Outcome of laparoscopic diagnosis and treatment of intestinal malrotation in infants and young children

Yasser M. El Basatiny[a], Mohamed R. Abdella[b]

[a]Department of Laparoscopic Surgery, Al Iman General Hospital, Riyadh, Kingdom of Saudi Arabia, [b]Department of General Surgery, Faculty of Medicine, El Minia University, Minia, Egypt

Correspondence to Mohamed R. Abdella, MD, Department of General Surgery, Faculty of Medicine, El Minia University, Minia, 5255, Egypt
Tel: +20 966 509 030 521; fax: 4312799;
e-mail: mrabea177@gmail.com

Received 08 September 2014
Accepted 07 December 2014

The Egyptian Journal of Surgery
2015, 34:22–27

Objective
The aim of this study was to evaluate the safety and efficacy of laparoscopy in the diagnosis and treatment of intestinal malrotation in infants and young children.

Patients and methods
Diagnostic laparoscopy was performed on 27 infants and young children aged 4 months–5 years with suspected intestinal malrotation on clinical examination, imaging studies, or both. All patients with malrotation on exploration were treated with laparoscopic Ladd's procedure. After completion of laparoscopic Ladd's procedure, patients were followed up for 3–18 months.

Results
On diagnostic laparoscopy, seven patients (26%) with normal rotation, two patients (7.4%) with volvulus converted to open surgery, and 18 patients (66.6%) with malrotation only underwent laparoscopic Ladd's procedure. The rate of conversion to laparotomy was 18.5% in all patients and 11.1% in patients who underwent laparoscopic Ladd's. There was a significant association between presence of malrotation and preoperative presentation with bilious emesis. Sixteen patients completed laparoscopic Ladd's procedure for mlarotation with an average operative time of 46 ± 16 min, an average time to normal feeding of 2.7 ± 1 days, and an average postoperative hospital stay of 4.8 ± 2 days. There were no early postoperative complications, and there were no cases with late volvulus. Wound infection occurred in one patient who underwent open approach for volvulus and early adhesive small bowel obstruction in another patient who underwent open laparoscopic Ladd's.

Conclusion
Laparoscopy is a safe and effective method in the diagnosis and treatment of intestinal malrotation in infants and young children, with or without preoperative symptoms.

Keywords:
infants, intestinal malrotation, Ladd's procedure, laparoscopy

Egyptian J Surgery 34:22–27

1110-1121

Introduction

In embryological life, the rotation of the intestine occurs in counterclockwise direction at the level of the duodenum, as well as in the region of the small intestine loop and the cecum. Intestinal malrotation occurs when:

(a) The C-shaped duodenal loop is not rotated to the left,
(b) The mesentery of the small intestine has not become adherent to the posterior wall,
(c) The cecum is not located in the right iliac fossa,
(d) The retroperitoneal fixation of the ascending colon is missing, and
(e) The duodenum is constricted from the outside by the so-called Ladd's bands [1].

The incidence of intestinal malrotation is difficult to determine, but symptomatic intestinal malrotation has an incidence of about 1 in 6000 live births [2].

Malrotation can present at any age, although the classic presentation is in infants with bile vomiting due to duodenal obstruction (extrinsic because of Ladd's bands or by virtue of the twist of the volvulus) [3]. Early diagnosis of intestinal malrotation is of paramount importance to prevent the potentially devastating complications of this anomaly [4]. There is emerging literature to demonstrate the safety and efficacy of laparoscopy in the diagnosis and correction of malrotation in infants and children. Diagnostic laparoscopy is the procedure of choice when intestinal malrotation is suspected. If present, malrotation can be treated adequately with laparoscopic Ladd's procedure [5].

The aim of this study was to evaluate a personal experience with laparoscopy in the diagnosis and surgical treatment of intestinal malrotation in infants and young children in terms of its safety and efficacy.

