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Adult Intussusception

Saulius Paskauskas and Dainius Pavalkis
Lithuanian University of Health Sciences
Kaunas
Lithuania

1. Introduction

Intussusception is defined as the invagination of one segment of the gastrointestinal tract and its mesentery (intussusceptum) into the lumen of an adjacent distal segment of the gastrointestinal tract (intussusciens). Sliding within the bowel is propelled by intestinal peristalsis and may lead to intestinal obstruction and ischemia.

Adult intussusception is a rare condition which can occur in any site of gastrointestinal tract from stomach to rectum. It represents only about 5% of all intussusceptions (Agha, 1986) and causes 1-5% of all cases of intestinal obstructions (Begos et al., 1997; Eisen et al., 1999). Intussusception accounts for 0.003–0.02% of all hospital admissions (Weilbaecher et al., 1971). The mean age for intussusception in adults is 50 years, and the male-to-female ratio is 1:1.3 (Rathore et al., 2006). The child to adult ratio is more than 20:1. The condition is found in less than 1 in 1300 abdominal operations and 1 in 100 patients operated for intestinal obstruction. Intussusception in adults occurs less frequently in the colon than in the small bowel (Zubaidi et al., 2006; Wang et al., 2007).

Mortality for adult intussusceptions increases from 8.7% for the benign lesions to 52.4% for the malignant variety (Azar & Berger, 1997)

2. Etiology of adult intussusception

Unlike children where most cases are idiopathic, intussusception in adults has an identifiable etiology in 80- 90% of cases. The etiology of intussusception of the stomach, small bowel and the colon is quite different (Table 1).

50-75% of adult small bowel intussusception are due to benign pathology. The most common lesions are adhesions and Meckel's diverticulum. Other lesions include lymphoid hyperplasia, lipomas, leiomyomas, hemangiomas and idiopathic causes are more likely to occur in the small intestine than in the colon. Other conditions that predispose to small bowel intussusception include anorexia nervosa and malabsorption. The increased flaccidity of the bowel wall facilitates invagination. Unregulated anticoagulant therapy may cause submucosal hemorrhages that can lead to intussusception (Wang et al., 2007). Malignant causes of small bowel intussusception include primary leiomyosarcomas, malignant gastrointestinal stromal tumors, carcinoid tumors, neuroendocrine tumors and lymphomas. Less commonly, malignant tumors may act as lead points with metastatic disease being the most common, especially melanomas.

60-75% of large bowel intussusception are caused by malignant neoplasm. The most common malignant cause is primary adenocarcinoma and the most common nonmalignant cause is lipoma (Barussaud et al., 2006). Independent predictors of malignancy include: patients age, site of intussusception (more often colonic than enteric) and presence of anemia (hemoglobin <12g/dl) (Goh et al., 2006).

Benign or malignant neoplasms cause two thirds of these cases with a lead point; the remaining cases are caused by infections, postoperative adhesions, Crohn's granulomas, intestinal ulcers (Yersinia), and congenital abnormalities such as Meckel's diverticulum (Barussaud et al., 2006).

Lesion	Stomach	Small Bowel	Large Bowel
Benign	Adenoma Leiomyoma Lipoma Hamartoma Inflammatory polyps	Lipoma Leiomyoma Haemangioma Neurofibroma Adenomatous polyp Meckel diverticulum Intestinal duplication Inflammatory lesions Trauma GIST Postoperative adhesions Lymphoid hyperplasia Adenitis Coeliac disease Henoch-Schonlein purpura Roux-en-Y anastomoses Peutz-Jeghers syndrome Tuberculosis Tropical sprue Giardiasis	Lipoma Adenomatous polyp Postoperative adhesion Leiomyoma GIST Endometriosis (appendiceal) Previous anastomosis Crohn's disease Mucocele of appendix
Malignant	Primary: Adenocarcinoma Leiomyosarcoma	Primary: Lymphoma Malignant duodenal ulcers Malignant GIST Secondary: Metastatic melanoma Adenocarcinoma metastasis (lung or breast) Osteosarcoma Lymphoma	Primary: Adenocarcinoma Leiomyosarcoma Malignant GIST Secondary: Metastatic melanoma Lymphoma
Idiopathic		Motility disorder	Motility disorder

Table 1. Lesions associated with adult intussusception. GIST - gastrointestinal stromal tumor

Non neoplastic processes constitute 15–25% of cases, while idiopathic or primary intussusceptions account for only about 10%. Idiopathic causes of adult intussusception are more likely to occur in the small intestine than in the colon (Wang et al., 2007).

Some etiological differences were observed in primary adult intussusception between Western developed world and central, western Africa. This geographic variation in pathology has been attributed to the fiber content of the diet (which affects fecal load), dietary habits (large amount of beans and rice after several days without eating producing excess colonic peristalsis), and chemicals in the gut from parasites (ascaris toxins are smooth muscle stimulants) or food, and genetics (mobile right colon with a long mesentery) (VanderKolk et al., 1996).

3. Pathophysiology of intussusception

The most common locations in the gastrointestinal tract where an intussusception can take place are the junctions between freely moving segments and retroperitoneally or adhesionally fixed segments. Stimulation of the gastrointestinal tract by a food bolus produces an area of constriction above the bolus and relaxation below. Any intraluminal lesion in the gastrointestinal tract or irritant within the lumen, which alters the normal peristaltic pattern, is able to initiate intussusception. The duodenum, stomach, and esophagus are rarely involved in intussusception because they are less redundant and less mobile within the abdomen (Cera, 2008). A historical cause of both antegrade and retrograde small bowel intussusception in adults is the use of long cantor tubes (Shub et al., 1978). Antegrade intussusception in this situation occurs as telescoping of the bowel over the tube especially when it is fixed in place with tape at the nose. Retrograde intussusception occurs during or after the tube is removed, especially if removed quickly and with force (Cera, 2008).

