Imaging and intussusception

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Intussusception is one of the most common surgical emergencies in childhood although many patients will present initially to paediatricians. Imaging has a major role both in the diagnosis and management of this condition. Intussusception occurs when a segment of bowel invaginates into an immediately adjacent segment, often likened to a telescope. The proximal, inner (inverting) segment of bowel is called the intussusceptum, and the outer distal (receiving) segment the intussuscipiens. The intussusceptum is propagated distally by bowel peristalsis leading to compression and angulation of the mesenteric vessels which causes reduced perfusion, venous congestion and bowel wall oedema, leading to ischaemia and eventually bowel necrosis. The physical presence of an intussusception also causes bowel obstruction, with colicky abdominal pain, distension and vomiting. Intussusception can occur at any age but is most common in the first two years of life, with its peak incidence between the ages of 3–9 months. It is often seasonal, occurring with increased frequency during late spring and autumn in the UK, rather than summer or winter.1

Four types of intussusception are described; ileocolic, ileo-ileo-colic, colo-colic and small bowel intussusception (jejuno-jejunal and ileo-ileo). Ileo-colic intussusception is the most common type, accounting for over 80% of cases in children. In approximately 90% of these no underlying cause is found, although most probably arise as a result of hypertrophy of lymphoid tissue in Peyer’s patches or mesenteric lymph nodes following a recent infection acting as a “lead point” for intussusception to occur. A history of upper respiratory tract or gastrointestinal viral infection in the preceding week is often elicited. The terminal ileum is particularly rich in lymphoid tissue which explains why the ileocaecal region is so frequently involved. Even when there is evidence of lymphoid hyperplasia on imaging or at surgery, these types of intussusception are referred to as idiopathic.

Pathological lead points are uncommon in children, occurring in approximately 5–10% of cases.

Patients with recurrent intussusception and intussusceptions occurring in older children are much more likely to be associated with a pathological lead point (box 1). The most common pathological lead points in children are Meckel’s diverticulum, bowel duplication cysts and lymphoma. In contrast, a pathological lead point is found in approximately 80% of adults with intussusception and most cases involve the small bowel.2

**Box 1 Pathological lead points in intussusception**

- Meckel’s diverticulum
- Duplication or mesenteric cysts
- Polyps—for example, Peutz-Jeghers syndrome
- Intramural haematoma—for example, Henoch–Schönlein purpura
- Neoplastic masses—for example, lymphoma

**CLINICAL PRESENTATION AND DIAGNOSIS OF INTUSSUSCEPTION**

When a diagnosis of intussusception is made early it is much less likely to be associated with bowel ischaemia. There is also a greater chance that the condition can be managed without surgery, avoiding postoperative complications and a longer hospital stay. However, the clinical diagnosis of intussusception is not always easy to make. In many cases the clinical symptoms and signs are similar to gastroenteritis, which may even precede the development of intussusception. As with gastroenteritis, patients with intussusception may be dehydrated to a varying degree and frequently require fluid resuscitation. Typically patients with intussusception are previously well and present with intermittent colicky abdominal pain. This is often accompanied by screaming, pallor and drawing up of the legs towards the chest. A sausage shaped abdominal mass may be palpated, particularly in between attacks of pain when the child may behave normally. Vomiting is commonly associated and may become bilious. Blood in the stools is also a relatively frequent occurrence, although the characteristic “redcurrant jelly” stool which is a mixture of mucus and blood from sloughing of intestinal mucosa occurs relatively late in the history. The classic triad of colicky abdominal pain, a palpable abdominal mass and redcurrant jelly stools is present in less than half of children with intussusception and some may even be pain-free at presentation.3

**ABDOMINAL RADIOGRAPHS**

The role of the abdominal radiograph (AXR) in suspected intussusception is debatable. It is una-
sual to make the diagnosis from this modality alone because specific signs of intussusception are rarely seen. The target sign is a rounded soft tissue mass representing the intussusception, with concentric lucencies due to the presence of mesenteric fat within the mass (fig 1). The meniscus sign is a crescent of gas within the colonic lumen outlining the apex of the intussusception (fig 2). Non-specific signs of intussusception on AXR that may suggest or support the diagnosis include soft tissue density and absence of gas in the right lower quadrant (fig 5), the presence of a soft tissue mass in the upper abdomen obscuring the right liver edge (fig 4), and signs of small bowel obstruction (fig 5). Small bowel obstruction or ileus is also associated with other diagnoses such as appendicitis. Although free intraperitoneal gas can be detected on AXR, its absence cannot reliably exclude bowel perforation associated with intussusception. Perforations may be found at surgery despite negative radiographs and may be uncovered following surgical reduction of the intussusception.

**ULTRASOUND**

Ultrasound can reliably exclude or diagnose intussusception and may also be used to monitor its reduction, with the major advantage that it does not involve any ionising radiation. Intussusception

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**Figure 1** Target sign of an intussusception in the right upper quadrant (arrow).

