

# Laparoscopic Management of Uncomplicated Intestinal Malrotation in Children

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## Abstract

**Introduction:** Anomalies of midgut rotation and fixation associated with volvulus and vascular compromise require urgent surgical intervention. Recent literature supports laparoscopic management of intestinal malrotation in children. But conversion and complication rates of laparoscopic treatment are higher, especially in neonates, and when associated volvulus and bowel ischemia are present. The authors present their experience and results of laparoscopic management of uncomplicated cases of intestinal malrotation in children excluding newborns. **Methods:** A retrospective analysis of all the children who underwent elective laparoscopic Ladd's (LL) procedure was done. All neonates and children presenting with signs of acute volvulus and bowel ischemia were excluded from LL procedure. Between April 2007 and April 2013, 12 patients underwent LL procedure at the author's institution. Of the 12 patients, 8 were boys and the age ranged from 3 months to 9 years. All patients were presented with symptoms of abdominal pain and intermittent bilious vomiting. Diagnosis of intestinal malrotation was suggested either by Doppler ultrasonography or upper gastrointestinal contrast study and confirmed by diagnostic laparoscopy in all the patients. A standard Ladd's procedure with appendectomy was performed laparoscopically in all cases. **Results:** All procedures were completed laparoscopically. Average duration of procedure was about 95 min (75–130 min). Feeding was started on post-op day 1 and all patients were discharged by day 4. There were no immediate or early postoperative complications, but one patient developed intestinal obstruction on follow-up and required intervention. All patients are doing well on latest follow-up. **Conclusion:** LL procedure can be successfully performed in infants and children with uncomplicated cases of intestinal malrotation. Conversion rates are negligible and complications are minimal if strict selection criteria are followed.

**Key words:** malrotation, midgut, laparoscopy, volvulus, Ladd's procedure.

## INTRODUCTION

Malrotation is a spectrum of congenital anomalies resulting from aberrant rotation and fixation of gut during early weeks of gestation. The embryology of malrotation is complex, but fairly well understood. Since these anomalies can be asymptomatic, the exact incidence is difficult to determine, but the incidence of symptomatic malrotation is estimated at 1 in 6000 live births.<sup>1</sup> Clinical presentation of malrotation can be present at any age, but highest incidence of symptomatic malrotation occurs in neonates. Bilious vomiting is the usual symptom present in newborns but

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older children are presented with variable complaints like vague abdominal pain, intermittent bilious or non-bilious emesis, failure to thrive, diarrhea, and constipation.<sup>2</sup> A high index of suspicion is required to diagnose rotational anomalies of gut as none of the radiological investigations are confirmatory. About 20% of malrotation cases are found incidentally while undergoing surgical exploration for an associated anomaly and during upper gastrointestinal (GI) series.<sup>3</sup> As serious complications like midgut volvulus can occur even in late adulthood, all cases of malrotation should be corrected once they are diagnosed.

Ladd's procedure, as described by William Ladd in 1936,<sup>4</sup> still remains the gold standard for correction of malrotation and is traditionally performed by the open method. With the first successful laparoscopic management of acute volvulus with malrotation in a neonate by van der Zee and Bax in 1995, the role of laparoscopy in the management of malrotation became evident.<sup>5</sup> In the last decade, several smaller and larger series further confirmed the feasibility, safety, and efficacy of the LL procedure.<sup>6-12</sup> But conversion to open procedure and complications like clinical relapse due to recurrence of malrotation, volvulus, or both are higher especially in neonates and when associated volvulus and bowel compromise are present. So, the authors have excluded all neonates and children presenting with signs acute volvulus and bowel ischemia from laparoscopic management of intestinal malrotation. In this article, the authors present their experience and results of LL procedure for uncomplicated cases of intestinal malrotation in children, excluding neonates.

