

Management of Meckel diverticulum in Children

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Abstract

Background: Meckel diverticulum (MD) is one of the most common congenital anomalies of the small intestine. Traditionally operative management of MD involves laparotomy with diverticulectomy. Today laparoscopic surgery is becoming increasingly popular. However, questions about what type of surgery should be chosen in children with MD still under debate. The aim of this study was summarized own experience in the management of MD in children.

Material and Methods: We retrospectively evaluated results of management of 87 patients with MD that treated at L'viv regional children's clinical hospital «OXMATDYT» for 2010-2019 years. Among all patients, 75 (86.2%) of them required the emergency surgery and 12 (13.8%) underwent the elective surgery. The open laparotomy approached in 66 (75.9%) patients, while 21 (24.1%) patients approached laparoscopically.

Results: Segmental ileal resection with anastomosis (19 patients), wedge-shaped resection of MD (37 patients), and simple diverticulectomy (10 patients) was applied at the open surgery. Laparoscopic diverticulectomy was performed at 14 patients and transumbilical laparoscopic-assisted diverticulectomy – at 7 patients. Operative time and length of hospital stay was shorter in patients that were operated laparoscopically (p0.05).

Conclusion: The diagnosis of MD still remains a challenge because of overlapping clinical features of other acute surgical and inflammatory conditions of the abdomen. Laparoscopy is safe and effective in the management of simple and complicated MD in children. It is useful as both a diagnostic and therapeutic modality. Laparoscopic-assisted approach appears to be safe, feasible, and produces similar results to traditional laparotomy.

Key words: children, Meckel diverticulum, surgery, laparoscopy, laparoscopic-assisted procedure

Introduction

Meckel diverticulum (MD) is one of the most common congenital anomalies of the small intestine [1]. MD results from an incomplete obliteration of the vitelline (omphalomesenteric) duct, which connects the midgut to the yolk sac in the fetus, usually between the fifth and sixth weeks of gestation as the bowel settles into normal anatomical position [2]. Some authors characterized MD by the rule of “twos”: frequency of 2%, 2 times more predominate in males, diagnosed most in children below of 2 years old, located within 2 feet (60 cm) of the ileocecal valve, commonly 2 cm in diameter, 2 inch (5 cm) of length, and may content of 2 types of ectopic mucosa (gastric and pancreatic) [3-6]. Being in most cases remains asymptomatic [6-8], but in some cases, MD may provoke life-threatening complications, such as intestinal obstruction, intestinal bleeding, intraabdominal infection, and umbilical anomalies [4, 5, 9]. The lifetime risk for an MD-related complication varies from 4% to 34% [10, 11], and this risk decreases with age [12].

The clear preoperative diagnosis of MD in patients with acute abdominal pain or signs of intestinal obstruction is challenging, despite the availability of modern imaging. Due to that, the lot cases of MD diagnosed intraoperatively [13, 14]. Symptomatic MD always required its removing [7, 15], whereas in cases of incidentally discovered MD there is controversy regarding surgical resection [11, 16, 17].

Traditionally operative management of MD involves laparotomy with diverticulectomy with or without small bowel resection [15, 18]. With the advent of laparoscopic surgery,

the intracorporeal diverticulectomy with the laparoscopic stappling devices or laparoscopic-assisted excision, is becoming increasingly popular [19, 20]. However, questions about what type of surgery should be chosen in children with the different types of MD still under debate.

The aim of this study was summarized own experience in the management of MD in children.

Material and Methods

We retrospectively evaluated results of management of 87 patients with MD that treated at L'viv regional children's clinical hospital «OXMATDYT» for 2010-2019 years. This study was approved by the local ethics committee of L'viv regional children's clinical hospital «OXMATDYT». The need for informed consent was waived because no identifying information was collected.

Preoperative diagnosis of MD was established in 14 (16.1%) patients, by that 12 of them were previously operated and the presence of MD was noted, but it was not removed. In two patients the presence of MD was suspected during contrast enhanced CT. At the rest 73 (83.9%) patients MD was diagnosed intraoperatively.