**Figure 2** Meniscus sign of an intussusception in the proximal transverse colon (arrow).

**Figure 3** Absence of gas in the right iliac fossa and upper quadrant in a child with intussusception.

**Figure 4** Absence of gas and soft tissue density in the right upper quadrant, obscuring the inferior liver edge in a child with intussusception.
has a characteristic appearance on ultrasound which makes it easily recognisable and when properly performed by an experienced sonographer, the examination has an accuracy of 97–100% in children.45 Intussusception can be missed when there is established small bowel obstruction with marked gaseous distension that obscures the intussusception.

Sonographically, intussusceptions are usually quite superficial masses measuring 2.5–5 cm in diameter, and most are found in the right side of the abdomen. In transverse section concentric rings of tissue representing components of the bowel wall and mesenteric fat are seen, sometimes referred to as the doughnut or target sign (fig 6). In longitudinal section the mass is roughly ovoid in shape, with different tissues appearing layered longitudinally. This appearance is often likened to a sandwich (fig 7) or called the pseudokidney sign (fig 8). Enlarged lymphoid tissue or lymph nodes may be seen within the mass in transverse or longitudinal section (fig 9). Other sonographic features such as trapped fluid between the layers of bowel (fig 10) and reduced flow within the mass on colour Doppler studies have been associated with a higher failure rate of non-surgical reduction and increased likelihood of bowel necrosis respectively.45 A small amount of free intraperitoneal fluid is frequently seen in association with intussusception on ultrasound, and occasionally pathological lead points are identified using this modality.

**DIAGNOSTIC ENEMA**

Barium enema was the gold standard for diagnosis of intussusception until the mid-1980s when it was established that ultrasound could accurately diagnose the condition. Around the same time it was

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**Figure 5** Multiple dilated bowel loops consistent with small bowel obstruction in a child with intussusception.

**Figure 6** Target sign on transverse ultrasound of an intussusception. The concentric layers of the mass represent the different tissues in the bowel wall of the intussusceptum and the intussuscipiens. The curved, echogenic (bright) area is due to trapped mesenteric fat.

**Figure 7** Longitudinal ultrasound of an intussusception demonstrating different layers that appear “sandwiched”.

**Figure 8** Longitudinal ultrasound of an intussusception—the pseudokidney sign. Trapped mesenteric fat in the central echogenic area resembles fat in the renal sinus.
also recognised that air could be used both to diagnose and treat intussusception. By performing an enema, diagnosis and treatment of the intussusception can be done in one procedure. Clinical signs of dehydration or hypovolaemic shock, peritonitis and perforation are absolute contraindications to air or contrast enema, both diagnostic and therapeutic. The classic signs of intussusception on contrast enema are the *meniscus sign* where the apex of the intussusception projects into the contrast material (fig 11), and the *coiled
spring sign which is produced when small amounts of contrast material accumulate between the intussusceptum and intussuscipiens.

**COMPUTED TOMOGRAPHY AND MAGNETIC RESONANCE IMAGING**

Although computed tomography (CT) and magnetic resonance imaging are not used routinely to diagnose intussusception in children they both demonstrate characteristic features of the condition. These modalities are reserved for evaluation of selected patients in whom an atypical sonographic appearance suggests a pathological lead point such as lymphoma (fig 12A and B).

**MANAGEMENT OF INTUSSUSCEPTION**

Successful management of intussusception depends on early recognition and diagnosis, adequate fluid resuscitation and prompt reduction. Typically patients are managed by surgeons and radiologists, and non-operative (image-guided) reduction is attempted in the majority of patients in the first instance. However, the decision to manage a patient non-operatively or operatively will depend on how sick they are at presentation and how they respond to resuscitation. It is imperative that patients are fully fluid resuscitated before attempting any form of image-guided reduction. Failure to ensure this requirement is unsafe and markedly increases risks associated with the procedure and the ability of the patient to withstand complications (such as perforation) that may ensue. Patients with suspected or confirmed intussusception should be assessed by an experienced surgeon, to decide what form of management is appropriate. Those who do not respond to fluid resuscitation, have signs of peritonitis or radiographic evidence of air in the peritoneal cavity are managed operatively, as the likelihood of necrotic bowel requiring resection is very high. The patient may need to be transferred to a tertiary centre for further management if appropriate radiological or surgical expertise is not available locally. In general, the longer the duration of symptoms (particularly if >24 h) the lower the likelihood of successful non-operative reduction. Decreased reduction rates are also reported when the intussusception is situated in the rectum, in children with small bowel obstruction and those under 3 months of age.7

Non-surgical reduction of intussusception has a long history, with enema treatment for ileus described for centuries. Hippocrates (born circa 490 BC) recommended inflation of the bowel via bellows applied to the anus if hydrostatic reduction using oil had failed. Hirschprung first described hydrostatic reduction of intussusception in 1876 and the first fluoroscopically controlled barium enema reductions were described by Scandinavian radiologists in the 1920s. The first report of pneumatic reduction of intussusception came from Argentina in 1959.8

Non-operative reduction techniques using enemas may be hydrostatic (using barium, water soluble contrast, saline or Hartmann’s solution) or pneumatic (using either air, or medical gases such as carbon dioxide), both of which can be performed under fluoroscopic or ultrasound guidance. There are numerous papers in the medical literature describing series of patients managed with the varying techniques, and their success rates. Many of these studies are not comparable due to different patient populations and non-standardisation of techniques.

