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The Accuracy of Ultrasonography Technique in Detection of the Intussusception

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Abstract: This study was conducted to retrospectively evaluate the accuracy and performance of ultrasonography in detection of intussusception as well as to prevent unnecessary surgery. Between May 2007 to December 2008, 54 patients with suspected intussusception underwent screening ultrasonography. The mean age of the patients was 2.7 years. Patients were divided into groups according to age and gender. Out of 54 patients, 27 had negative ultrasonographic results and the rest 27 had positive results. Out of 27 patients who had a negative ultrasonographic result, 26 patients had a correct ultrasonographic results and one has no intussusception was evident on air enema. Among those 26 patients, in 21 (96.2%) patients air enema was positive for intussusception (true negative) and in 5 (3.7%) patients surgery were positive for intussusception (false negative). Twenty-seven patients had a positive ultrasonographic result; 25 (92.5%) (True positive) were confirmed by air enema and 2 (7.4%) intussusception were confirmed by surgery (false positive). The total accuracy rate was 94.4%, sensitivity was 92.5%, specificity was 96.2%, positive predictive value was 96.1% and negative predictive value was 92.8%. Accuracy of ultrasonography in screening for suspected intussusception is high and has gained both the respect and confidence of the pediatricians. However, sonographically guided hydrostatic reduction of childhood intussusception is a simple, safe and very successful technique that does not expose the child to ionizing radiation and can in many cases replace operative management.

Key words: Intussusception, ultrasonography, accuracy

INTRODUCTION

Intussusception is one of the most common surgical emergencies in childhood with a peak incidence between the 4th and 10th months of age and with a male predominance of 2:1 (Young, 1998). Imaging has a major role both in the diagnosis and management of this condition (Grunshaw, 2005; Byrne *et al*., 2005; Shanbhogue *et al*., 2009; Williams, 2008). Intussusception occurs when a segment of bowel invaginates into an immediately adjacent segment, often likened to a telescope. 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 (Navarro and Daneman, 2004). There is an increased incidence of intussusception in patients with cystic fibrosis and coeliac disease. Postoperative intussusception is rare and can be a diagnostic challenge as the symptoms are similar to postoperative ileus. Most postoperative intussusceptions affect the small bowel and generally require operative treatment, particularly when the patient is symptomatic (Navarro and Daneman, 2004). 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 (Daneman and Navarro, 2003). 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 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 (Daneman and Navarro, 2003). 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. Other sonographic features such as trapped fluid between the layers of bowel 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 (Daneman and

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Navarro, 2003; Sorantin and Lindbichler, 2004). 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. 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 also recognized that air could be used both to diagnose and treat 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. 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 (Applegate, 2005). A newer technique involves hydrostatic reduction of intussusception using saline enema and ultrasound guidance (Wood *et al*., 1992). The obvious advantage of this technique is a complete lack of radiation exposure and more detailed visualization 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 (Gu *et al*., 2000; Lee *et al*., 2006; Yoon *et al*., 2001).

The aim of this study was to evaluate the accordance between the above-mentioned radiologic examinations and their accordance with the surgical findings with regard to presence and/or absence of intussusception, with a brief analysis of treatment results.

MATERIALS AND METHODS

We retrospectively analyzed the clinical, imaging, surgical, and pathologic findings in fifty-four cases (17 girls and 37 boys) of small-bowel intussusception with age range of 3 months to 10 years (Mean age of 2.7 years), who presented with ileocolic, ileoileocolic, or colocolic intussusception at our institution, the Imam Khomeini Hospital, Ahwaz, Iran, during the 1.5 year period from May 2007 to December 2008. The study was approved by the research ethics board of our hospital. Only patients with isolated small-bowel intussusception were included. Patients with ileocolic intussusception and intussusception associated with feeding tubes were excluded. Symptoms were defined as acute if they occurred within 48 h before presentation and as chronic if they had lasted longer than 48 h. All confirmed cases are evaluated by the pediatric surgeons. Information recorded for each patient included age, gender, past medical history, clinical symptoms, physical examination findings at presentation and detailed analysis of various radiologic examinations, including plain abdominal radiography, initial abdominal ultrasonography, colonography with barium or air and follow up abdominal ultrasonography after conservative management and finally the surgical outcome with pathological evaluation. The following sonographic parameters were documented: presence of small-bowel intussusception; length of intussusception in centimeters (measured with electronic calipers along the greatest longitudinal axis of the intussusception); presence of sonographic features of small-bowel obstruction (dilated, fluid-filled loops of small- bowel greater than 3 cm in diameter proximal to the level of intussusception with collapsed distal loops) and presence of ascites. Patients were divided into groups according to gender. We also divided the patients into three groups based on the age criteria: less than 6 month, from 6 month to 2 years and more than 2 years age. All confirmed cases are evaluated by the pediatric surgeons. Radiologic studies were performed by the chief residents of the radiology unit. Presence of pseudokidney sign on abdominal ultrasonography and filling defect of intussusceptum on colonography were considered to be definitive for intussusception (Littlewood and Vogel, 1998).

