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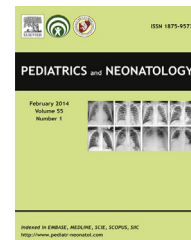
ORIGINAL ARTICLE

Diverse Presentations in Pediatric Meckel's Diverticulum: A Review of 100 Cases

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Background: Our objective was to analyze demographics and characteristics of Meckel's diverticulum with different manifestations in pediatric patients.
Methods: This is a retrospective study in children with symptomatic Meckel's diverticulum who underwent resection between September 1998 and October 2010. The diagnosis was confirmed by surgery and pathology. Demographic characteristics, manifestations, Meckel's scan results, surgical and histological findings were analyzed.
Results: One hundred symptomatic Meckel's diverticula were identified in 74 boys and 26 girls aged from one day to 18 years old over 13 years. Depending on whether or not obstruction occurred, the patients were classified into two categories. Each category was further subdivided into two diagnostic groups: 17 intussusception and 24 non-intussusception bowel obstruction in the obstructive category and 44 gastrointestinal bleeding and 15 diverticulitis and/or perforation in the non-obstructive category. The gender discrepancy was higher in the non-obstructive category than in the obstructive category (male-to-female, 4.36 vs. 1.73, $p < 0.05$). Forty-one of 44 patients with gastrointestinal bleeding underwent a Meckel's scan with a high positive rate (92.7%). The ectopic tissues were identified in 73 patients and included 61 gastric type, two pancreatic type and 10 mixed type. Ectopic tissues were more prevalent in non-obstructive category ($p < 0.05$) with ectopic gastric tissue even more pronounced ($p < 0.01$). Ectopic pancreatic tissue was significantly more prevalent in intussusception ($p < 0.01$). Laparoscopic surgery was performed more frequently in Meckel's diverticulum with non-obstructive symptoms ($p < 0.001$).

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Conclusion: Diverse presentations in pediatric Meckel's diverticulum are affected by different ectopic tissue types and male gender. Laparoscopic surgery is widely used for children with non-obstructive symptoms.

1. Introduction

Meckel's diverticulum (MD) is an outpouching or bulge of the small intestine that develops as a result of incompletely obliterated vitelline duct or omphalomesenteric duct between the 7th and 8th weeks of gestation. Johann Friedrich Meckel's first described and established the embryological origin in 1809. Patent vitelline duct (PVD) is similar in etiology to MD, but it is characterized by an intact ductal structure and persistent umbilical discharge.[1]

MD is the most prevalent congenital anomaly of the alimentary tract.[2] The rule of two traditionally describes its characteristics, such as a prevalence rate of 2% in the general population, a male-to-female ratio of 2:1, an incidence rate of 2% for symptomatic MD, presence of symptoms before age 2 years, a location at a distance of 2 feet to the ileocecal valve, a diverticular length of 2 inches, and two types of common ectopic tissues.[3] Symptomatic MD varies considerably in clinical presentation, including intussusception, volvulus, internal hernia, adhesion, Littre hernia, gastrointestinal bleeding, diverticulitis, and perforation.[4–7]

In the pediatric population, MD is the most common cause of massive lower gastrointestinal (LGI) bleeding, which is characterized by painless, massive melena usually leading to shock. Severe and characteristic LGI bleeding often implies possible MD with ectopic gastric mucosa. Meckel's scan using technetium Tc 99m pertechnetate, which is capable of binding to the gastric mucosa, offers a preoperative diagnosis for bleeding MD.[8] Volvulus occurs when the small bowel twists around a fibrous cord, or Meckel's band, tethering the MD to the umbilicus. MD complicated with intestinal obstruction secondary to internal hernia or entrapped enterolith has been reported.[9,10] Internal hernia arising from adhesion of the tip of MD with neighboring mesentery usually causes a closed bowel loop or constrictive ring. Littre hernia, a less common type of hernia involving protrusion of MD through any abdominal opening, also serves as a potential cause of intestinal obstruction.[6,7]

Large-scale surveys on pediatric symptomatic MD remain limited. The objective of this study was to investigate different manifestations of symptomatic MD in childhood based on our 13 years of experience.

2. Methods

2.1. Patients

A retrospective study of pediatric patients (≤18 years of age) with MD or PVD who underwent diagnosis and treatment at Chang Gung Children's Hospital between September 1998 and October 2010 was conducted. Patients were identified by chart review according to the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes 751.0 for Meckel's diverticulum or remnants of vitelline duct. Patients who underwent incidental diverticulectomy were excluded from the analyses. The age at symptom onset, sex, clinical features, treatment, imaging studies, surgical findings, and histopathological reports were reviewed and analyzed.