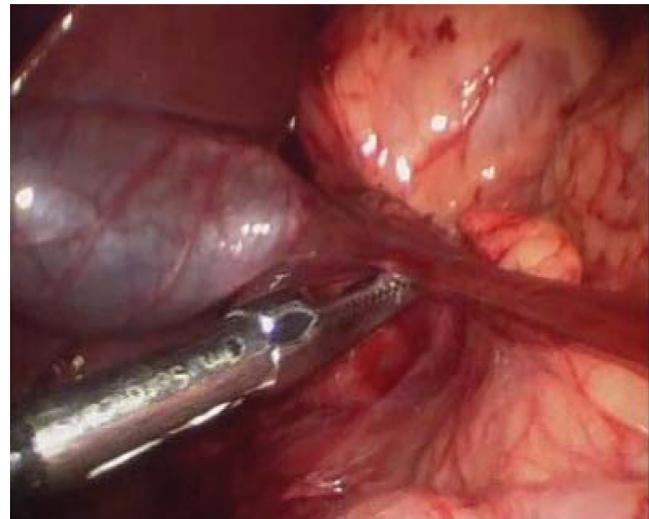
## MATERIALS AND METHODS

A retrospective analysis of all the children who had undergone elective LL procedure from April 2007 to April 2011, was done at the author's institution. Case records of patients were reviewed thoroughly for history, examination, investigations, operative findings, post-op period, and follow-up. All neonates and children presenting with signs of acute volvulus and bowel compromise were excluded from the study. All the patients in were haemodynamically stable, not associated with any serious congenital anomalies and were operated electively by one of the senior pediatric surgeons in the department.

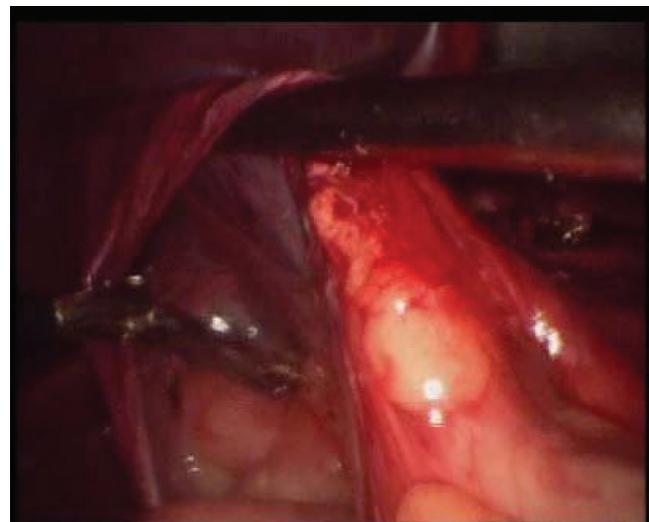
### Laparoscopic Ladd's procedure

Under general anesthesia, in supine position, 5 mm infra umbilical port was inserted by open technique and 6–12 mm Hg of pneumo-peritoneum (depending on patient's age)

was created. After confirming the diagnosis, right and left 5 mm working ports were placed under direct visualization. An additional 5 mm working port in epigastrium to retract the liver/stomach/bowel was used, when necessary. By gentle retraction of ascending colon towards left side, Ladd's bands running between duodenum, gallbladder, and ascending colon were well visualized and lysed carefully with bipolar cautery (Fig. 1). Once these bands were released, duodeno-jejunal (DJ) flexure covered by thick duodeno-colonic bands was well exposed and released with extreme care to avoid injuring mesenteric vessels (Fig. 2). Following up small bowel from DJ to caecum and reduction of volvulus, when present,



**Figure 1:** Ladd's bands between colon and duodenum extending over gallbladder



**Figure 2:** Thick duodeno-colonic bands covering DJ flexure

are the essential steps of LL procedure. The small bowel was followed up from DJ flexure to the ileo-cecal (IC) junction and further Kocherization of duodenum and incision of furred portions of small bowel mesentery helped in achieving wider mesenteric root with straightened out DJ flexure. The small bowel loops were placed on right side and caecum and colon were placed on left. Appendix was delivered out through the left port and appendectomy was completed extra-corporeally in all patients.