Patients and methods

Study population

After approval of the study protocol by the Local Ethical Committee and obtaining written fully informed parents' consent. The study included 27 infants and young children who underwent diagnostic

 DOI: 10.4103/1110-1121.153367

laparoscopy for suspected intestinal malrotation and further treatment of proven disease on exploration, from January 2011 to December 2013 in Al Iman General Hospital, Riyadh, Kingdom of Saudi Arabia, and Al Jafel International Hospital, Riyadh, Kingdom of Saudi Arabia. The ages ranged from 4 months to 5 years. The laparoscopic evaluation was indicated on the basis of clinical evaluation in all patients and imaging studies with findings suspecting or confirming malrotation. In symptomatic patients, diagnosis was made within 24 h (eight patients) or less than 7 days (19 patients) of symptom onset. All patients were scheduled for laparoscopic exploration after clinical and/or radiological suggestion. The study excluded patients with preoperatively diagnosed congenital diaphragmatic hernia, gastroschisis, or omphalocele.

Operative technique

All procedures were performed with the patient positioned in a supine head up position. Three trocars of 5 mm diameter were used. A Veress needle was placed through an incision (5 mm) at the inferior umbilical fold, and the abdomen was insufflated to 8 mmHg with CO_2. Thereafter, the needle was replaced by the trocar that contained a camera (5 mm, 30°). The other two trocars were placed at the right and left mid to lower quadrants. Intraoperatively, malrotation was defined as the duodenojejunal junction and the cecum near the midline and the base of the mesentery less than 50% of the diameter of the abdomen, implying a greater risk of midgut volvulus [6]. The presence of Ladd's bands extending across the duodenum confirmed the diagnosis of malrotation. All patients with malrotation on exploration were treated with Ladd's procedure including division of adhesive bands, broadening of the intestinal mesentery, incidental appendectomy, and placement of the bowel in a nonrotated position.

To ensure that the malrotation is treated properly, the whole duodenum and the jejunum should lie on the right side; thus, it was important to free the duodenum in the distal direction and transect all bands. When the anterior mesentery has been widened enough, it is further incised distally and the adjacent bowel is further displaced to either side. Appendectomy was performed in all patients with malrotation using a standard technique, and then the appendix was mobilized using a mid-abdominal wall trocar. When malrotation was doubtful, visualization of the ligament of Treitz was carried out. When there was no malrotation, visualization of the ileocecal region was carried out to confirm whether it was normally fixed. If there was volvulus, difficult bowel orientation, intestinal ischemia, or other inaccessible diagnoses on laparoscopic exploration, conversion to open surgery was carried out.

Postoperative care and follow-up

A nasogastric tube was left behind until gastric retention had ceased. Hospital stay was related to recovery from the procedure and immediate procedure-related complications. The follow-up period for patients who underwent laparoscopic Ladd's procedure ranged from 3 to 18 months (average: 12 ± 4 months).

Statistical analysis

All statistical analyses were performed using SPSS, version 16 (SPSS Inc., Chicago, Illinois, USA). Quantitative numerical variables were presented as mean ± SD and were compared using Student's *t*-test. Qualitative and categorical variables were presented as number and percentage and were compared using the χ^2-test. Measurement of association between different variables and laparoscopic diagnosis of malrotation was performed by calculating odds ratio and its 95% confidence interval. All *P*-values were two sided, and data were considered statistically significant at *P*-value less than 0.05.

Results

At the time of diagnostic laparoscopy for suspected malrotation, there were 27 patients (16 male and 11 female) aged 4 months–4.5 years (14.85 ± 10 months; 1.23 ± 0.83 years) with suspected intestinal malrotation. There were 18 patients (66.7%) aged less than 1 year and nine patients (33.3%) aged more than 1 year. Preoperative symptoms suggesting malrotation were encountered in 19 patients (70%), and eight patients (30%) were asymptomatic. Of the 19 symptomatic patients, 10 patients had more than one symptom. The presenting symptoms include bilious emesis (11; 40.7%), abdominal pain (10; 37%), fever (four; 14.8%), and nonbilious emesis (two; 7.4%). The preoperative imaging studies were performed on 15 patients (55.5%) and not performed in 12 patients (44.5%). These studies include upper gastrointestinal (UGI) contrast series (11; 40.7%), ultrasonography (six; 22.2%), abdominal computed tomography (CT) scan (two; 7.4%), and barium enema (two; 7.4%). There were six patients who underwent more than one imaging study (Table 1).