Among all patients, 75 (86.2%) of them required the emergency surgery due to the presence of signs of acute intestinal obstruction, intestinal bleeding, or peritonitis, and 12 (13.8%) underwent the elective surgery. The patients were divided into 2 groups according to whether they underwent open or laparoscopic surgery. The open laparotomy approached in 66 (75.9%) patients, while 21 (24.1%) patients

initially approached laparoscopically.

Simple MD presented with the clear base with edematous or mild/moderate reactive inflammatory changes of diverticulum tissue, while complicated MD presented with edematous base, gangrenous changes of diverticulum or visualized hole of diverticulum.



Figure. (A) Complicated MD with the reactive changes of adjacent intestine that required segmental ileal resection. (B) Simple MD with wide edematous base

Open diverticulectomy was applied in 66 (75.9%) patients, by that in 34 patients it performed through incision in the right lower quadrant and in 32 patients – through midline laparotomy.

In laparoscopically treated patients two technics were applied: three port laparoscopic procedure with the use of endoscopic linear stapler-cutting device (14 patients) and transumbilical laparoscopic-assisted procedures (7 patients).

For the laparoscopy, patients placed in the supine position under general anesthesia. The first 5-mm port was placed in the subumbilical area to insert camera 30° using the Hasson open technique. Working 3- or 5-mm ports were inserted at the left and right lower quadrant of abdomen. One of working port was changed for the 10-mm port when the liner stapler-cutting device was applied. Resected MD was placed in a EndoBag (Karl Storz) that was retrieved through the umbilical port.

For the laparoscopic-assisted diverticulectomy, the supraumbilical incision was extended by about 3-4 cm to exteriorize the MD for wedge-shaped resection or small bowel resection with anastomosis using a hand-sewn method. The bowel was then reinserted to the abdomen and the incisions and ports were closed with interrupted sutures.

The SPSS 15.0 software package was used for the statistical analysis of the results. The data were represented as mean \pm standard deviation; the two groups were compared using the mean rank sum test, with $p < 0.05$ being used for significant differences.

Results

There were 65 males and 22 females, with the mean age of 6.7 years ranging from 3 month to 17 years old. Patient characteristics and clinical presentation of MD summarized in table 1.

Table 1. Patients characteristics

Characteristic	
Age	6.7 \pm 5.02 (range 3 m – 17 yrs)
Sex, n	
Male	65 (74.7%)
Female	22 (25.3%)
Clinical presentation	
Pain	54 (62.1%)
Vomiting	41 (47.1%)
High temperature	29 (33.3%)
Nausea	12 (13.8%)
Bloody stool	10 (11.5%)
Anxiety	13 (14.9%)
Constipation	8 (9.2%)
Asymptomatic	14 (16.1%)

Most patients (73.6%) were younger than 10 years, and 39.1% of them were younger than 3 years. The mean age of patients with intussusception was 4.2 years (range from 1 year to 11 years).

Thirty-nine (44.8%) patients were operated with symptoms of peritonitis. Among them, the acute (phlegmonous or gangrenous) diverticulitis was noted in 28 patient and perforation of MD – in 11 patients. Twenty-six (29.9%) patients were operated with the signs of acute bowel obstruction: in 10 of them the intussusception with the MD as lead point was revealed, in 7 – was volvulus, and in 6 – strangulation caused Meckel bands. Ten (11.5%) patients had signs of gastrointestinal bleeding, 2 of them without pain, the other with abdominal pain.

Among symptomatic patients, the presence of ectopic gastric mucosa was revealed in 11 (14.7%) patients and gastric with pancreatic heterotopia – in 5 (6.7%) of them.

Simple MD was established in 56 (64.4%) and complicated MD – in 31 (35.6%) of patients.

