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Review article

Ileocolic intussusception: Predicting the probability of success of ultrasound guided saline enema from clinical and sonographic data

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ABSTRACT

Background/purpose: To identify factors that dim the efficacy of ultrasound guided saline enema (USGSE) and to design a mathematical model for predicting the probability of success of USGSE.
Methods: Retrospective review of patients admitted with the diagnosis of ileocolic intussusception from 2009 to 2014. Demographics, clinical and sonographic data were reviewed.
Results: 116 first episodes of ileocolic intussusceptions. 109 USGSE attempts were analyzed. Composite reduction rate was 77%. A significant relationship was found between initial location of the intussusception, free peritoneal fluid (OR = 0.329, 95% CI: 0.124–0.875), negative Doppler signal and sonographic signs of intestinal occlusion and unsuccessful USGSE. Initial location beyond the splenic angle was an independent risk factor for USGSE failure (OR = 0.053, 95% CI: 0.005–0.534). A predictive model based on onset of symptoms, free peritoneal fluid and intussusception location was a reliable tool for prediction (AUC 0.63, 95% CI: 0.53–0.817). Assuming that a patient with less than 75.3% chance of USGSE success is going to fail, we would identify more than 80.9% of the real failures.
Conclusions: This predictive model could be a filter selection for the patients at risk of USGSE failure and therefore candidates to further imaging investigations or referral to a surgical unit.
Level of evidence: III.

Contents

Intussusception was first described by Barbette in 1674 [1]. He depicted the slide of a segment of intestine into the adjacent segment. Intussusception causes secondary ischemia and intestinal occlusion that account for morbidity and mortality.

The incidence of intussusception is between 20 and 100/100000 [2]. It is one of the most frequent causes of intestinal occlusion in patients aged 2 years, most cases occurring between 5 and 9 months [3]. Intussusception is mostly idiopathic or related to gastrointestinal or respiratory infections. First generation vaccines against Rotavirus have also been related to

Abbreviations: H, hours from onset of symptoms; FF, free peritoneal fluid; TC, intussusception head in the transverse colon; SA, intussusception head in the splenic angle; BSA, intussusception head beyond the splenic angle; *P(success), probability of success.*

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this condition [4]. In infants aged more than 2 years, a leading point of intussusception is more likely to be found: Meckel's diverticulum, lymphoma, polyp, duplication cyst, persistence of vitelline duct, appendix [5,6] or intramural hematoma in Schönlein–Henoch's purpura [4].

Noninvasive procedures have been developed for reducing the invaginated intestinal loop such as barium, air and ultrasound guided saline enema (USGSE) (Kim et al. 1982 [7]). Unlike barium or air enema reduction under fluoroscopy, USGSE has the main advantage of not exposing the child and the medical team to radiation. This benefit has popularized the use of USGSE reaching success rates up to 96% [8]. The ultrasound scan allows for monitorization of the retrograde movement of the intussusceptum [9], clear demonstration of reduction and assessment of pathologic lead points without ionizing radiation exposure [10]. Some prognostic factors have been described for successful reduction under fluoroscopy, e.g., the intussusception bowel ratio and the appendix sign (radiographic visualization of the appendix in the absence of air or contrast reflux into the small intestine) [11]. However, the prognostic factors for successful reduction under USGSE are not well defined. Some clinical features such as time from onset, hematochezia or dehydration and some sonographic parameters like free peritoneal fluid or intussusception head location have already been analyzed in the literature, and conclusions are contradictory [2,6,7,12–14].

Owing to these controversial issues in the efficacy of the USGSE, we aimed to investigate which factors were related to reduction failure and to develop a mathematical model to predict the probability of success of this technique for a particular case.

1. Materials and methods

In this retrospective single center study (referral pediatric hospital), we reviewed the data of all first episodes of ileocolic intussusceptions sonographically diagnosed between January 2009 and December 2014. Data were reviewed from patient charts, digital information systems and archived sonography images. The ultrasound images were reassessed by a single senior and experienced pediatric radiologist.

