Introduction

Intussusception (invagination) is the most common cause of acute bowel obstruction in infants and young children. It occurs when a portion of the bowel becomes telescoped into the adjacent bowel segment. The peak incidence of intussusception is between six months and two years of age (40% of all cases are between three and nine months of age). Only 10% of pediatric intussusception cases are older than three years of age [1]. Most of the pediatric cases of intussusception are ileocolic [1,2]. In the present study, we aimed to obtain mean dimensions and locations of intussusceptions in our pediatric patient group with ultrasonography (US) and to report both these data and other sonographic findings of intussusceptions with their clinical and therapeutic outcomes.
Materials and methods

We retrospectively reviewed the medical records and US examinations of 13 consecutive children with intussusceptions between April 2008 and June 2011. Age, gender, major symptom on referral, types and locations of intussusceptions, US appearances, additional US findings, treatment methods and patients' clinical status after treatment were recorded. No abdominal radiography or other cross-sectional imaging modalities had been performed. All the procedures in our hospital were effectuated according to the World Medical Association Declaration from Helsinki. All the patients' parents were informed about the US examination procedures and surgical procedures. Oral consent was obtained for US examinations and written informed consent was obtained before surgery.

Abdominal US was performed with a Logic 200 Pro US device (General Electric Medical Systems, Seongnam, Gyeonggi-do, Korea), using 3–3.5 MHz convex and 7.5–8 MHz linear probes. Multiple, concentrical, target-like appearances of the wall layers of invaginated segments (multiple concentric ring sign, target sign) on axial scans, besides pseudokidney sign, sandwich sign and hayfork sign on longitudinal scans were accepted as basic ultrasonographic diagnostic criteria for intussusception. Outer diameters were measured with electronic calipers in the largest cross-sections (fig 1) and lengths were measured along the greatest longitudinal axises of the intussusceptions (fig 2). In the cases with free intraperitoneal fluid, the thickness of fluid was measured in vertical direction, in the locations where the fluid was most prominent, with the patient in supine position. Patients were grouped according to the intussusceptions type (ileocolic, ileocolocolic, and colocolic) and according to the modality of treatment (surgical and non-surgical treatment). Numeric data about intussusceptions were presented as the number of cases and mean values±standard deviation (SD). Independent samples t test was used to compare the difference between mean diameters, mean lengths of patient groups. P values < 0.05 were considered as statistically significant. All analyses were done with SPSS software (version 16.0: SPSS Inc, Chicago, IL).

Results

In the study group the male-to-female ratio was 7:6 with median age of 24 months (range 5–108 months). All cases had crampy abdominal pain (n=13/13). Eleven cases were surgically treated.

During US examinations, incompressible intraabdominal bowel mass with multiple concentric ring/target sign.
sign on axial scans (fig 3) and pseudokidney sign, sandwich sign and/or hayfork sign on longitudinal scans were detected in all cases (n = 13/13). The mean diameter±SD was 30±5 mm and mean length±SD was 59±21 mm. The surgically treated cases had ileocolic (n=9/11, 81.8%), ileocolocolic (n=1/11, 9.1%) and colocolic (n=1/11, 9.1%) intussusceptions. In ileocolic intussusceptions the mean diameter±SD was 29.1±4.4 mm and the mean length±SD was 61.7±18.1 mm. Right upper quadrant of the abdomen was the most common location for ileocolic intussusceptions (n = 7/9) comparing with paraumbilical regions (n = 2/9). The two cases of intussusceptions with colocolic involvement (ileocolocolic and colocolic intussusceptions located in the right upper quadrant and left lower quadrant, respectively) had the mean diameter±SD 37.5±0.7 mm and the mean length±SD 75.5±21.9 mm. The difference between mean diameters of ileocolic intussusceptions and intussusceptions with colocolic involvement was statistically significant (p=0.03), whereas the difference between mean lengths of these two groups was not statistically significant (p=0.36). In the surgically treated cases (n = 11/13), the mean diameter±SD was 30.6±5.2 mm and the mean length±SD was 64.2±18.5 mm. In the non-surgically treated cases of intussusceptions (n = 2/13), (located in the right lower quadrant of abdomen), the mean diameter±SD was 27.4±2.2 mm and the mean length±SD was 32.5±10.6 mm. The difference between the mean diameters of intussusceptions in surgically and non-surgically treated groups was not statistically significant (p=0.37), whereas the difference between the mean lengths of these two groups was statistically significant (p=0.04). Mildly increased free intraperitoneal fluid was detected in 30.8% of cases (n = 4/13). In these cases, surgery revealed no complications such as perforation or peritonitis. Free fluid was most prominent in the left lower quadrant in a case with colocolic intussusception (n=1/13), in the left paracolic gutter in a case with ileocolic intussusception (n=1/13), in the right upper quadrant in cases with ileocolic intussusceptions (n=2/13) with a maximum thickness of 22.5 mm, 21.7 mm and 7 mm, respectively. With US, mildly enlarged mesenteric lymph nodes inside intussusceptions could be demonstrated in 46.1 % of cases (n = 6/13).