3.1 Antegrade intussusception

Antegrade intussusception occurs when any mucosal, intramural or extrinsic lead point acts as a focal area of traction in the proximal segment of the gastrointestinal tract and is pulled forward by progressive smooth muscle contractions into the distal segment (Cera, 2008). The result of this process is invagination of the involved wall and telescoping of one gastrointestinal tract segment over the adjacent segment with its mesenteric fold as result of overzealous or impaired peristalsis, further obstructing the free passage of intestinal contents and, more severely, compromising the mesenteric vascular flow of the intussuscepted segment (Figure 1). This occurrence may be transient, and therefore asymptomatic if reduction occurs spontaneously. However, more commonly, the intussusception persists because of the continued peristaltic contractions, which can lead to gastrointestinal tract obstruction accounting for the majority of the presenting symptoms. If left untreated, the mesentery involved in the intussusception may become stretched and compressed leading to vascular insufficiency, strangulation, and necrosis of the associated bowel. These events, in turn, may lead to perforation, peritonitis, and death.

In the non neoplastic cases, when lead point is absent, intussusception may be caused by functional disturbances without bowel wall abnormality, such as in coeliac disease. In these cases the loss of normal tone in the small bowel owing to the toxic effect of gluten causes flaccid, dilated bowel loops that are more prone to non obstructing intussusception.

Individuals with pelvic floor abnormalities such as nonrelaxing puborectalis and rectocele may develop rectoanal intussusception in the setting of chronic straining (Weiss & McLemore, 2008).

The origin of intussusception after gastric bypass is different from that of intussusception provoked by other causes. It is likely to be related to motility disorders in the divided small bowel, especially in the Roux limb. This rare condition may cause obstruction and lead to bowel necrosis if not recognized and treated promptly (Daellenbach & Suter, 2011).

Rectoanal intussusception is the functional disorder telescoping of the rectal wall during defecation.

Two predominant hypotheses exist regarding the etiology of rectoanal intussusception:

1. Rectoanal intussusception as a primary disorder. Some theorize that rectoanal intussusception may be the initial stage of a dynamic continuum of anomalies initiated by repetitive traumatic injury from intussusception, which may lead to solitary rectal ulcer and eventual full thickness rectal prolapse (Hwang et. al., 2006).
2. Rectoanal intussusception as a secondary phenomenon. Individuals with pelvic floor abnormalities such as nonrelaxing puborectalis and rectocele may develop rectoanal intussusception in the setting of chronic straining. Rectoanal intussusception may also develop in patients with paradoxical contraction and other spastic anal sphincter disorders (Weiss & McLemore, 2008).

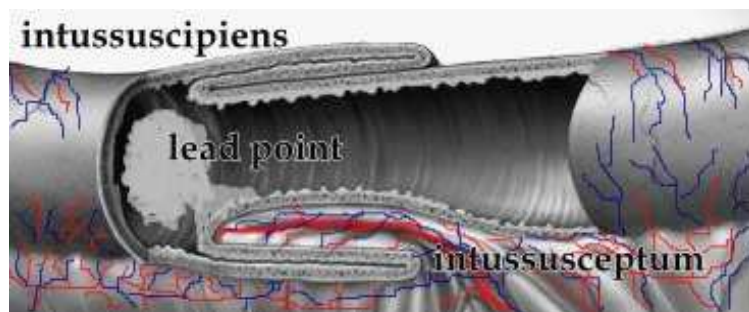


Fig. 1. Intussusception of the bowel with the lead point in the lumen.

3.1 Retrograde intussusception

Retrograde intussusception is especially rare. Altered peristalsis in focal areas of the bowel wall can lead to dysrhythmic contractions and can cause retrograde intussusception. In addition, altered peristalsis may occur as a result of functional deficits such as neuronal intestinal dysplasia where bowel dysmotility is caused by aberrant neuronal development. The exact mechanism precipitating of an antegrade and retrograde intussusception is still unknown.

4. Classification of intussusception

There are no accepted classification of adult intussusception. We recommend to classify the intussusception according to:

1. The anatomical location of the intussusception (gastric, small bowel or colon):
 - gastroenteric,
 - enteroenteric,
 - appendiceal,
 - appendiceal-ileocolic,
 - ileocolic,
 - colocolic,
 - rectoanal,
 - stomal.
2. Cause:
 - 2.1 neoplastic
 - benign,
 - malignant;
 - 2.2 nonneoplastic
 - 2.3 idiopathic
3. Lead point:
 - intussusception with lead point;
 - intussusception without lead point,
4. Direction:
 - antegrade,
 - retrograde.
5. Clinical course:
 - acute
 - chronic,
 - persistent,
 - recurrent
 - transient.
6. Bowel obstruction:
 - with lumen obstruction,
 - without lumen obstruction.
7. Vascular insufficiency:
 - with disturbance of the blood stream,
 - without disturbance of the blood stream.

5. Clinical presentation of adult intussusception

Adult intussusceptions pose a further challenge as they are often presented with nonspecific symptoms and run a chronic indolent course. The spectrum of clinical presentation depends on the site of the intussusception, the timing of clinical presentation, and the predilection for spontaneous reduction.

The clinical presentation of adult intussusception may be presented with a variety of acute (duration less 4 days), subacute (duration 4-14days), and chronic (duration more than 14 days) or intermittent symptoms. Most patients manifest subacute (about 24%) or chronic (about 50-73%) symptoms (Barussaud et al., 2006). Duration of symptoms is longer in benign lesions as compared with malignant lesions and is longer in enteric lesions as compared with colonic lesions. The classic pediatric presentation triad of abdominal pain, palpable abdominal mass and bloody discharge from the rectum are seen only in 10% of

cases. In adults, intussusception typically manifests as an acute or chronic obstruction and the presentation of adult intussusception is similar to that of small and large bowel obstruction.

Unlike intussusception in children, an acute abdomen is very occasionally present in adults. The most common symptom in the acute presentation is abdominal pain (71-100%), associated or not with an intestinal obstructive syndrome, which occurs in 78 to 100% of patients (Erkan et al., 2005; Barussaud et al., 2006; Paskauskas et al., 2010). Intermittent abdominal pain and vomiting (40-60% of the cases) and/or nausea are the major symptoms of subacute or chronic adult intussusception. Bleeding per rectum occurs in 8-27% of the cases (Table 2). This wide range is usually based on the site of the intussusception, with colonic ones bleeding more frequently than the ileal varieties. Other findings as fever, constipation or diarrhoea, tenesmus are rare in presentation of patients with intussusception.