According to clinical features, patients with symptomatic MD were further categorized into four groups as follows: (1) intussusception; (2) nonintussusception (NI) bowel obstruction; (3) gastrointestinal bleeding; or (4) diverticulitis and/or perforation. The diagnosis of MD-associated intussusception was established by surgery. The term nonintussusception bowel obstruction referred to mechanical obstruction caused by a condition other than intussusception such as MD-related volvulus, internal hernia, adhesions, or Littre hernia. Diverticulitis or perforation was confirmed by either surgical or histopathological findings of acute inflammation, acute suppurative exudate, or perforation. For analysis of clinical presentations, intussusception and NI bowel obstruction comprised the obstructive category whereas gastrointestinal bleeding and diverticulitis/perforation constituted the nonobstructive category.

2.2. Statistical analysis

The data were analyzed using descriptive statistical procedures for calculating means, standard deviations (SD), frequencies, and percentages. In addition, univariate logistic regression analyses were applied to evaluate factors including age, sex, distance to the ileocecal valve, diverticular length, diverticular diameter, length-to-diameter ratio, and the presence of ectopic tissue associated with obstructive or nonobstructive presentations. The Wald chi-square test was used to determine statistical significance. Results of the logistic regression model were presented in terms of odds ratios (OR), 95% confidence intervals (CI), and p values. A p value < 0.05 was considered statistically significant. All analyses were conducted with SPSS version 13.0 (SPSS Inc, Chicago, IL, USA).

3. Results

During a 13-year period, 126 consecutive children (92 boys, 34 girls) received a diagnosis of Meckel's diverticulum or patent vitelline duct. Eighteen children underwent

Table 1 Clinical characteristics in different symptomatic groups.

	All patients (N = 100)	Intussusception (n = 17)	NI bowel obstruction (n = 24)	Gastrointestinal bleeding (n = 44)	Diverticulitis and/or perforation (n = 15)
Demographic characteristics					
Age (mean ± SD, y)	5.32 ± 4.74	4.55 ± 3.76	6.16 ± 5.80	5.30 ± 4.58	4.88 ± 4.55
Gender (male/female)	74/26	9/8	17/7	37/7	11/4
Clinical features [n (%)]					
Fever	25 (25.0)	4 (23.5)	5 (20.8)	6 (13.6)	10 (66.7)
Vomiting	53 (53.0)	13 (76.5)	23 (95.8)	7 (15.9)	10 (66.7)
Bloody stool	50 (50.0)	5 (29.4)	0 (0)	44 (100)	1 (6.7)
Abdominal pain	57 (57.0)	14 (82.4)	20 (83.3)	12 (27.3)	11 (73.3)
Positive Meckel's scan [n (%)]*	—	—	—	38 (92.7)	—
Operation findings					
Distance to ileocecal valve (mean ± SD, cm)	47.58 ± 14.50	44.38 ± 19.35	46.56 ± 16.10	52.59 ± 11.15	38.18 ± 12.10
Diverticular length (mean ± SD, cm)	3.72 ± 1.95	4.03 ± 2.22	3.54 ± 1.68	4.06 ± 2.25	2.91 ± 0.84
Diverticular diameter (mean ± SD, cm)	1.65 ± 0.66	2.17 ± 0.47	1.56 ± 0.65	1.68 ± 0.68	1.53 ± 0.66
Length-to-diameter ratio (mean ± SD)	2.47 ± 1.60	2.10 ± 0.63	2.52 ± 1.99	2.50 ± 1.15	2.49 ± 2.26
Ectopic tissue [n (%)]	73 (73.0)	12 (70.6)	11 (45.8)	43 (97.7)	7 (46.7)

NI = non-intussusception.
* Forty-one children underwent the scan before surgery.

incidental diverticulectomy during surgery for gastroschisis, jejunal atresia, meconium ileus, or ingested foreign body. Eight had patent vitelline duct. Eventually, the remaining 100 symptomatic patients were enrolled in the current study. Demographic characteristics of the patients are listed in Table 1. A total of 100 children (74 boys, 26 girls) with a mean age of 5.32 ± 4.74 years (range, 1 day to 17.83 years) were included. They were further categorized into four groups: 17 in the intussusception group, 24 in the NI bowel obstruction group, 44 in the gastrointestinal bleeding group, and 15 in the diverticulitis and/or perforation group. The mean age of patients in the NI bowel obstruction group was older (6.16 ± 5.80 years). In each group, males accounted for more cases than females. The clinical

Table 2 Surgical procedures for obstructive and nonobstructive categories.