On the initial diagnostic laparoscopy, there were seven patients (26%) with normal rotation, two patients (7.4%) with volvulus converted to open surgery, and 18 patients (66.6%) with malrotation only who underwent further laparoscopic Ladd's procedure, which was converted to open Ladd's procedure in two patients

(2/18; 11.1%) for further bowel orientation. There were no intraoperative complications during laparoscopic Ladd's procedure. Of the seven patients with normal rotation, six patients underwent diagnostic laparoscopy alone and one patient was converted to open surgery for other diagnoses (pyloric stenosis). Thus, conversion to laparotomy was indicated in five out of 27 patients who underwent initial laparoscopy (18.5%). The preoperative demographic characteristics and clinical presentation in 18 patients with malrotation were comparable to those in the nine patients with volvulus or no malrotation (Table 2). There was a statistically significant association between presence of malrotation and preoperative presentation with bilious emesis [odds ratio = 10 (95% confidence interval 1.02–97.5), $P = 0.02$].

As regards operative and postoperative outcome of 16 patients who completed laparoscopic Ladd's procedure for malrotation (Table 3), the operative time averaged 46 ± 16 min (range: 30–120 min). Normal feeding was started on postoperative day 1–5 (average: 2.7 ± 1 days), and postoperative hospital stay ranged from 3 to 7 days (average: 4.8 ± 2 days). There were no early postoperative complications in the 16 patients who completed laparoscopic Ladd's procedure; however, these complications occurred in two out of five patients who had been converted to open surgery because of malrotation or other diagnoses, including wound infection in one patient who underwent open approach for volvulus, and early adhesive small bowel obstruction in another patient who underwent open approach for malrotation. There were no cases with volvulus after Ladd's procedure during the follow-up period. There was no statistically significant influence of age at surgery and presence of preoperative symptoms on the outcome, after completion of laparoscopic Ladd's procedure in 16 patients (Table 4) and (Figs. 1 and 2).

Table 1 Demographic and clinical characteristics of 27 patients who underwent diagnostic laparoscopy for suspicion of malrotation

Variables	*N* (%)
Age	
Less than 1 year	13 (48)
More than 1 year	14 (52)
Sex	
Male	16 (59.3)
Female	11 (40.7)
Presence of clinical symptoms	19 (70)
Bilious emesis	11 (40.7)
Abdominal pain	10 (37)
Fever	4 (14.8)
Nonbilious emesis	2 (7.4)
Imaging studies	
Upper gastrointestinal series	11 (40.7)
Ultrasonography	6 (22.2)
CT scan	2 (7.4)
Barium enema	2 (7.4)

CT, computed tomography.

Table 2 Association of preoperative demographic and clinical characteristics with malrotation diagnosed on laparoscopy

Characteristics	Laparoscopic diagnosis (*n* = 27) [*n* (%)]		Odds ratio (95% CI)	*P*-value
	Malrotation (*n* = 18)	No malrotation (*n* = 9)		
Age				
Less than 1 year	14 (77.7)	4 (44.4)	2.5 (0.47–13.2)	0.08
More than 1 year	4 (20.3)	5 (55.6)		
Sex				
Male	11 (61.1)	5 (55.6)	1.25 (0.24–6.3)	0.78
Female	7 (38.9)	4 (44.4)		
Presence of symptoms				
Symptomatic	12 (66.7)	7 (77.8)	0.57 (0.09–3.6)	0.55
Asymptomatic	6 (33.3)	2 (22.2)		
Bilious emesis				
Present	10 (55.6)	1 (11.1)	10 (1.02–97.5)	0.02*
Absent	8 (44.4)	8 (88.9)		
Abdominal pain				
Present	6 (33.3)	4 (44.4)	0.62 (0.12–3.2)	0.57
Absent	12 (66.7)	5 (55.6)		
Fever				
Present	3 (16.7)	1 (11.1)	1.6 (0.14–18)	0.70
Absent	15 (83.3)	8 (88.9)		
Nonbilious emesis				
Present	1 (5.6)	1 (11.1)	0.47 (0.02–8.5)	0.60
Absent	17 (94.4)	8 (88.9)		

CI, confidence interval, *Significant difference.

Discussion

Intestinal malrotation results from a failure in the normal embryologic sequence of bowel rotation and fixation. Because its consequences are associated with volvulus leading to devastating intestinal necrosis, an increased awareness of this entity and an understanding of its varied presentation at different ages may reduce the time to diagnosis and improve patient outcome [7,8]. The present study included 27 infants and young children with suspected malrotation, and 18 of them had a confirmed diagnosis of malrotation on initial diagnostic laparoscopy, whose ages were less than 1 year in 77.7%. These findings are in agreement with the literature, which reports that 75–85% of patients are diagnosed by the age of 1 year [9].