Clinical symptoms of obstructive defecation are typical for rectoanal intussusception. One of the most common frustrations in patients with symptomatic rectoanal intussusception is the sensation of incomplete evacuation. These individuals will also frequently describe a sensation of obstruction and pressure toward the sacrum, which may increase with straining. Fecal incontinence is also a common symptom associated with rectoanal intussusception (Weiss & McLemore, 2008).

5.1 Physical and laboratorial findings of intussusception

Adult intussusception has no specific physical findings. Common physical findings include abdominal distention, hypoactive or absent bowel sounds, occult blood test. Palpable abdominal mass or mass protruding through the anus are rare (Ahn et al., 2009; Paskauskas et al., 2010). In those with colonic lesions, up to one half can demonstrate a mass compared with 14% of those with enteric lesions. If the presentation is late in the course of the condition, signs of bowel ischemia such as pain out of proportion to examination or generalized peritonitis may result with corresponding signs of shock such as hypotension and tachycardia.

By digital examination the rectocele, anismus can be helpful to suspicion of the rectoanal intussusception (Weiss & McLemore, 2008). The longer the intussusception, the more closely the clinical examination correlated with defecography (Karlhom et al., 2004). Blood examination gives up to 40% evaluated leukocyte level (Table 2), with left shift on differential until 38% (Ahn et al., 2009). Anaemia is strong by associated with carcinoma as lead point of intussusception (Goh et al., 2006).

6. Diagnostic tools for adult intussusception

Preoperative diagnosis is a challenge because of rarity of adult intussusception, longstanding, intermittent, nonspecific symptoms and physical findings, and signs on imaging. Despite of the evaluation of the radiological procedures, intussusception is diagnosed preoperatively from 14 to 75% of the cases. The most important factors in arriving at the correct diagnosis are an awareness of the possibility of this condition existing in any patient with symptoms, suggesting prior episodes of partial intestinal obstruction, and the vigorous approach towards complete radiographic examination in such patients (Cotlar & Cohn, 1961).

Clinical presentation	
Abdominal pain	71-100 %
Nausea	35-59 %
Vomiting	31-59 %
Loss of weight	4-33 %
Episodes of diarrhoea	9-28%
Hematochezia, rectal bleeding	8-27%
Constipation	13-26%
Fever	4-25%
Tenesmus	3 %
Physical findings	
Abdominal distension	23-54%
Palpable abdominal mass	8-33%
Mass protruding through the anus	2-8 %
Laboratorial blood tests	
Anaemia (hemoglobin <12 g/dl)	43%
Leukocytosis	40%

Table 2. Common clinical, physical and laboratorial findings of adult patients with intussusception.

Non-invasive radiologic imaging techniques can be of significant help in identifying an intussusception, but most cases are diagnosed at emergency operation, after abdomen exploration and excision of the intussuscepted segment of the gastrointestinal tract.

6.1 Plain abdominal film

Plain abdominal films are typically the first diagnostic tool in acute abdomen and usually demonstrate signs of acute intestinal obstruction (air-fluid levels) and may provide information regarding to the site of obstruction (Eisen et al., 1999). Sensitivity of this diagnostic tool regarding to intussusception is only about 25% (Yakan et al., 2009).

6.2 Barium enema

Barium enema examination is cheap, quite easy to carry out, and seems to be useful method with an accuracy rates from 20 to 45% for the diagnosis of intussusceptions, but remains limited to the ileocolic or colonic lesions (Barussaud et al., 2006; Goh et al., 2006). Barium enema with barium reflux in the lumen of the space between the intussusceptum and intussusciens can help to identify the site and cause (Figure 2) of the intussusception, particularly in more chronic cases. Signs of intussusception include a spiral, "coil spring" or "stacked coin" appearance with narrowed central canal (Eisen et al., 1999). These signs result from the retrograde filling of the contrast between the walls of the invaginated bowel loop. The narrowed central canal is the edematous, obstructing intussusceptum (Goh et al., 2006).

Contrast studies are obviously contraindicated if there is a possibility of bowel perforation or ischemia.