There has been a trend among paediatric radiologists towards increased use of pneumatic reduction over fluoroscopically-guided hydrostatic reduction.9 The advantages of pneumatic over hydrostatic reduction include more accurate control of pressure (via a pressure monitoring device or valve), the technique is less messy and there is less contamination of the patient.

**Figure 13** (A) Image taken during pneumatic reduction of an ileocolic intussusception. The intussusception is in the hepatic flexure (arrow). The procedure was done with the patient prone but the image has been flipped horizontally for ease of interpretation. (B) Same patient as figure 13A. Following reduction, the intussusception is no longer visible and air has entered the small bowel.
Intussusception occurs when one segment of bowel (the intussusceptum) invaginates into an immediately adjacent segment (the intussuscipiens). The most common type of childhood intussusception is ileocolic, 90% of which are idiopathic. Intussusception may be diagnosed using abdominal radiograph, ultrasound, air or contrast enema. Radiographs are unreliable for diagnosing intussusception because characteristic signs are rarely seen. The diagnostic imaging method of choice for intussusception in children is ultrasound because it is accurate and lacks ionising radiation. Adequate fluid resuscitation of patients is required before attempting non-operative reduction of an intussusception. Dehydration or hypovolaemic shock, peritonitis and perforation are absolute contraindications to non-operative reduction.

WHAT HAPPENS IF IMAGE-GUIDED REDUCTION FAILS?
It is generally standard practice to proceed directly to surgery following unsuccessful image-guided reduction of intussusception, however delayed repeat reduction attempts may be considered if the intussusception has moved during the initial procedure and the patient remains clinically stable. The length of time that the repeat procedure is delayed is decided by the managing surgeon and radiologist. It is believed that partial reduction and the time between attempts allows bowel wall oedema and venous congestion to decrease, making it easier to reduce the residual intussusception on delayed attempt.

RECURRENT INTUSSUSCEPTION
Reported rates for recurrence of intussusception following non-operative reduction are in the order of 10%. Recurrence is not a contra-indication to further attempts at image-guided reduction, but the presence of a pathological lead point should always be considered. In some cases pathological lead points are identified at the initial diagnostic ultrasound scan. The presence of a pathological lead point does not preclude non-operative management although most will eventually require surgery.

Intussusception is one of the most common surgical emergencies in childhood. Most intussusceptions in children are idiopathic and involve the ileocolic region. Reducing diagnostic delay facilitates a higher non-operative reduction rate and fewer complications. Overall, patients with intussusception are optimally managed in centres where greater numbers of cases are seen, and there is paediatric surgical, anaesthetic and radiology support. Not only patients should be fully resuscitated with venous access in situ, and a person trained in paediatric resuscitation should be in attendance with paediatric anaesthetic equipment available. The surgical team (and anaesthetist) should also be aware that the procedure is taking place if they are not present. A maximum pressure of 120 mm Hg is recommended with initial attempt at pressure of 60–80 mm Hg. It is recommended that a maximum of three attempts at reduction are performed, each sustained attempt lasting up to 3 min. A target of at least 65–70% success using image-guided reduction is recommended for hospitals performing the procedure.

A newer technique involves hydrostatic reduction of intussusception using saline enema and ultrasound guidance. The obvious advantage of this technique is a complete lack of radiation exposure, and more detailed visualisation of the intussusception itself. Reduction is confirmed by disappearance of the mass, with passage of fluid and air bubbles into the terminal ileum. Published series report high success rates and a very low incidence of complications. Ultrasound guided pneumatic reduction has also been reported with similarly high success rates. As yet, neither technique has been widely adopted in the UK.

Surveys of intussusception diagnosis and management by UK radiologists published in 1995 and 1999 showed that there was a wide variation in techniques used and that procedures were not standardised. Since then no further surveys of UK practice have been published, but the British Society of Paediatric Radiologists (BSPR) published draft guidelines for suggested safe practice on their website in 2003. The guidelines recommend pneumatic reduction as the optimal technique and certain standards to optimise safety during image guided reduction. Before the procedure.
does this increase the likelihood of a successful image-guided reduction, but is a safer situation for patients requiring surgery or those in whom the condition is complicated by an adverse event.

**Competing interests:** None.

**REFERENCES**


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