In this study, preoperative clinical symptoms suggesting malrotation were reported in 70% of patients. The indication for initial laparoscopy was based not only on clinical symptoms but also on radiological suspicion. Moreover, the results of the present study show that presence of symptoms was not significantly associated

with the presence of malrotation on exploration and did not influence the outcome after laparoscopic correction. These findings were supported by the published data in previous studies, which recommend surgical management using Ladd's procedure for symptomatic or asymptomatic infants and children with malrotation because of the high risk of midgut volvulus, which can have devastating consequences at any age, increasing mortality related to malrotation [10,11].

The presence of bilious vomiting was the only preoperative sign that had a significant association with presence of malrotation on laparoscopic exploration. In the literature, pediatric patients with symptomatic malrotation of the intestine presented with bilious vomiting, which is the most common clinical presentation in neonates, whereas bilious vomiting, recurrent abdominal pain, and failure to thrive are the most common symptoms after the newborn period [12,13]. Moreover, a sudden onset of bilious vomiting in a previously healthy infant has been suggested as hallmark presentation of intestinal malrotation [9]. Thus, our findings also may urge that diagnosis of malrotation should always be kept in mind when assessing any infant or child with symptoms of vomiting and pain, particularly when the vomiting is bile-stained.

Preoperative imaging studies were performed in 55.5% of infants and young children with suspected malrotation, including UGI contrast series, ultrasonography, abdominal CT scan, and barium enema. The imaging studies may play a role in the preoperative diagnosis of malrotation due to nonspecific clinical findings in most cases. The goal of initial bowel imaging is the early detection or exclusion of malrotation to prevent volvulus and potentially life-threatening bowel ischemia. On a plain abdominal radiograph, malrotations may show a wide spectrum of appearances [14]; thus, other modalities such as UGI contrast series are preferred in stable patients with a documented accuracy greater than 80% [10]. Although it is true that the UGI series is the gold standard for the

Table 3 Operative and postoperative outcome of 16 patients who completed laparoscopic Ladd's procedure for malrotation

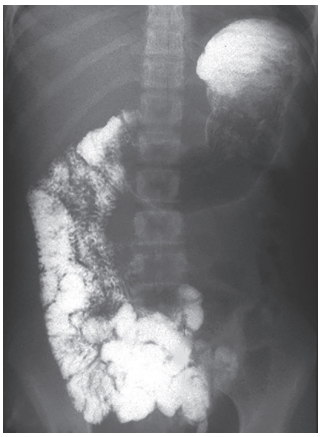
Outcome	Laparoscopic Ladd's procedure (n = 16)
Operative time (min)	46 ± 16
Time to normal feeding (days)	2.7 ± 1
Postoperative hospital stay (days)	4.8 ± 2
Conversion to open procedure	2 (11.1)
Postoperative complications	0 (0)

Data are expressed as mean ± SD, or number and percentage.

Table 4 Influence of age at surgery and presence of preoperative symptoms on outcome after completion of laparoscopic Ladd's procedure in 16 patients

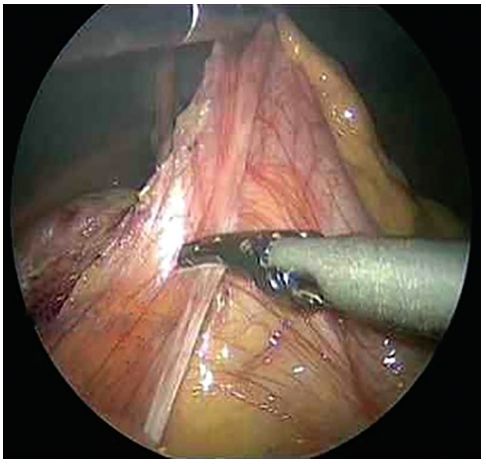
Outcome	Age			Symptoms		
	<1 year (n = 12)	>1 year (n = 4)	P-value	Present (n = 10)	Absent (n = 6)	P-value
Operative time (min)	44.4 ± 18.7	50 ± 18	0.60	49.5 ± 18.4	42.5 ± 18	0.47
Time to normal feeding (days)	2.8 ± 0.92	2.9 ± 1.2	0.86	2.9 ± 0.9	2.8 ± 1.1	0.90
Postoperative hospital stay (days)	4.6 ± 1	5.2 ± 1.7	0.39	5.1 ± 1.3	4.6 ± 1.3	0.55

Figure 1



Upper gastrointestinal contrast study in a 3-year-old child with intestinal malrotation. The duodenojejunal flexure and the small bowel lie to the right of the midline.