Surgery was performed in cases presenting with delayed referral (n=11/13) (more than 24 hours after onset). No obvious cause was reported in surgery. One of the non-surgically treated cases (27-month-old boy) was successfully hydrostatically treated under US guidance. In the other non-surgically treated case (108-month-old boy), the intussusception resolved spontaneously after cleansing rectal enema. No complication occurred and all the patients were discharged in good conditions.

Discussion

Intussusception occurs most commonly in children (94% of all cases). The predominant location is the ileocecal valve level. The principal causes that could be demonstrated in about 5% of the pediatric cases are: Meckel diverticulum and inssissated meconium in infants younger than three months and Burkitt lymphoma, Peutz-Jeghers syndrome, polyloid hemangioma, enterogenous cyst, ectopic pancreas, suture granuloma, periappendicitis, Henoch-Schönlein purpura, coagulopathy in children older than three years of age. The major symptom of intussusception is the abrupt onset of violent crampy pain (94%). Palpable abdominal mass is detected in only 59% of cases [1].

Imagistic investigations are very important for the prompt and accurate diagnosis. Plain radiography could be used as an initial screening tool but the accuracy varies between 40–90% [1]. Barium enema examination has been considered to be the standard imaging method for the diagnosis of intussusception for many years. Also, computed tomography (CT) can demonstrate proximal obstruction and invaginated segments [1]. Due to the ability of US to confidently diagnose or rule out intussusception, make alternative diagnoses, and characterize causes [2] we did not use the other mentioned techniques in our study in order to avoid unnecessary radiation exposure. In the study of Shanbhogue et al, US had a sensitivity of 98.5% and a specificity of 100% for intussusception diagnosis in children [3]. The role of contrast enema is limited now to therapeutic applications [3]. Justice et al found the sensitivity of abdominal US in the detection of intussusception in infants younger than two years of age as 97.5% and the specificity as 99% [4]. Bhisitkul et al reported US to be a rapid, sensitive screening procedure in the positive diagnosis or exclusion of childhood intussusception [5].

In the present study, we found that the US findings were consistent with surgical results and clinical outcomes, and we suggest that US should be used as the first imagistic technique for the pediatric patients clinically suspected to have intussusception. We found that intussusceptions with colocolic involvement were larger than ileocolic intussusceptions in diameter and the mean lengths of the invaginated segments in non-surgically treated cases were smaller than that of the surgically treated cases. These data could be helpful in daily US practice, but it seems that a larger number of cases are required to verify the results.