This first enema reduction attempt may comprise one or several consecutive attempts with a minimal time interval between them. If this first enema reduction attempt is not successful, a decision is made in consultation with the pediatric surgeons as to whether the patient should proceed to surgical reduction or undergo one or several delayed, repeated reduction attempts. Delayed, repeated reduction attempts are only considered when partial reduction has been achieved with the first attempt and the patient is clinically stable. Sonography is performed before each delayed, repeated reduction attempt to rule out interval spontaneous reduction. For the purpose of this study, we have considered an attempt as delayed when there is an interval of 15 min or more between the reduction attempts. Surgery is again considered each time that delayed, repeated reduction attempts are unsuccessful. Between the delayed reduction attempts, the patients do not receive any antibiotics or sedation and they are kept under close observation in the surgical ward.

Statistical analysis: Results were expressed as Mean±SD. Basic descriptive statistics were used along with the chi-square test to evaluate the accordance of radiologic examination results in and with the surgical findings with regard to presence and/or absence of intussusception. A probability value of less than 0.05 was considered to be statistically significant. Sensitivity and specificity were calculated according to standard formulas, namely:

$$\text{Sensitivity} = (TP)/(TP+FN)$$

$$\text{Specificity} = (TN)/(TN+FP)$$

where, TP is true positives, FN is false negatives, TN is true negatives and FP is false - positives. The predictive values (PV), whether positive (+) or negative (-), were similarly calculated, with +PV being (TP) / (TP + FP) and -PV being (TN) / (TN + FN).

RESULTS

The patients with small-bowel intussusception were 17 girls (31.48%) and 37 boys (68.51%) with a mean age of 2.7 years (range, 3 Month-10 years). The male: female ratio was 2:1.7. Out of 54 patients, 27 had negative ultrasonographic results and the rest 27 had positive results. Indications for the examinations included symptoms referable to the abdomen (abdominal pain, vomiting, lethargy or failure to thrive, lower gastrointestinal bleeding, weight loss, fever, diarrhea, hematemesis and constipation). Eleven patients had no symptoms and abdominal sonography was performed for other reasons (evaluation of an inguinal hernia, suspected patent urachus and assessment before liver transplantation). The clinical characteristics of the two groups of patients are shown in Table 1. Twenty-five patients underwent screening ultrasonography only and were then kept under observation in the emergency room. They were all diagnosed as having a non-surgical condition.

Out of 27 patients who had a negative ultrasonographic result, 26 patients had a correct ultrasonographic results and one has no intussusception

Table 1: Characteristics and clinical presentation of patients with small-bowel intussusception

Characteristic	Study groups (n = 54)
Age	
Mean (y); Range; 95% CI (y)	2.7; 3 month-10 years; 3.6 -11.4
Acute symptoms	15
Chronic symptoms	10
No symptoms	2
Abdominal pain	12
Vomiting	5
Lethargy or failure to thrive	0
Lower gastrointestinal bleeding	3
Hematemesis	0
Weight loss	8
Fever	0
Diarrhea	0
Constipation	1

Table 2: Correlation between radiologic study results and surgical findings

	Ultrasonography		
	Total groups (n = 54)		
Surgery	Intussusception negative	Intussusception positive	Total
Intussusception negative	26	25	51
Intussusception positive	1	2	3
Total	27	27	54
Female group (n = 17)			
Intussusception negative	8	8	16
Intussusception positive	1	0	1
Total	9	8	17
Male group (n = 37)			
Intussusception negative	18	17	35
Intussusception positive	1	1	2
Total	19	18	37
Age 6 month to 2 years group (n = 25)			
Intussusception negative	11	13	24
Intussusception positive	1	0	1
Total	12	13	25
Age less than 6 years group (n = 11)			
Intussusception negative	6	5	11
Intussusception positive	0	0	0
Total	6	5	11
Age more than 2 years group (n = 18)			
Intussusception negative	9	7	16
Intussusception positive	1	1	2
Total	10	8	18

Table 3: Diagnostic Indices of sonography for patients with small-bowel intussusception