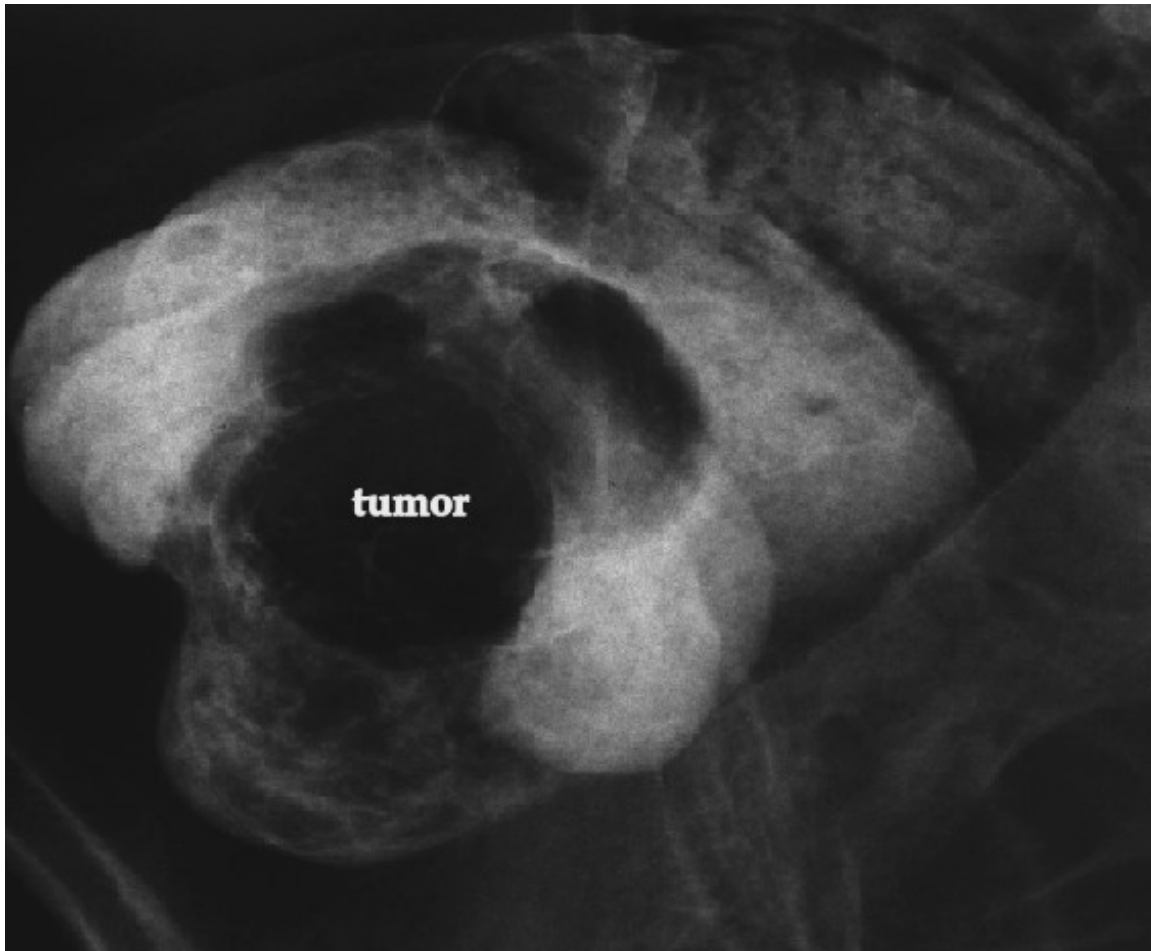


Fig. 2. Colonic intussusception with tumor as lead point in the bowel lumen (figure from Paskauskas et al., 2010).

6.3 Ultrasonography

Ultrasonography is considered to be a useful tool for the diagnosis of suspected intussusception (Figures 3, 4), when the characteristic a „target and doughnut sign“ (an even thickened hypoechoic outer and a central hyperechoic core on transverse view), a „crescent-in-doughnut sign“ (an even outer hypoechoic rim with a central hyperechoic crescent) or a „multiple concentric rings sign“ (a mass with multiple alternating hypoechoic and hyperechoic concentric rings (Figures 5, 6)), and other views are shown (Figures 3, 4). It is quick and cost-effective and shows, when done by an experienced physician, similar sensitivity and specificity like a CT scan (Martin-Lorenzo et al., 2004). Ultrasonography is a more available and generalized technique than CT, enabling it to be used more often with emergency and acute symptoms and thus being available at times of abdominal crisis in intermittent processes. Sonography allows a study on all planes and in real time, which is important as intussusception is often a dynamic phenomenon. The most characteristic, in fact most specific, sonographic aspect of intestinal invagination is obtained on a cross-section and depends on the area of the invagination in which it is performed, its length and the existence or not of a lesion that acts as a head (Martin-Lorenzo et al., 2004). If color flow Doppler is used, the presence of bowel necrosis may be demonstrated by showing compromised blood flow to the intussusceptum. The major disadvantage of ultrasound is masking by gas-filled loops of bowel, and operator dependency.

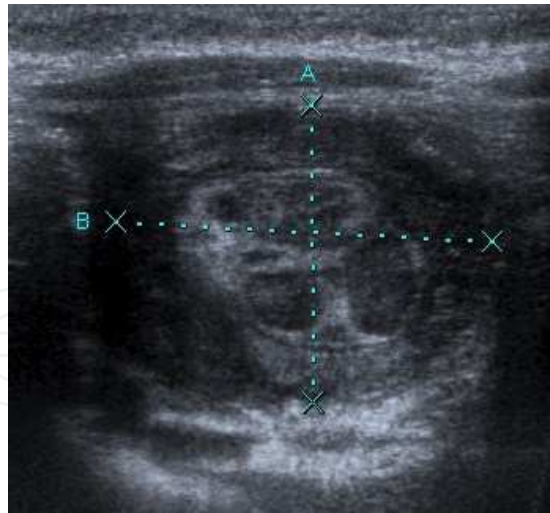


Fig. 3.

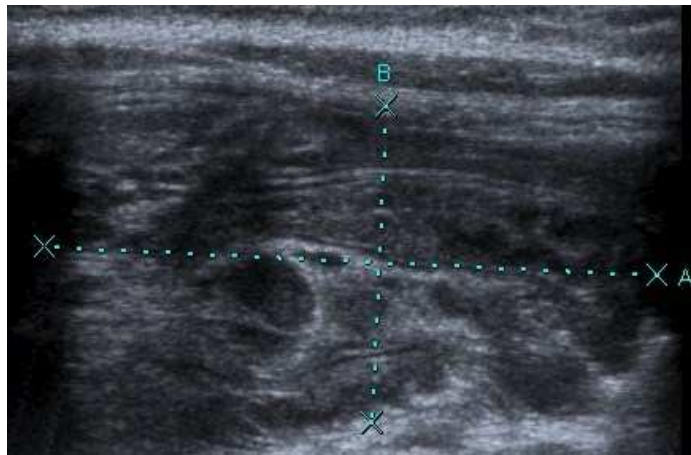


Fig. 4.



Fig. 5.



Fig. 6.

Fig. 3 - Fig. 6. Ultrasonography views of an intussusception (figures are provided from Radiology department of Lithuanian University of Health Sciences).

Figures 3 and 5 show a transverse view of the intussuscepted bowel. Figure 4 and 6 represent longitudinal view of the intussuscepted bowel. In figures 3 and 4 the lines A and B mark the intussuscepted bowel lumen. In figure 5 alternating hyperechoic and hypoechoic concentric rings are present within the lumen of a distended loop of bowel, giving the typical "target" sign. In figure 6 multiple layers of bowel wall are shown within the lumen of the intussusciens.

6.4 Computed tomography

In recent years, CT has become the first imaging method performed, after plain abdominal films, in the evaluation of patients with non-specific abdominal complaints. Intussusception is well diagnosed on multi-slice spiral computed tomography with a diagnostic accuracy near 100%. Abdominal CT is the most useful diagnostic tool not only for detecting an intussusception, but also helps in identifying the underlying cause (Huang & Warshauer, 2003). CT demonstrates the collapsed intussusceptum lying within the opacified lumen of the distal intussusciens (Figures 7, 8). The CT appearance of an intussusception is often a complex target-shaped or sausage-shaped in-homogeneous soft tissue mass with an eccentric area of fat density contained within, which represents the mesenteric fat (Yakan et al., 2009). Later, a layering effect occurs as a result of longitudinal compression and venous congestion in the intussusceptum (Bar-Ziv & Solomon, 1991). Multislice CT facilitates the assessment of vascular supply to the affected bowel loop in cases of intussusception where impending ischemia is suspected (Gayer et al., 2002). Especially in cases in which a malignancy is suspected, CT can be useful for diagnosing the surrounding area (Martin-Lorenzo et al., 2004). In comparison to ultrasonography CT has the limitations of less accessibility and a static and initially only single-plane exploration, apart from involving a dose of radiation and generally requiring the administration of oral and intravenous contrast material, which delays the study and may entail adverse effects.