	Total (N = 100)	Obstructive			Nonobstructive		
		Intussusception (n = 17)	NI bowel obstruction (n = 24)	Subtotal (n = 41)	Gastrointestinal bleeding (n = 44)	Diverticulitis and/or perforation (n = 15)	Subtotal (n = 59)
Simple diverticulectomy [n (%)]							
Laparotomically	8 (8.0)	3 (17.6)	3 (12.5)	6 (14.6)	1 (2.3)	1 (6.7)	2 (3.4)
Laparoscopically	3 (3.0)	0 (0)	0 (0)	0 (0)	3 (6.8)	0 (0)	3 (5.1)
Wedge-shaped excision [n (%)]							
Laparotomically	12 (12.0)	5 (29.4)	3 (12.5)	8 (19.5)	3 (6.8)	1 (6.7)	4 (6.8)
Laparoscopically	2 (2.0)	0 (0)	0 (0)	0 (0)	2 (4.5)	0 (0)	2 (3.4)
Segmental bowel resection [n (%)]							
Laparotomically	51 (51.0)	8 (47.1)	17 (70.8)	25 (61.0)	17 (38.6)	9 (60.0)	26 (44.1)
Laparoscopically	24 (24.0)	1 (5.9)	1 (4.2)	2 (4.9)	18 (40.9)	4 (26.6)	22 (37.3)
Laparotomy [n (%)]	71 (71.0)	16 (94.1)	23 (95.8)	39 (95.1)[†]	21 (47.7)	11 (73.3)	32 (54.2)[†]
Laparoscopy [n (%)]	29 (29.0)	1 (5.9)	1 (4.2)	2 (4.9)[‡]	23 (52.3)	4 (26.7)	27 (45.8)[‡]
Diverticulectomy [n (%)]	11 (11.0)	3 (17.6)	3 (12.5)	6 (14.6)	4 (9.1)	1 (6.7)	5 (8.5)
Bowel resection [n (%)]*	89 (89.0)	14 (82.4)	21 (87.5)	35 (85.4)	40 (90.9)	14 (93.3)	54 (91.5)

* Bowel resection included wedge-shaped excision and segmental bowel resection.
[†,‡] p < 0.001 by chi-square test.

Table 3　Histopathological diagnosis of ectopic tissues in obstructive and nonobstructive categories.

	Total (N = 100)	Obstructive			Nonobstructive		
		Intussusception (n = 17)	NI bowel obstruction (n = 24)	Subtotal (n = 41)	Gastrointestinal bleeding (n = 44)	Diverticulitis and/or perforation (n = 15)	Subtotal (n = 59)
Ectopic tissue [n (%)]							
Gastric	61 (61.0)	6 (35.3)	10 (41.7)	16 (39.0)	38 (86.4)	7 (46.7)	45 (76.3)
Pancreatic	2 (2.0)	2 (11.8)	0 (0)	2 (4.9)	0 (0)	0 (0)	0 (0)
Coexistent	10 (10.0)	4 (23.5)	1 (4.2)	5 (12.2)	5 (11.4)	0 (0)	5 (8.5)
Absence [n (%)]	16 (16.0)	4 (23.5)	6 (25.0)	10 (24.4)	1 (2.3)	5 (33.3)	6 (10.2)
Necrosis [n (%)]	11 (11.0)	1 (5.9)	7 (29.2)	8 (19.5)[†]	0 (0)	3 (20.0)	3 (5.0)[†]
Ectopic gastric tissue [n (%)]*	71 (79.8)	10 (62.5)	11 (64.7)	21 (63.6)[‡]	43 (97.7)	7 (58.3)	50 (89.3)[‡]
Ectopic pancreatic tissue [n (%)]*	12 (13.5)	6 (37.5)[§]	1 (5.9)[§]	7 (21.2)	5 (11.4)	0 (0)	5 (8.9)[§]

* The necrosis group was excluded.
† OR 4.53, $p < 0.05$ by chi-square test.
‡ OR 4.76, $p < 0.01$ by chi-square test.
§ OR 6.70, $p < 0.01$ by chi-square test, intussusception versus NI bowel obstruction plus non-obstructive category.

features in each group varied. The most commonly encountered clinical manifestations were fever (66.7%) in the diverticulitis and/or perforation group, bloody stool (100%) in the gastrointestinal bleeding group, and vomiting (95.8%) and abdominal pain (83.3%) in the NI bowel obstruction group.