Types of open diverticulectomy based on size and presence/absent inflammatory changes of MD and adjacent intestine. Segmental ileal resection with anastomosis (19 patients) was applied in cases of complicated MD (Fig. A) with the reactive inflammatory changes of adjacent intestine; wedge-shaped resection of MD (37 patients) – in case of complicated MD without inflammatory changes of adjacent intestine or simple MD with the wide edematous base of MD (Fig. B), and simple diverticulectomy with the purse-string suturing (10 patients) – in case of simple or incidentally-found MD with the narrow base.

The operation time was longest at cases with segmental ileal resection (range from 72 to 96 min, mean – 82.2 \pm 7.26 min), shortest at cases with simple diverticulectomy – from 38 to 56 min (mean – 47.2 \pm 6.28 min), and in case of wedge-shaped resection operation time ranged from 49 to 86 min (mean – 66.5 \pm 12.76 min).

Operative and postoperative outcomes of open and laparoscopic surgery for MD presented in table 2.

Laparoscopic diverticulectomy by the endoscopic linear stapler-cutting device was performed in 14 patients with the simple MD, transumbilical laparoscopic-assisted diverticulectomy in 4 patients with simple MD (wedge-shaped resection), and in 3 patients with complicated MD (segmental ileal resection). The operation times for the laparoscopically assisted procedure and for laparoscopy only were 46-92 min (62.4 \pm 16.43 min) and 27-62 min (39.8 \pm 9.42 min),

respectively ($p < 0.05$).

Table 2. Operative and postoperative outcomes of open vs. laparoscopic surgery for MD

	Open surgery (n=66)	Laparoscopic surgery (n=21)	p-Value
Operative time (minutes)	68.2±15.26	47.7±16.25	<0.001
Length of hospital stay (d)	7.4±1.29	6.8±1.27	0.087
30-Days mortality	0%	0%	1
Intestinal obstruction	4.55% (3)	4.8% (1)	0.884
Organ/space infection	4.55% (3)	4.8% (1)	0.884
Deep incisional infection	1.5% (1)	0% (0)	0.314
Time to flatus (days)	3.9±1.19	3.1±0.85	0.007
Time to soft diet (days)	6.5±0.95	4.8±0.93	<0.001
Re-operation	3.0% (2)	0% (0)	0.155
Re-admission	0%	0%	1

The time to flatus (3.1 vs. 3.9 days, $p = 0.007$), time to soft food intake (4.8 vs. 6.5 days, $p = < 0.001$), and length of hospital stay (6.8 vs. 7.4 days, $p = 0.087$) were shorter in the laparoscopic group than in the open surgery group (Table 2).

Postoperative complications occurred in 7 (10.6%) patients in the open surgery group and in 2 (9.5%) patients in the laparoscopic group, resulting in similar rates in both groups ($p = 0.886$). The most common complication was intestinal obstruction, which occurred in 3 (4.55%) patients after open diverticulectomy and in one (4.8%) patient in laparoscopic group, as well organ/space infection with the frequency 4.55% (3 patients) and 4.8% (1 patient) (Table 2). Wound infection was diagnosed in one (1.5%) patient in open surgery group that treated conservatively. Two patients with intestinal obstruction in the open surgery group underwent re-operation during initial admission and 2 patients with ileus of both groups treated conservatively. There no cases of re-admission and no 30-days mortality in both groups of patients.

Discussion

Most authors pointed that MD is one of the most often congenital anomalies of gastrointestinal tract in children [1, 2, 6, 7], however, Lin et al allows that MD is rarely observed in children [21]. According to our study, the incidence of MD was 1.5% that corresponded with literature data [22, 23]. The clear preoperative diagnosis of MD is challenging, due to symptoms variability, despite the availability of modern imaging [1, 24]. Furthermore, traditional diagnostic methods, such as barium series, ultrasonography, and CT or scintigraphy with Tc-99m pertechnetate had high false negative or positive rates [1, 25, 26]. In this study, the clear preoperative diagnosis of MD was established only in 14 (16.1%) of patients, including 12 patients that had previous surgery, when the presence of MD was noted, but it was not removed. In the rest of patients, the diagnosis was established intra-operatively that consistent with the literature data [1].