Abdominal CT scanning is the preferred noninvasive radiologic modality for diagnosing intussusception from colonic lipomas (Taylor & Wolff, 1987). The CT characteristics of lipoma include a spherical or ovoid shape; smooth, sharply demarcated margins with a thin fibrous septa and homogeneous fatty density with CT values between -40 and -120 Hounsfield units (Chiang et Lin, 2008). If prominent fibrous septa and nodularity are evident, the most imperative differential diagnosis is a well-differentiated liposarcoma, despite the few reports of gastrointestinal liposarcomas in the literature (Pereira et al., 2005).



Fig. 7. Coronary view of small bowel intussusception (marked with arrows) and tumor of the left kidney. (Figure is provided from Radiology department of Lithuanian University of Health Sciences).



Fig. 8. Axial view of small bowel intussusception (marked with arrows). (Figure is provided from Radiology department of Lithuanian University of Health Sciences).

6.5 Magnetic resonance imaging

The general imaging characteristics of adult intussusception on MRI are similar to those on CT. Unlike CT, MR examination, is not technically limited by the presence of previously administered barium (Tamburrini et al., 2004).

6.6 Capsule endoscopy

Intussusception during capsule endoscopy is an accidental finding (Culliford et al., 2005).

6.7 Colonoscopy

Colonoscopy is also a useful tool for evaluating intussusception, especially when the presenting symptoms indicate a large bowel obstruction, but have limitations in small bowel examination. Colonoscopy plays a role in the evaluation of large bowel obstruction caused by intussusception by defining benign from malignant causes. It can be used as part of the preoperative assessment or, if the intussusception is found intraoperatively as it most commonly occurs, can be performed intraoperatively to facilitate appropriate surgical management (Cera, 2008). It may not be advisable to perform endoscopic biopsy or polypectomy in those individuals with long-term symptoms because of the high risk of perforation, which is more likely to happen in the phase of chronic tissue ischemia, and perhaps necrosis because of vascular compromise in intussusception (Erkan et al., 2005).

6.8 Defecography

Defecography is the gold standard for the diagnosis of the rectoanal intussusception. Dynamic pelvic magnetic resonance imaging and transperineal ultrasound are attractive alternatives to defecography; however, their sensitivity is poor in comparison to the gold standard at this time.

6.9 Laparoscopy

Laparoscopy, although not an imaging study, is obviously an excellent evaluation tool when intussusception is suspected in a patient with bowel obstruction. It allows for identification of the location, the nature of the lead point, and the presence of compromised bowel. It aids in the choice of an appropriate location for the incision that would minimize length (Barussaud et al., 2006).

Laparoscopic operation may be applicable as a less-invasive method, but not in acute bowel obstruction.

The sensitivities of the different radiological methods are abdominal ultrasounds (35%), upper gastrointestinal barium study (33%), abdominal computed tomography (58-100%), barium enema (73%), and colonoscopy (66%) (Huang et al., 2003; Erkan et al., 2005; Barussaud et al., 2006; Yakan et al., 2009).

7. Differential diagnosis

Because the symptoms are similar to other causes of intestinal obstruction and acute abdomen an intussusception in adults must be suspected in the differential diagnosis of these conditions.

8. Treatment

Many therapeutic interventions have been tried for the treatment of adult intussusception, which vary from conservative treatment to various surgical procedures. Treatment is almost always surgical in adults when compared to children and invariably leads to resection of the involved bowel segment with subsequent primary anastomosis. The choice of using a laparoscopic or open approach depends on the clinical condition of the patient, the location and extent of intussusception, the possibility of underlying disease, and the availability of surgeons with sufficient laparoscopic expertise. Emergency operations are necessary in about 35–60% of all adult patients with intussusception. For all patients who present with signs of perforation, shock, or peritonitis, immediate laparotomy is necessary. In the absence of these signs, the majority of adult patients are brought to the operating room with the preoperative diagnosis of bowel obstruction and an intussusception seen at the time of exploration. Unlike children, preoperative reduction with barium or air should not be recommended in adults as a definitive treatment (Huang et al., 2003). Overall, the type of surgical intervention depend on the cause of intussusception (benign or malignant), patients age, functional status, medical history and intraoperative findings (a gangrenous bowel or a perforation with peritonitis; location and length of intussuscepted segment) (Paskauskas et al., 2010). The main problem is to distinguish the benign and the malignant lesions preoperatively (Nagorney et al., 1981; Chiang & Lin, 2008). Patients with malignant disease may undergo major surgery, including resection of the involved segment and regional lymph nodes, while patients with benign lesions may undergo simple resection (Figure 9). In most cases, the histological diagnosis is arrived at only after the excision of the tumor. Intraoperative histopathology is important examination for selected doubtful cases of adult intussusception, which can also assist in guiding the exact diagnosis and optimize surgical treatment planning (Jiang et al., 2007; Paskauskas et al., 2010).

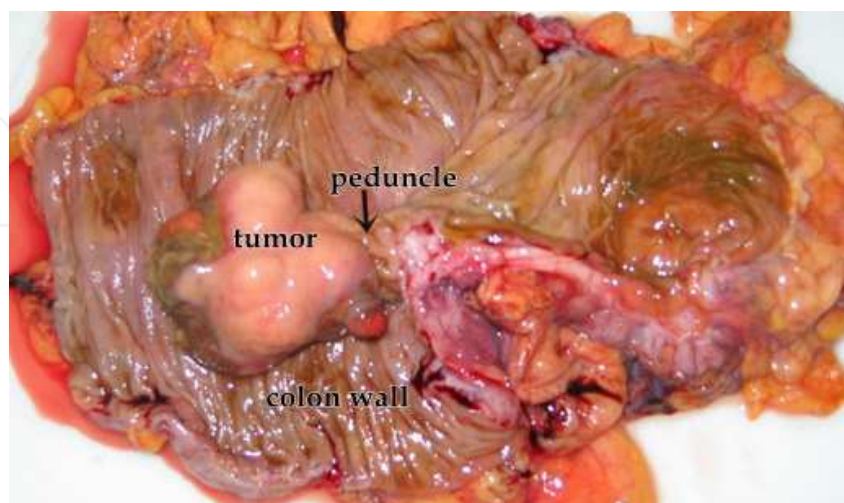


Fig. 9. Pedunculated colonic lipoma in lumen of resected specimen.