Blood test and IV-line placement were mandatory for all the patients suspected with ileocolic intussusception based on history and clinical examination. Fluid and electrolyte correction were undertaken in case of severe dehydration or long duration of symptoms. There was not an agreed analgesia protocol for the pain control. An ultrasound examination was done in less than 2 h after admission to confirm the diagnosis.

Once the diagnosis was made, USGSE was the first therapeutic option unless the patient condition was unstable and worsened by infection, peritonitis or intestinal perforation or a pathologic lead point was identified. The procedure was performed by senior pediatric radiologists under the presence of the pediatric surgeons. All patients underwent a conventional ultrasound examination with a 6 MHz curved-array and a 14 MHz linear transducers (Toshiba, Aplio 300). Under conscious sedation with intranasal (up to 0.5 mg/kg) or intravenous (0.1–0.2 mg/kg) midazolam, the patient was placed in the supine position, legs extended and tight buttocks. A 22F Foley catheter was inserted into the rectum and the balloon was inflated with 10 mL water. Normal saline was infused at 37 °C at a pressure of 100–120 cmH_20. A maximum of three attempts were done under the same condition. The duration of the procedure was not registered. Disappearance of the intussusception head, visualization of the ileocecal valve and passage of saline into the small intestine without increased peritoneal fluid were considered as successful. After three unsuccessful attempts, no delayed USGSE enema was repeated afterwards and patients underwent a second-line treatment. Before 2012, the air enema fluoroscopically-guided reduction under general anesthesia was the second therapeutic choice. Since 2012, owing to the low reduction rates of the air enema after USGSE in our unit, the intussusception that could not be reduced with USGSE was directly reduced surgically.

Patients with sonography-diagnosed ileocolic intussusception and markedly reduced general condition or confirmed pathologic lead point were treated by primary surgical reduction without attempting hydrostatic reduction. Bowel resection was performed as required.

We analyzed the success rate of USGSE depending on patient's sex, age and weight. We also analyzed the influence of hours from onset (H), intussusception location, free peritoneal fluid (FF), lymph nodes, Doppler signal in the intussusception head and intestinal occlusion signs (distention, motility anomalies, intraluminal fluid) on the likelihood of success. The colonic extent of intussusception was categorized as follows: hepatic angle (HA), transverse colon (TC), splenic angle (SA) and beyond the splenic angle (BSA). The numbers of reduction attempts and procedure-related complications were also registered as well as the need of subsequent air enema or surgery. Early (< 24 h) and late (>24 h) relapses were also recorded.

Reduction rates were calculated according to the papers of Bekdash et al. [14] and Menke et al. [13] (Table 1). They represent the ratio of persistently successful nonsurgical reductions versus different denominators. Depending on whether we included all the intussusceptions or just the attempted USGSE reductions we calculated the crude reduction rate or the selective reduction rate respectively. Excluding the patients that required a bowel resection, we calculated the composite reduction rate and the corrected selective reduction rate derived from the indexes mentioned above. Uncomplete procedures were considered unsuccessful attempts.

Statistical analyses were performed using SPSS 19.0 (IBM Corp. Released 2010. IBM SPSS Statistics for Windows, version 19.0, Armonk,

Table 1
Reduction rates in accordance with the papers of Bekdash et al. and Menke et al.

Index	Formula	Calculation
Crude Reduction Rate	$\frac{\text{Nonoperative reductions with permanent success}}{\textbf{All intussusceptions}}$	80/116 = 0.69
Selective Reduction Rate	$\frac{\text{Nonoperative reductions with permanent success}}{\textbf{Attempted nonoperative reductions}}$	80/109 = 0.73
Composite Reduction Rate	$\frac{\text{Nonoperative reductions with permanent success}}{\textbf{Nonoperative AND operative reductions (without resection)}}$	80/ (116–12) = 0.77
Corrected Selected Reduction Rate	$\frac{\text{Nonoperative reductions with permanent success}}{\textbf{Attempted nonoperative AND operative reductions (without resection)}}$	80/ (109–6) = 0.78
Technical Success Rate	$\frac{\text{Nonoperative reductions with technical success (\textbf{including} early relapses)}}{\textbf{Attempted nonoperative reductions}}$	82/109 = 0.75