In the intussusception group (n = 17), patients aged between 3 months and 3 years made up 52.9% of all intussusceptions. The preoperative diagnosis of intussusception was established by abdominal ultrasound (82.4%), plain abdominal film (5.9%), and abdominal computed tomography (5.9%). However, MD as the lead point was not confirmed until surgery. In one patient, intussusception had remained unrecognized until laparotomy because of clinical symptoms mimicking appendicitis. Ten of 12 patients (83.3%) who underwent preoperative pneumatic or barium reduction encountered reduction failure. Successful reduction was achieved only in two patients, but subsequent recurrence resulted in unsuccessful reduction. According to surgical records, ileocolic type was found in three patients, and small-bowel intussusception (ileoileal

type) with or without colonic involvement was identified in the others.

In the gastrointestinal bleeding group (n = 44), 41 patients underwent the technetium Tc 99m pertechnetate Meckel's scan before surgery; of these, 38 (92.7%) showed positive results and three (7.3%) showed negative results. Thirty-two patients required blood transfusion because of hypotension or shock.

In the NI bowel obstruction group (n = 24), obstruction was caused by volvulus, internal hernia, adhesion band, or combined circumstances in most cases. In addition, one boy presented with inguinal type of Littre hernia.

The mean values of the distance to ileocecal valve, the diverticular length, and the diverticular diameter were 47.58 ± 14.50 cm, 3.72 ± 1.95 cm, and 1.65 ± 0.66 cm, respectively. A length-to-diameter ratio of 2.47 ± 1.60 was counted.

Table 2 shows the surgical procedures for symptomatic MD. Patients were managed by segmental bowel resection (75%), wedge-shaped excision (14%), and simple diverticulectomy (11%). In both categories, the preferable surgical

Table 4　Univariate analysis of clinical characteristics in obstructive versus nonobstructive categories.

Variable	Obstructive (n = 41)	Nonobstructive (n = 59)	Odds ratio	95 % CI	p[†]
Age (mean ± SD, years)	5.49 ± 5.06	5.19 ± 4.54	0.99	0.91−1.07	0.751
Gender: male [n (%)]	26 (63.4)	48 (81.4)	2.52	1.01−6.27	0.047
Distance to ileocecal valve (mean ± SD, cm)	45.83 ± 16.85	48.63 ± 13.01	1.01	0.98−1.05	0.454
Diverticular length (mean ± SD, cm)	3.66 ± 1.79	3.76 ± 2.04	1.03	0.80−1.32	0.834
Diverticular diameter (mean ± SD, cm)	1.69 ± 0.14	1.64 ± 0.10	1.14	0.54−2.41	0.739
Length-to-diameter ratio (mean ± SD)	2.43 ± 0.37	2.49 ± 0.22	0.98	0.71−1.34	0.877
Presence of ectopic tissue [n (%)]*	23 (69.7)	50 (89.3)	3.62	1.18−11.17	0.025
Ectopic gastric tissue [n (%)]*	21 (63.6)	50 (89.3)	4.76	1.58−14.37	0.006
Ectopic pancreatic tissue [n (%)]*	7 (21.2)	5 (8.9)	0.36	0.11−1.26	0.111

* The necrosis group was excluded.
† Wald chi-square test.

technique was segmental bowel resection. The unduly low proportion of segmental bowel resection was found among the patients with intussusception (52.9%) compared with those with NI bowel obstruction (75.0%), gastrointestinal bleeding (79.6%), and diverticulitis and/or perforation (86.7%). Overall, the percentages of laparotomic and laparoscopic procedures were 71% and 29%, respectively. Conventional laparotomy was still the choice of treatment in intussusception or NI bowel obstruction, and laparoscopically assisted procedures were preferred in the gastrointestinal bleeding group ($\chi^2 = 19.64$, $p < 0.001$).

