidence to suggest that peritoneal fluid culture at the time of appendicectomy is useful.

Conservative management

Acute appendicitis can be treated with antibiotics alone. However, up to 20% of patients are re-admitted in cases of acute simple appendicitis following treatment. A recent pilot randomized controlled trial in children suggested that only 5% of children treated conservatively had recurrence of appendicitis in the follow-up period, although a further 19% of children underwent appendicectomy for recurrent abdominal pain. In comparison, re-admission rates in children with acute complicated appendicitis treated with antibiotics alone is much higher (34%) with a rate of intra-abdominal abscess formation of 27%.

It is generally accepted that children with an 'appendix mass' should be treated with antibiotics in the first instance as surgery is likely to be technically challenging with much higher risk of complication. However, the term 'appendix mass' is often used loosely and can range from a simple inflammatory mass to a fully developed appendix abscess. The latter can be treated with ultrasound-guided drainage. Conservative management versus interval appendicectomy around 6–8 weeks following initial presentation remains controversial. Approximately 20% of children will re-attend with symptoms of appendicitis and require acute surgery.

Surgical treatment

A recent systematic review concluded that laparoscopic appendicectomy was 'likely to be beneficial' versus open appendicectomy when performed by an experienced laparoscopist. Laparoscopic appendicectomy is associated with reduced risk of wound infection, reduced postoperative pain, shorter hospital stay and quicker return to normal activities. An additional benefit of laparoscopy is intra-abdominal inspection which can be advantageous in peri-pubertal females. On the other hand, laparoscopy can be more time consuming and, at least in historic series of perforated appendicitis, is associated with a higher rate of intra-abdominal abscess postoperatively. There is a lack of strong evidence for this in children.

The key to postoperative care of children with gangrenous or perforated appendicitis is insertion of a PICC or long line to allow secure vascular access for reliable administration of antibiotics, analgesia and fluids. Too often, this essential step is omitted and

children have a miserable postoperative recovery with multiple cannulations and haphazard medication administration. Total parenteral nutrition may be required in cases of prolonged ileus and nasogastric tube for decompression should be used in these circumstances with replacement of nasogastric losses postoperatively.

A thorough washout of the abdomen should be performed including assessment of the bowel for interloop abscesses as children with acute perforated appendicitis are at high risk of intra-abdominal collection.

Alternative pathology such as ovarian pathology or Meckel's diverticulum should be sought in cases of negative appendicectomy. Endometriosis should be considered and looked for in the pelvis in post-menarchal females.

Non-specific abdominal pain

Approximately 60% of all children admitted to hospital with abdominal pain will be diagnosed as having non-specific abdominal pain (NSAP). This is a loose diagnostic category encompassing all those children in which no cause is diagnosed and who recover with no specific treatment. Anorexia is common although less so than with appendicitis; most other symptoms are less prominent. Local tenderness may be present although guarding and rebound are rare. In cases of diagnostic doubt a period of observation can be useful prior to embarking on surgery. Even with careful history taking and examination, and prudent use of appropriate investigations and periods of observation, normal appendices are often removed. Most surgeons regard a negative appendicectomy rate of 10–20% as acceptable. ◆

FURTHER READING

- Advanced Life Support Group. *Advanced paediatric life support*. 3rd edn. BMJ Books, 2001.
- Anderson BR, Kallehave FL, Andersen HK. Antibiotics versus placebo for prevention of postoperative infection after appendicectomy. *Cochrane Database Syst Rev* 2005; **3**. CD001439.
- Binkovitz LA, Unsdorfer KM, Thapa P, et al. Pediatric appendiceal ultrasound: accuracy, determinacy and clinical outcomes. *Pediatr Radiol* 2015 Dec; **45**: 1934–44.
- Callahan MJ, Anandalwar SP, MacDougall RD, et al. Paediatric CT dose reduction for suspected appendicitis: a practice quality improvement project using artificial Gaussian noise – part 2, clinical outcomes. *Am J Roentgenol* 2015 Mar; **204**: 636–44.
- Hall NJ, Jones CE, Eaton S, Stanton MP, Burge DM. Is interval appendicectomy justified after successful nonoperative treatment of an appendix mass in children? A systematic review. *J Pediatr Surg* 2011 Apr; **46**: 767–71.
- Holcolmb GW, Murphy JD, eds. *Ashcraft's pediatric surgery*. 6th edn. Elsevier, 2014.
- Jaschinski T, Mosch C, Eikermann M, Neugebauer EA. Laparoscopic versus open appendectomy in patients with suspected appendicitis: a systematic review of meta-analyses of randomised controlled trials. *BMC Gastroenterol* 2015 Apr 15; **15**: 48.
- MacMahon RA. *An aid to paediatric surgery*. Churchill Livingstone, 1991.
- Nazarey PP, Stylianos S, Velis E, et al. Treatment of suspected acute perforated appendicitis with antibiotics and interval appendectomy. *J Pediatr Surg* 2014 Mar; **49**: 447–50.

- O'Neill JA, Rowe MI, eds. *Pediatric surgery*. 5th edn. Mosby, 1998.
- Pastore V, Cocomazzi R, Basile A, Pastore M, Bartoli F. Limits and advantages of abdominal ultrasonography in children with acute appendicitis syndrome. *Afr J Paediatr Surg* 2014 Oct–Dec; **11**:293–6.
- Sauerland S, Jaschinski T, Neugebauer EA. Laparoscopic versus open surgery for suspected appendicitis. *Cochrane Database Syst Rev* 2010; **10**. CD001546.
- Simillis C, Symeonides P, Shorthouse AJ, Tekkis PP. A meta-analysis comparing conservative treatment versus acute appendectomy for complicated appendicitis (abscess or phlegmon). *Surgery* 2010; **147**: 818–29.
- Snelling CM, Poenaru D, Drover JW. Minimum postoperative antibiotic duration in advanced appendicitis in children: a review. *Pediatr Surg Int* 2004 Dec; **20**: 838–45.
- Svensson JF, Patkova B, Almström M, et al. Nonoperative treatment with antibiotics versus surgery for acute nonperforated appendicitis in children. A pilot randomized controlled trial. *Ann Surg* 2015; **261**: 67–71.