In the largest patient series (each containing >100 patients), the proportion of symptomatic MD is 9.0% to 71.1% of all resected specimens [5, 27, 28]. In the present study, the proportion of symptomatic patient was 86.2% that insignificantly higher than literature data.

Open surgical management has been laparotomy and simple diverticulectomy or wedge excision of the adjacent ileum, or segmental ileal resection and anastomosis, which

seems to be the most popular surgical procedure for MD to date [29]. That is consistent with results of this study, where 75.9% of patients were operated by open approach. Among them, in 56.1% the wedge-shaped resection of MD was performed, in 28.8% – segmental ileal resection with anastomosis, and in 15.1 – simple diverticulectomy with the purse-string suturing was used.

In 1992 Attwood et al. [30] first reported laparoscopic treatment of MD and after that several studies have confirmed the possibility of laparoscopic treatment [1, 7, 18, 31]. Currently, there are two laparoscopic procedures that are performed for MD. The first technique is a three-port laparoscopic procedure with the applying of stapler device and the second is transumbilical laparoscopic-assisted diverticulectomy, which allows the exteriorization of the diverticulum through the navel and the performance of the diverticulectomy outside of the abdomen with its repair in relationship to the enteric defect and morphology [1, 15, 29].

Laparoscopic diverticulectomy was applied in 66.7% of patients with a simple type of MD that treated laparoscopically. We performed intracorporeal diverticulectomy by the endoscopic linear stapler-cutting device that coincide with literature data [9, 32].

Transumbilical laparoscopic-assisted wedge-shaped resection was applied in 19% and segmental ileal resection in 14.3% of patients of laparoscopic group. In case of laparoscopic-assisted procedure, simple diverticulectomy, segmental ileal resection or wedge-shaped resection of the MD are performed using hand-sewn method, which was used in our study, or staplers [1, 29, 31, 33]. This procedure has numerous advantages. First, extracorporeal resection and anastomosis can be performed easily and safely without the risk of intraperitoneal contamination [29]. Second, this technique allows the surgeon to assess the presence of remnant heterotopic mucosa by palpation of MD [33], and does not require expensive laparoscopic staplers [31, 32].

For our opinion, the transumbilical laparoscopic-assisted approach, especially in cases of complicated MD, in which the intestine is exteriorized through extension of the umbilical port site, may help to bridge the experience gap between the open and laparoscopic approaches, and may facilitate avoidance of open laparotomy.

Early in a surgeon's experience with laparoscopic cases, the operative time for laparoscopic surgery will often exceed that of open surgery, but this difference insignificant [18, 34]. In our study, the operative time for laparoscopic surgery, including laparoscopy only and laparoscopic-assisted procedure, was significantly shorter then for open surgery ($p < 0.001$) that coincide with literature data [1, 35]. This difference can be explained by the fact that frequency of segmental ileal resection was lower in the laparoscopic group than in open surgery (14.3% vs. 28.8%).

Complications following resection of MD can occur with the range from 8.3% to 32.8% [18, 24, 33]. In the present study, the overall rate of complication was 11.5% and did not differ between the types of surgery (10.6% in open surgery and 9.5% in laparoscopic surgery, $p = 0.886$) that confirmed other investigators [24]. The organ/space and deep incisional infection (5.7%) and intestinal obstruction (4.6%) were the

main postoperative complications in our patients that is like the prior studies [18, 33, 36].

The major limitation of our study is that it is a retrospective chart review and therefore not as robust as a prospective study would be.

Conclusion

The diagnosis of MD still remains a challenge because of overlapping clinical features of other acute surgical and inflammatory conditions of the abdomen. Laparoscopy is safe and effective in the management of simple and complicated MD in children. It is useful as both a diagnostic and therapeutic modality. Laparoscopic-assisted approach appears to be safe, feasible, and produces similar results to traditional laparotomy.

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