The ectopic tissues identified in each group of symptomatic MD are shown as Table 3. Overall, histopathology revealed ectopic tissue in 73 specimens (73%). Gastric type ectopic tissues were detected in 61 specimens (61%), pancreatic type in two (2%), and coexistent gastric and pancreatic type in 10 (10%). No other type of ectopic tissue was found in this series. The presence of ectopic gastric tissue accounted for 97.7% of gastrointestinal bleeding. The presence of ectopic pancreatic tissue was more in the intussusception group than in the other groups ($\chi^2 = 9.65$, $p < 0.05$). Necrosis was more significantly observed in histopathology in the obstructive category than in the nonobstructive category ($\chi^2 = 5.14$, $p < 0.05$).

Table 4 shows the results of the univariate logistic regression analysis between obstructive and nonobstructive categories. Male predominance was more prominent in nonobstructive than obstructive presentations (male to female, 4.4:1 vs. 1.7:1, OR 2.52, $p < 0.05$). An ectopic tissue was significantly identified more frequently in the nonobstructive category (89.3% vs. 69.7%, OR 3.62, $p < 0.05$). Moreover, the presence of ectopic gastric tissue was also more associated with nonobstructive than obstructive features (89.3% vs. 63.6%, OR 4.76, $p < 0.05$). Age, the distance to the ileocecal valve, diverticular length, diverticular diameter, and length-to-diameter ratio were not significantly different in terms of presentations.

4. Discussion

It is well known that symptomatic MD commonly presents before the age of 2 years[3,7]; however, patients younger than 2 years comprise only 35% of symptomatic MD in this study. Park et al. demonstrated that the frequency of symptomatic MD declines with age in the pediatric population.[11] Painless or minimally painful gastrointestinal bleeding is the most common presentation, and it accounts for 46.7–59.3% symptomatic MD in children.[10,12–14] Sixty-seven percent to 71% of patients presenting with massive LGI bleeding required blood transfusion.[13,15] This study shows a similar percentage (72.7%) of transfusion requirement in the case of massive hemorrhage. However, some series have reported that intestinal obstruction is a predominant symptom in children.[11,15,16]

Some have reported that younger patients in the pediatric population with symptomatic MD are more prone to present with obstructive symptoms[11,13]; nevertheless, no such age discrepancy can be found in our gastrointestinal bleeding group compared with either the intussusception group or the NI bowel obstruction group ($p = 0.56$ and $p = 0.50$, respectively).

Intussusception and volvulus are the two most common causes of intestinal obstruction in MD. In secondary intussusception, MD is the most common lead point.[17] Idiopathic intussusception typically occurs between the ages of 3 months and 3 years. Tseng et al. reported that half of MD-associated intussusception occurs in patients older than 3 years.[13] Our series shows a similar percentage (47.1%, 8/17) of MD-associated intussusception occurring at ages older than 3 years. Furthermore, in this study 82.4% of MD-associated intussusception presented as small-bowel intussusception with or without colonic involvement. This observation may explain the high failure rate of pneumatic or barium reduction and mandatory surgical intervention in MD-associated intussusceptions. Volvulus represented the third leading cause of obstruction in this study. It is uncommon that one child in our series presented with inguinal type of Littre hernia. Approximately half of Littre hernias reported in the literature occur in inguinal region during adulthood,[6,18] and the umbilical type of Littre hernia is more common in pediatric population.[7]

The dimensions of MD have been associated with symptom occurrence from a previously asymptomatic MD. Patients with diverticular length greater than 2 cm were more prone to develop symptoms according to the Mayo Clinic survey.[11] Some studies have also documented that a long or thin-based MD is more likely to develop symptoms than a short or broad-based one.[19,20] In our series, the distance to the ileocecal valve is in agreement with the rule of two, whereas the mean length of MD does not follow the traditional rule. A correlation between dimensional characteristics and diverse symptoms cannot be established in our series.

The technetium Tc 99m pertechnetate Meckel's scan is a widely used diagnostic tool to identify ectopic gastric mucosa. In the literature, some medications including H-2 receptor antagonists, somatostatin, glucagon, and pentagastrin have been documented to enhance the sensitivity of the scan.[3,5,12,21] Cimetidine is thought to work by inhibiting and blocking tracer secretion by mucus cells, resulting in an enhanced accumulation of tracer. Patients were routinely treated with H-2 receptor antagonist (cimetidine) before the examination in our series. The usual protocol in our series was multiple (2–3) doses of cimetidine administered intravenously at a dosage of 5–10 mg/kg every 6 hours before the scan. Meckel's scan has been reported to have a diagnostic sensitivity for MD in up to 95% in pediatric patients.[21,22] Likewise, our series shows a high positive rate of 92.7%. Even though Meckel's scan is more accurate and sensitive in children than in adults, false-negative bleeding MD may require repeated scanning to diagnose if the clinical condition permits.[23]