Groups	TP	TN	FN	FP	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
All groups (n = 54)	25	26	2	1	92.5	96.2	96.1	92.8	94.4
Female group (n = 17)	8	8	1	0	88.8	100.0	100.0	88.8	94.1
Male group (n = 37)	17	18	1	1	94.4	94.7	94.4	94.7	94.5
Age 6 month to 2 years group (n = 25)	13	11	1	0	92.8	100.0	100.0	91.6	96.0
Age less than 6 months group (n = 11)	5	6	0	0	100.0	100.0	100.0	100.0	100.0
Age more than 2 years group (n = 18)	7	9	1	1	87.5	90.0	87.5	90.0	88.8

was evident on air enema. Among those 26 patients, in 21 (96.2%) patients air enema was positive for intussusception (true negative) and in 5 (3.7%) patients surgery were positive for intussusception (false negative). Twenty-seven patients had a positive ultrasonographic result; 25 (92.5%) (True positive) were confirmed by air enema and 2 (7.4%) intussusception were confirmed by surgery (false positive) (Table 2). The total accuracy rate was 94.4%, sensitivity was 92.5%, specificity was 96.2%, positive predictive value was 96.1% and negative predictive value was 92.8% (Table 3). The overall accuracy in both genders was almost similar with values of 94.1 and 94.5% in female and male groups, respectively. Sensitivity, specificity, positive predictive value and negative predictive value were different between gender and groups (Table 3). The highest accuracy was belonging to less than 6 months group (100%).

DISCUSSION

Intussusception is the most common cause of bowel obstruction in early childhood, with the peak incidence between 6 months and 2 years of age (Limberg, 1998). It is typically presented with an acute onset of colicky abdominal pain; however, when the bowel obstruction is not complete, the clinical symptoms can be confusing with the recurring non-specific abdominal symptoms. The apex of the intussusceptum is the part most prone to the development of pathologic changes. Most cases of intussusception are idiopathic, with no identifiable lesion acting as the lead point. Rarely, a mechanical lead point, such as intestinal polyp, Meckel diverticulum, duplication cyst or lymphoma, can be found. Even rarer is the intussusception in correlation with cystic fibrosis, Henoch-Schonlein purpura, hemophilia or intussusception after operative abdominal procedures. Intussusception can begin in any free-moving part of the bowel; however, the ileocolic intussusception is the most common, with the ileum being telescoped through ileocelcal valve into the cecum. Less frequently, small-intestinal (segment of small intestine enters into the immediately distal segment of the small intestine), colo-colic (analogous pathology in the colon) or ileocecal (ileocecal valve is the lead point) types can develop. The diagnosis of intussusception is made by a contrast enema or ultrasound. With Doppler imaging the presence of compromised/absent blood flow in the bowel wall can be demonstrated, which is important in differentiation from the acute inflammation. In all three patients that we examined, the ileocolic intussusception was detected and the described characteristic signs were clearly visible. Ultrasonography is highly accurate in the diagnosis of intussusception with a specificity of 100% and a sensitivity of 88 - 93% (Verschelden *et al*., 1992; Eshed *et al*., 2004; Bhisitkul *et al*., 1992). In the current retrospective study we also achieved a relatively high accuracy rate (94.4%). However, sensitivity was only 92.5% and specificity and NPV were 96.2 and 92.8%, respectively, while other studies documented 95-100% sensitivity and NPV (Klein *et al*., 2004; Harrington *et al*., 1988; Pracros *et al*., 1987; Shehata *et al*., 2000). In present study we had only two false-positive through the ultrasonography examinations. Weinberger and Winters (1992) reflected some concerns about the reported high sensitivity and NPV of ultrasonography in suspected intussusception. The clinical setting of a child with colicky abdominal pain represents many abdominal conditions, not only intussusception. Indeed in our study, a large percentage of patients with suspected intussusception were released from the emergency room with the diagnosis of acute gastroenteritis. We argue that the pseudokidney sign resulting from thickened bowel wall in this setting can be confusing and recommend a high index of suspicion, performing an air enema when there is doubt.

Bhisitkul *et al*. (1992) suggested dividing all children with suspected intussusception into two groups-higher and lower clinical suspicion. They recommended ultrasonography in children with non-classic symptoms of intussusception. We performed ultrasonography mainly in children with non-classic symptoms of intussusception. However, we believe a joint decision between clinician and radiologist regarding management is essential for providing the appropriate treatment. According to published data, the sonographically guided hydrostatic reduction of childhood intussusception is curative in 76-93% of cases (Peh *et al*., 1996; Tander *et al*., 2007).

CONCLUSION

From our initial experience and review of the literature we can conclude that the sonographically guided hydrostatic reduction of childhood intussusception is a simple, safe and very successful technique that does not expose the child to ionizing radiation and can in many cases replace operative management.

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