Recently, minimally invasive techniques such as endoscopic procedure, laparoscopic small and large bowel resections, have been applied to the treatment of small or large bowel obstruction and intussusception. The minilaparotomy approaches have many advantages over conventional laparotomy.

In specific situations, of both the large and small intestine intussusceptions of benign etiology an adhesolysis, appendectomy, enterotomy, polypectomy, or diverticulectomy is the sufficient treatment after reduction providing the bowel is viable (Erkan et al., 2005; Wang et al., 2007), but a polypectomy through a limited colotomy or enterotomy is done through an oedematous bowel, with an increased theoretic risk of leak (Barussaud et al., 2006).

Gastroduodenal and coloanal intussusceptions are extremely rare and may require innovative surgical techniques (Yalarnathi et al., 2005).

The optimal management of adult intussusception still remains controversial, but in any case it should be cut out.

8.1 Conservative treatment

In selected patients, when intermittent intussusception is associated with celiac disease, Crohn's disease and malabsorption syndrome as a result of abnormal intestinal contractions, these transient ones can be managed conservatively in the absence of any severe abdominal symptoms (Catalano, 1997).

8.2 Surgical treatment of large bowel intussusception

In adults, large bowel intussusception almost always requires surgical therapy (laparoscopy or laparotomy).

Two-thirds of colonic intussusceptions are resulted from malignant processes, therefore not diagnosed benign lesions before operation must be interpreted as cancer and should be treated by surgical oncological principles (Azar & Berger, 1997; Wang et al., 2007; Chiang & Lin, 2008). In most cases of adult colonic intussusception, primary resection without reduction should be performed due to the theoretical risks of perforation and the seeding of colonic microorganisms or tumor to the peritoneal cavity and venous embolization in regions of ulcerated bowel mucosa, after exposing and handling the ischemic, friable, and edematous bowel tissue (Nagorney et al., 1981).

An oncologic en bloc resection, after evaluation of the abdomen in search of distant metastases, is the surgical treatment of choice in cases of large bowel intussusception (Figure 10), if the intraoperative condition of the patient is stable (Erkan et al., 2005; Franz et al., 2010), particularly in those over 60 years of age due to a higher risk of malignancy.

En bloc resection eliminates the possibility of recurrence, is beneficial in patients at risk for short gut, and avoids enterotomy or anastomosis in edematous or compromised bowel. The reductions of intussusception also increase the risk of anastomotic complications (the bowel wall may be weakened during manipulation) and the potential for bowel perforation. For this reason, some authors advocate en bloc resections of all intussusception in adults regardless of location (enteric or colonic) or cause (benign or malignant).

Management strategies of rectoanal intussusception including conservative measures such as biofeedback and surgical procedures including mucosal proctectomy (Delorme), rectopexy, and stapled transanal rectal resection (STARR) procedures have varied degrees of efficacy (Weiss & McLemore, 2008). Overall, treatment of this pathology is multidisciplinary.