For children with obstructive symptoms, despite low specificity, the utilization of radiological or sonographic modalities is clinically preferred to a Meckel's scan because MD accounts for only a small fraction of intestinal obstruction. Although some imaging clues for MD can be identified by experienced radiologists, routine computed tomography is not advocated in cases presenting with intestinal obstruction.[24] From our series, it is conceivable that there may be a relatively low positive rate of Meckel's scan in cases of MD presenting as intestinal obstruction because of lower prevalence of ectopic gastric tissue and higher prevalence of necrosis, both leading to a negative

Meckel's scan. Ischemia following mechanical obstruction arising from intussusception, internal hernia, or volvulus may help to explain the significantly increasing frequency of necrosis of pathological specimens in obstructive MD, compared with those in the nonobstructive group. This in turn limits the utilization of Meckel's scan to make an explicit diagnosis before surgery.

Symptomatic MD should be treated by surgical resection. The choice of surgical techniques depends on the external appearance of MD.[25–27] In addition, a length-to-diameter ratio is helpful to determine surgical approach.[26] The surgical choice in the situation of bleeding MD is wedge-shaped excision or segmental bowel resection because the bleeding site is typically adjacent ileal wall.[19,28] Based on the surgical findings, bowel gangrene concurrently occurred in one-third of MDs with NI bowel obstruction. This is nearly twofold greater than those with intussusception (17.6%) in our series. For these reasons, simple diverticulectomy was performed more often in intussusception. Segmental bowel resection was carried out in the majority of symptomatic MD. In our center, one third of MDs were managed laparoscopically, similar to the current trend in the United States.[29] It appears that because of indefinite preoperative diagnosis in obstructive presentations, this category was mostly (~95%) managed laparotomically, whereas 52.3% of bleeding MD were managed laparoscopically in this series.

Ectopic tissues have been detected in 31–85% of symptomatic MD in previous pediatric series.[11–13,15,16,30,31] Ectopic tissues were present in 73% (73/100) of our series. Gastric and pancreatic tissues, respectively, accounted for 97.3% (71/73) and 16.4% (12/73) of ectopic tissue-containing MD. Ectopic pancreas occurs with an incidence of 0.4% in children,[32] and it has accounted for 3–23% of ectopic tissues within symptomatic MD.[3,11,15,16,33] It has been considered a pathological lead point for intussusception.[15,34] MD with intussusception accordingly exhibits higher prevalence of ectopic pancreas than those with other presentations in our series. Our series further clarifies that the presence of ectopic tissue is more associated with nonobstructive manifestations of MD.

Symptomatic MD is predominant in males, with a sex ratio ranging from 2:1 to 4:1.[12,13,15,31] Our series show similar male preponderance, which is even more exaggerated in nonobstructive MD. Excessive acid secretion from ectopic gastric tissues in males may predispose MD to develop bleeding ulcers or inflammation.[35] Male predisposition is observed in peptic ulcer disease, which implies that bleeding MD and peptic ulcer disease may share a similar pathogenesis. CDX2 is a protein, one of the caudal-related homeobox transcription factors. Recent studies have revealed a close relationship between lack of CDX2 expression and differentiation of ectopic gastric tissues in MD.[36] In addition, methylation of CDX2 with downregulation of gene expression is found to be increased in males.[37] These findings offer a hypothetical mechanism by which sex and some specific gene expression such as CDX2 may be involved in embryonic gut differentiation into ectopic gastric mucosa as well as consequent activity of gastric gland cells.

In conclusion, MD is an important differential diagnosis in pediatric patients presenting with intestinal obstruction, gastrointestinal bleeding, or peritonitis. Except for Meckel's scan-positive patients who undergo diagnostic survey for gastrointestinal bleeding, it remains a challenge in diagnosis before operation. Male predominance is more obvious in MD with nonobstructive symptoms than with obstructive symptoms. The presence of different ectopic tissues has great influence on clinical manifestations of symptomatic MD. This study clearly shows that ectopic gastric and pancreatic tissues, respectively, are predisposed to nonobstructive (bleeding, ulcerative, or inflammatory) and intussusception presentations.

Conflicts of interest

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