Ko et al retrospectively reviewed 19 cases of surgically proven symptomatic pediatric small bowel intussusceptions and reported that, US revealed the target
lesions (average diameter 2.9 cm) suggestive of intussusception in 13 out of 17 patients [6]. Tiao et al found the average US size of surgically proven small bowel intussusceptions in 11 out of 13 pediatric patients as 2.77 cm [7]. In these studies the majority of small bowel intussusceptions were located in the paraumbilical or left abdominal regions [6,7]. In our study, mean diameter±SD of ileocolic intussusceptions was 29.1±4.4 mm which is close to the aforementioned average values but the majority of our ileocolic intussusceptions were located in the right upper quadrant. This localisation can be beneficial in the differentiation of isolated small bowel intussusceptions from ileocolic intussusceptions. But a larger series is required to confirm the statistical results.

Hydrostatic and pneumatic reductions are valuable alternatives to surgery, the mortality being less than 1%, if reduction occurs earlier than 24 hours after the onset. Contraindications are pneumoperitoneum, peritonitis and hypovolemic shock. Standing abdominal radiographs should be obtained before reduction in order to exclude perforation [1]. Abdominal CT is more effective in the demonstration of small amounts of free air secondary to bowel perforation, but since the dose of ionizing radiation in CT is much higher than abdominal radiographs, the method should be reserved for complicated or delayed cases. Çalışkan et al. reported that in 12 (60%) of 20 pediatric intussusception cases, hydrostatic reduction with barium under fluoroscopy without any following surgery, was successful [8]. Cankorkmaz et al. treated 53 (45%) of 118 intussusception patients by nonoperative reduction under scope, performing control US examination after reduction. The remainder patients were treated surgically. Pneumatic reduction success rate was reported as 86% [9]. But the conventional barium reduction or pneumatic reduction of intussusception with fluoroscopic guidance is accompanied by considerable ionizing radiation. Rohrschneider et al. found that in 42 of 46 cases (91%) the hydrostatic reduction under US guidance using a normal saline enema was successful and reported no complications [10]. Crystal et al. reported that in 88 (89%) of the 99 pediatric intussusception cases, ultrasonographically guided hydrostatic reduction was successful and no complications during or after hydrostatic enema were noted [11]. Tander et al. reported that hydrostatic reduction under US guidance by anal application of saline was successful in 41 out of 51 patients with intussusception and no perforation or other complications were evidenced [12]. Alamdar et al. performed hydrostatic reduction of intussusception under US guidance in 66 patients with a success rate of 78.8% and concluded the US guided hydrostatic reduction using water enema to be an optimal method for treatment of childhood intussusception, being a simple and safe procedure with a high success rate and with no radiation exposure [13]. Among our cases, one patient was hydrostatically treated successfully under US guidance. In the other non-surgically treated case, who was suffering from intense, crampy abdominal pain for five hours and whose ultrasonographical intussusception findings did not show any change during 60 minutes’ follow-up before treatment, the intussusception unexpectedly resolved spontaneously after the application of pediatric cleansing rectal enema. In both of these non-surgically treated patients, US played the major role in the treatment decision. Due to delayed referral, the other cases (n=11) were surgical treated. For this reason, in the present study, the number of non-surgically treated patients was small, being one of the limitations of our study.

Swischuk et al. reported no perforation or intestinal damage in two cases of intussusception with free peritoneal fluid and declared that small amounts of fluid might be present in uncomplicated intussusception [14]. We detected free intraperitoneal fluid with maximum thickness of 22.5 mm in 30.8% of cases (n = 4) and these cases were proved to be uncomplicated (without any gangrene, infarction or perforation) by surgery.

Though US is the imaging tool of choice in pediatric patients presenting with symptoms and signs of intussusception, the diagnosis should also be kept in mind if hybrid imaging, particularly FDG PET/CT, is performed for a clinically suspicious patient. Recently, with FDG PET/CT, co-incidental depiction of intussusception has been reported in a pediatric lymphoma patient [15].

In conclusion, during US examinations of pediatric patients who are clinically suspected to have intussusception, a relatively large, target-like and sandwich or hayfork-like, incompressible intraabdominal bowel mass should be looked for. US should be the first imaging modality in pediatric patients who are clinically suspected to have intussusception, allowing a rapid and real-time evaluation of patients.

Conflict of interest

The authors declared no conflicts of interest.

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References