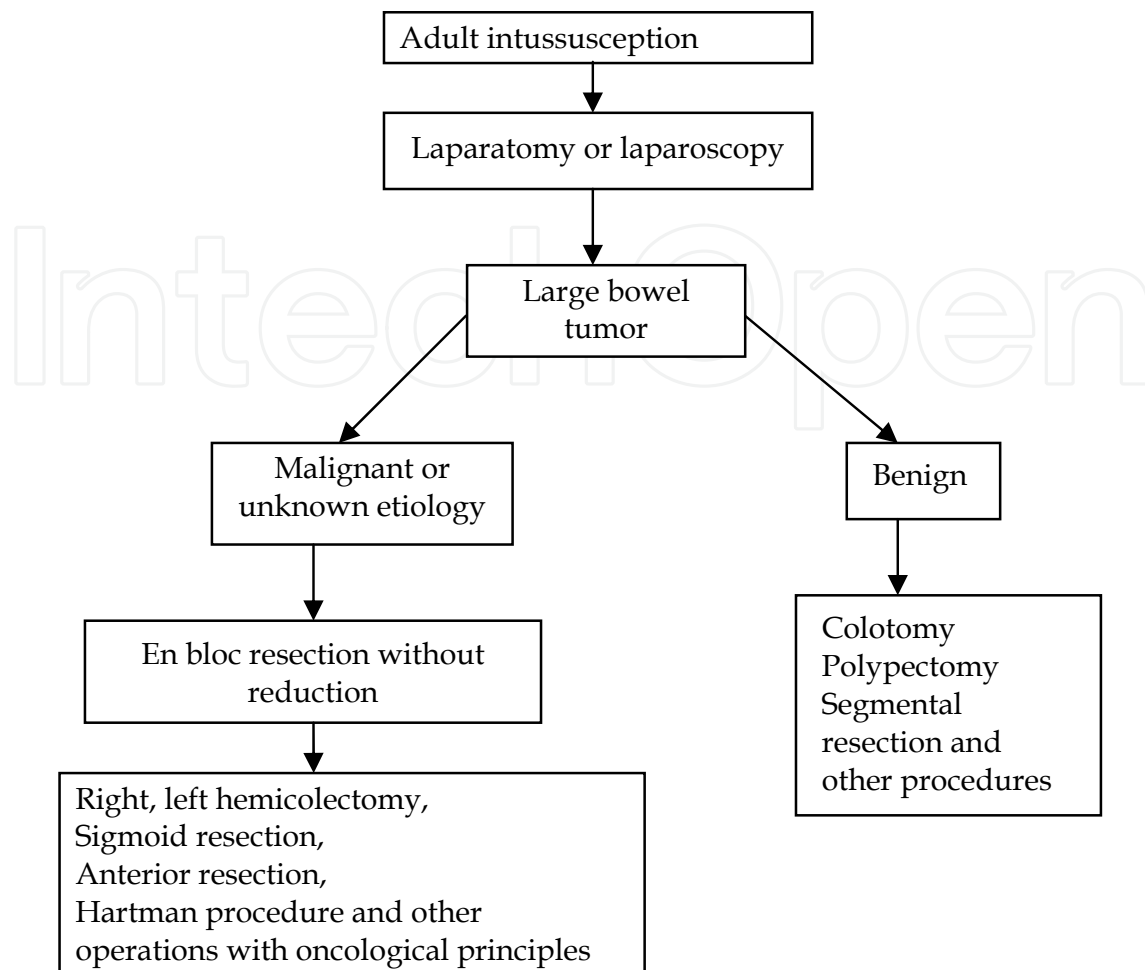


Fig. 10. Algorithm of surgical treatment of adult large bowel intussusception with tumor.

8.3 Surgical treatment of small bowel intussusception

Surgical treatment of small bowel intussusception is limited by remaining bowel length (Figure 11). In small bowel intussusception, initial reduction first of enteric lesions, before resection should be carried out in cases if the pre-operative diagnosis of benign etiology is confirmed, the bowel is viable or it entails resecting massive lengths of small bowel with the risk of short gut syndrome as a sequela (Takeuchi et al., 2003; Erkan et al., 2005; Khan et al., 2008; Franz et al., 2010).

Some authors reported the need for en bloc resection without reduction even in small bowel intussusception because of the inability to differentiate benign from malignant etiology preoperatively or intraoperatively (Wang et al., 2007). Reductions of these intussusceptions with subsequent enterotomy, biopsy, and excision of the etiologic lesion necessitate an enterotomy in edematous and previously ischemic bowel. The reduction of an intussusception secondary to a malignant lead point is potentially detrimental, as there is the theoretic risk of intraluminal or intraperitoneal seeding of the cancer, but oncologic resection is limited by the length of the remaining bowel. On the other hand, many malignancies causing enteric intussusception are metastatic implants in which the benefit of a formal oncologic resection is questionable and extent of resection does not impact overall survival and prognosis.

Benign enteric lesions that are not associated with adhesions require resection to prevent recurrent intussusception. The exception to this concept is postoperative adhesions, which are felt to be safe to reduce without resection as long as the bowel is viable (Azar & Berger, 1997). Because the leading tumors of intussusception in the small intestine are benign in frequency, laparoscopic operation may be applicable as a less-invasive method in not urgent situations.

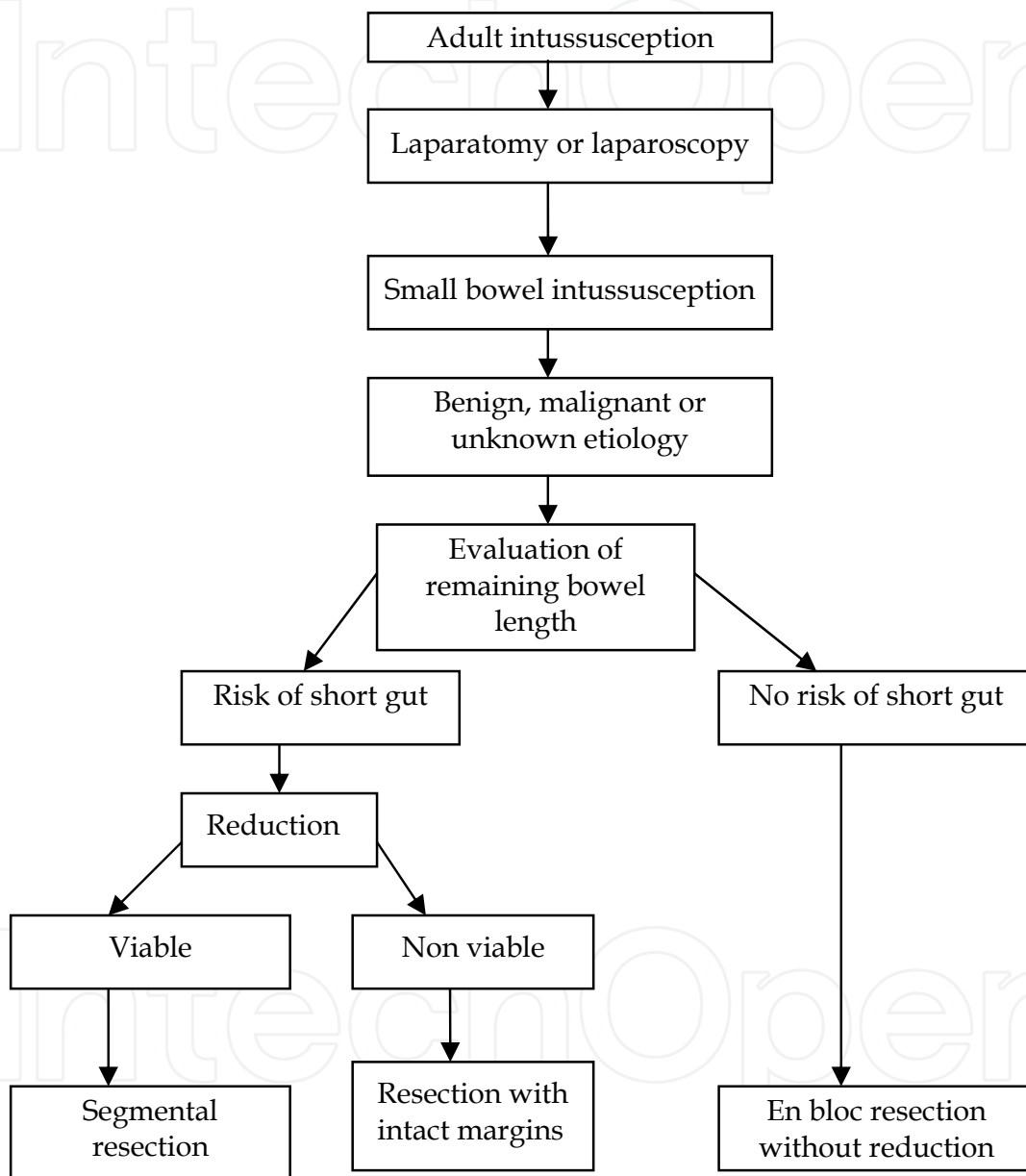


Fig. 11. Algorithm of treatment of adult small bowel intussusception.