Figure 2



Laparoscopic view demonstrating dissection of Ladd's band in an infant with malrotation.

diagnosis of malrotation, it has both false positives and false negatives. Meticulous technique and an awareness of the variations of normal anatomy are critical to minimize errors in the performance and interpretation of this test [15].

Intestinal malrotation is currently treated using the Ladd's procedure. Many surgeons feel that this operation should be performed using the open approach to facilitate adhesion development, thus decreasing the risk for volvulus [16]. The results of the present study show that in the absence of volvulus, laparoscopic approach for malrotation can be safely used for infants and young children with a low rate of conversion to open approach if there is concern about uncorrected volvulus, proper bowel orientation, or true nonrotation. These findings are in agreement with those of other studies supporting the safety and efficacy of laparoscopic Ladd's procedure [5,16–19].

In our experience, there is an important rule to reduce the difficulty of laparoscopic Ladd's procedure that is based on freeing duodenum distally and transecting all bands before widening the mesentry and visualization of whole intestine. Reducing the difficulty of laparoscopic Ladd's might attribute to increased bowel orientation and hence may reduce the rate of conversion to open procedure. In the present study, the overall rate of conversion from initial diagnostic laparoscopy to laparotomy in infants and young children with suspected malrotation was 18.5%, and the rate of conversion from laparoscopic to open Ladd's procedure in patients with laparoscopy-diagnosed malrotation was 11.1%. This rate is within the literature-reported rate in the same age groups, which was 8.3% in the study by Stanfill *et al.* [19], 25% in the study by Hagendoorn *et al.* [5], and 33% in the study by Fraser *et al.* [16]. The variation in the conversion rate might be attributed to the variety of patient, surgeon, and technical factors.

In our study, the operative times, hospital stay, and clinical outcomes were acceptable. In our 16 patients with completed laparoscopic Ladd's procedure, operative time ranged from 30 to 120 min with an average of 46 min, return to normal feeding ranged from 1 to 5 days with an average of 2.7 days, hospital stay ranged from 3 to 7 days with an average of 4.8 days, and the mortality rate was 0%. These results are supported by published similar findings of studies investigating the role of laparoscopic Ladd's procedure in infants and children. In a study by Bass *et al.* [17], operative time averaged 58 min (35–20 min), feeding was started within 2 days after surgery, and hospital stay ranged from 2 to 4 days (average: 2.2 days) in the patients with isolated malrotation, with no complications. In the study by Draus *et al.* [18], operative time averaged 111 min (range, 77–176 min), hospital stay ranged from 3 to 5 days (average: 3.6 days), and all patients were discharged home on a regular diet, with no deaths. In the study by Hagendoorn *et al.* [5], the average operating time was 115 ± 7.8 min and the overall average hospital stay was 11 ± 2.0 days (range: 2–60 days). Several relatively long hospital stays were experienced by children with multiple congenital abnormalities requiring multidisciplinary care. We excluded such patients from our analysis.

In the present study, there was no postoperative complications in patients who completed laparoscopic Ladd's procedure, whereas wound infection and adhesive intestinal obstruction were reported in patients who were converted to open surgery. This finding highlights the potential advantage of laparoscopic over open approach in reducing the likelihood of complications from adhesions [18]. Moreover, despite the underestimate rate of adhesive small bowel obstruction because of limited surgical follow-up after open Ladd procedure reported in the literature, it may reach 15% [20].

From our experience, the successful role of laparoscopy in the diagnosis and treatment of suspected malrotation without preoperative suspicion of volvulus could be attributed to critical variables that include understanding of the anatomy, applying standard rules of laparoscopic management, surgical experience, and case selection, by which the surgeon can decrease the intraoperative laparoscopic complication rate. Moreover, identifying the potential factors for conversion preoperatively that mainly include other diagnoses rather than malrotation, may assist the surgeons in making decisions.