9. Prognosis and complications of intussusception

Intussusceptions themselves have a good prognosis and depend on the cause. Mortality for adult intussusceptions increases from 8.7% for the benign lesions to 52.4% for the malignant cause. Intussusception-associated infant mortality rate account up to 2.3 per 1 000 000 live

births (Parashar et al., 2000). Risk of mortality depends on bowel obstruction, complications, urgent operation, associated malignancy, but not on intussusceptions themselves. In children, if left untreated, intussusception can cause severe complications, which are directly related to the amount of time that passes from when the intussusception occurred until it is treated. Most patients who are treated within the first 24 hours recover completely. Further delay increases the risk of complications, which include bowel ischemia, necrosis and perforation, infection, and death (untreated 2-5 days). Mortality with treatment is 1-3%. Recurrence of an adult intussusception after surgical treatment is rare condition (Barussaud et al., 2006). In children, recurrence is observed in 3-11% of cases. Most recurrences involve intussusceptions that were reduced with contrast enema.

10. Differences between adult and pediatric intussusception

The adult intussusception is distinct from pediatric intussusception in various aspects. Intussusception is most commonly encountered in children and has been reported to be the most common abdominal emergency in early childhood and the second most common cause of intestinal obstruction after pyloric stenosis. It typically occurs from age 6 to 18 months and occurs more commonly in boys than girls. After 2 years of age, the incidence of intussusception declines. Only 30% of all cases of intussusception occur in children older than 2 years. Formation of the intussusceptum occurs differently in the pediatric and adult population. Factors involved in causation include anatomic features of the developing gastrointestinal tract and infectious influences.

The presentation of pediatric intussusception often is acute with sudden onset of intermittent colicky pain, vomiting, and bloody mucoid stools, and the presence of a palpable mass. In contrast, the adult entity may present with acute, subacute, or chronic non-specific symptoms. In the adult population, intussusception presents a preoperative diagnostic challenge and the rate of a preoperative correct diagnosis in the pediatric group is higher (Demirkan et al., 2009).

The decreased rigidity in the wall of the pediatric cecum (secondary to delayed development of the teniae coli) naturally allows for easy intussusception of the thickened muscle of the ileocecal valve which, in children, tends to be more anteriorly located and therefore more mobile and prone to prolapse.

Infections in the pediatric population, most commonly adenovirus and rotavirus, are thought to cause hypertrophy of Peyer's patches, increased bowel motility during diarrhoea resulting in an intussusceptum (Cera, 2008). In children, intussusception is idiopathic in 90% of cases and results in the common scenario of ileocolic intussusception (Demirkan et al., 2009). In contrast to children, adult intussusception is a rare disorder and is usually not idiopathic. In less than 10% of pediatric cases, a lead point or underlying cause may be found. These non idiopathic causes may be due to congenital gastrointestinal tract abnormalities, such as Meckel's diverticulum and intestinal duplication, or due to the presence of neoplastic lead points such as polyps, hamartomas, or lipomas. With increasing age, the non idiopathic causes tend to become more prevalent. Malignant causes of intestinal intussusception in pediatrics include lymphomas, carcinoma as associated with juvenile polyposis syndrome, and leiomyosarcoma (Cera, 2008). The diagnosis and management in the pediatric population is relatively standardized with nonoperative reduction attempted first. In children, abdominal ultrasound and air or contrast studies are the most useful

(Demirkan et al., 2009). Ultrasound is quick and cost-effective when done by an experienced radiologist with sensitivity and specificity approaching 100%. Ultrasound is less useful in adults because massive air in distended bowel loops and obesity limit image quality. Pneumatic or hydrostatic (air contrast enemas) reduction of the intussusception is sufficient to treat the condition in 80% of the patients. In contrast, almost 90% of the cases of intussusception in adults are secondary to a benign or malignant lesion. Due to a significant risk of associated malignancy, radiologic decompression is not addressed preoperatively in adults. More than 90% of adult cases of intussusception require surgical treatment.

11. Conclusion

Adult intussusception is a rare condition which can occur in any site of gastrointestinal tract from stomach to rectum. Because of the rarity of adult intussusception and because of the nonspecific symptoms and physical findings, and signs on imaging, preoperative diagnosis is difficult. In adults, the treatment of intussusception is almost always surgical, employing resectional approach. Intussusceptions themselves have a good prognosis, but this depends on the primary disease causing intussusception.

12. Acknowledgements

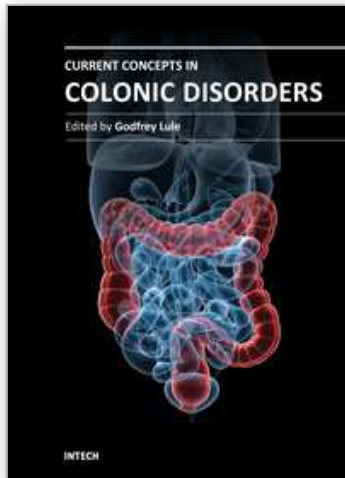
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Current Concepts in Colonic Disorders

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The 21st Century has seen a resurgence of research of the gastrointestinal tract, especially since it was established that it plays a central role as an immune system organ and consequentially has a huge impact on causation, impact and transmission of most human ailments. New diseases such as the Acquired Immunodeficiency Syndrome, hepatitis and tumours of the gastrointestinal tract have emerged and they are currently subjects of intensive research and topics of scientific papers published worldwide. Old diseases like diarrhea have become extremely complex to diagnose with new and old pathogens, drugs, tumours and malabsorptive disorders accounting for the confusion. This book has set out algorithms on how to approach such conditions in a systematic way both to reach a diagnosis and to make patient management cheaper and more efficient. "Current Concepts in Colonic Disorders" attempts to put all the new information into proper perspective with emphasis on aetiopathogenesis and providing rational approach to management of various old and new diseases. As the book editor, I have found this first edition extremely interesting and easy to understand. Comments on how to improve the content and manner of presentation for future editions are extremely welcome.

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