There are two main limitations of the present study: first is the small number of patients, which may be attributed to a low incidence of the disease; and second is the absence of a comparative analysis between laparoscopic and open procedures, which may be attributed to the prospective nature of the study and our trend during the study period to apply laparoscopy in all suspected cases of malrotation, whereas open procedure was not applied routinely for suspicion.

Conclusion

The findings of the present study reflect that laparoscopy is a safe and effective method in the diagnosis and correction of malrotation (Ladd's procedure) in infants and young children, with an acceptable rate of conversion to open Ladd's procedure, acceptable time

to normal feeding, and reduced stay in hospital after intervention.

Acknowledgements

Conflicts of interest

None declared.

References

1 Pumberger W, Kargl S. Malposition of the intestine malposition, malrotation, volvulus 'midgut volvulus'. Eur Surg 2012; 44:237–247.

2 Stringer MD. Intestinal Malrotation In: Puri P, Höllwarth M eds. *Pediatric surgery: diagnosis and management*. Berlin, Heidelberg: Springer-Verlag; 2009; 393–403.

3 Njere IL, Davenport M. MalrotationIn: Sinha CK, Davenport Meds. *Handbook of pediatric surgery*. London, UK: Springer-Verlag London Limited 2010; 89–93.

4 Ramirez R, Chaumoître K, Michel F, Sabiani F, Merrot T. Intestinal obstruction in children due to isolated intestinal malrotation. Report of 11 cases. Arch Pediatr 2009; 16:99–105.

5 Hagendoorn J, Vieira-Travassos D, van der Zee D. Laparoscopic treatment of intestinal malrotation in neonates and infants: retrospective study. Surg Endosc 2011; 25:217–220.

6 Mazziotti MV, Strasberg SM, Langer JC. Intestinal rotation abnormalities without volvulus: the role of laparoscopy. J Am Coll Surg 1997; 185:172–176.

7 Nehra D, Goldstein AM. Intestinal malrotation: varied clinical presentation from infancy through adulthood. Surgery 2011; 149:386–393.

8 Lee HC, Pickard SS, Sridhar S, Dutta S. Intestinal malrotation and catastrophic volvulus in infancy. J Emerg Med 2012; 43:e49–e51.

9 McVay MR, Kokoska ER, Jackson RJ, Smith SD. Jack Barney Award. The changing spectrum of intestinal malrotation: diagnosis and management. Am J Surg 2007; 194:712–717. discussion 718–719

10 Spigland N, Brandt ML, Yazbeck S. Malrotation presenting beyond the neonatal period. J Pediatr Surg 1990; 25:1139–1142.

11 Seashore JH, Touloukian RJ. Midgut volvulus. An ever-present threat. Arch Pediatr Adolesc Med 1994; 148:43–46.

12 Lin JN, Lou CC, Wang KL. Intestinal malrotation and midgut volvulus: a 15-year review. J Formos Med Assoc 1995; 94:178–181.

13 Millar AJ, Rode H, Cywes S. Malrotation and volvulus in infancy and childhood. Semin Pediatr Surg 2003; 12:229–236.

14 Daneman A. Malrotation: the balance of evidence. Pediatr Radiol 2009; 39(Suppl 2):S164–S166.

15 Applegate KE. Evidence-based diagnosis of malrotation and volvulus. Pediatr Radiol 2009; 39(Suppl 2):S161–S163.

16 Fraser JD, Aguayo P, Sharp SW, Ostlie DJ, St Peter SD. The role of laparoscopy in the management of malrotation. J Surg Res 2009; 156: 80–82.

17 Bass KD, Rothenberg SS, Chang JH. Laparoscopic Ladd's procedure in infants with malrotation. J Pediatr Surg 1998; 33:279–281.

18 Draus JM Jr, Foley DS, Bond SJ. Laparoscopic Ladd procedure: a minimally invasive approach to malrotation without midgut volvulus. Am Surg 2007; 73:693–696.

19 Stanfill AB, Pearl RH, Kalvakuri K, Wallace LJ, Vegunta RK. Laparoscopic Ladd's procedure: treatment of choice for midgut malrotation in infants and children. J Laparoendosc Adv Surg Tech A 2010; 20:369–372.

20 Chen LE, Minkes RK, Langer JC. Laparoscopic versus open surgery for malrotation without volvulus. Pediatri Endosurg Innov Tech 2003; 7: 433–438.