## RESULTS

During the study period, a total of 12 patients had undergone LL procedure for malrotation at the author's institute. Age of the patients ranged from 3 months to 9 years and the male-female ratio was 8:4 (Table 1). All patients were presented with symptoms of intermittent bilious vomiting and recurrent pain abdomen and all underwent Doppler ultrasonography and upper GI series. Only 4 patients showed altered superior mesenteric artery/superior mesenteric vein axis on Doppler and the diagnosis of malrotation was suggested by upper GI series in all patients (Fig. 3). Five patients had partial volvulus but none had bowel ischemia. A standard Ladd's procedure with appendectomy was performed in all



**Figure 3:** Upper GI series showing DJ flexure on right side

**Table 1:** Clinical details of patients who underwent laparoscopic Ladd's procedure

No.	Age (mean ~5 yrs)	Sex	Volvulus	Duration (min)	Postoperative complications
1	4 yrs	M	Nil	90	Nil
2	2 yrs	F	180°	60	Nil
3	1 yr	M	Nil	75	Nil
4	6 yrs	F	Nil	70	Nil
5	3 mo	M	180°	130	Nil
6	6 yrs	M	Nil	95	Intestinal obstruction
7	1 yr	M	270°	115	Nil
8	6 mo	F	Nil	90	Nil
9	9 yrs	M	Nil	85	Nil
10	1 yr	F	Nil	80	Nil
11	6 mo	M	180°	120	Nil
12	3 mo	M	180°	130	Nil

M: male; F: female; mo: months.

cases and all procedures were completed laparoscopically. Average duration of procedure is about 95 min (60–130 min). There were no intra-operative complications and all patients had a smooth postoperative course. Feeding was started on post-op day 1 and all patients were discharged on or before day 4. One patient presented with abdominal distension and bilious vomiting after a month of surgery and his X-ray abdomen showed dilated small bowel loops with multiple air fluid levels. As he did not improve with conservative management, open surgical adhesiolysis was done, but there were no residual Ladd's bands or volvulus. All patients including the one who required reoperation are doing well on last follow-up.

## DISCUSSION

The term "malrotation" comprises of complex congenital anomalies resulting from aberrant rotation and fixation of gut during early parts of gestation. During the last century, the

complex embryology and anatomy of intestinal malrotation became completely understood and its surgical treatment has also undergone evolution. Classically, the operation of choice is the Ladd's procedure that includes release of Ladd's bands, separation of duodeno-colonic adhesions, widening of the mesenteric root, and appendectomy.<sup>13</sup> Open Ladd's procedure was the gold standard approach for the correction of malrotation till the later part of 21st century. Owing to its complex anatomy and variable spectrum, laparoscopic management of malrotation was considered impossible in children till 1995, until when van der Zee and Bax reported their first successful laparoscopic management of acute volvulus with malrotation in a neonate.<sup>5</sup> Similar reports followed shortly by Gross et al. and Waldhausen et al., showed the possibility of successful Ladd's procedure by laparoscopic approach.<sup>6,7</sup> Thereafter several small series have demonstrated the safety and efficacy of LL in infants and children.<sup>8-10</sup> Lessin and Luks's approach of laparoscopic appendectomy and duodeno-colonic dissociation (LADD) allows excellent visualization of the duodeno-colonic bands and easily accommodates an extra-corporeal appendectomy.<sup>14</sup> Comparison of results of open and LL procedures have shown that the latter is more safe and effective in adults.<sup>15</sup> A detailed analysis of Stanfill et al. showed laparoscopic approach in children having more advantages than open approach.<sup>16</sup>

In spite of recent literature's recommendation towards laparoscopic management of intestinal malrotation, open repair is still preferred by most of the surgeons around the world, especially in developing countries because of high rates of conversion and relatively higher complications with LL (Table 2). Main reasons are complex anatomy of the malrotated gut, varied spectrum (like malrotation, nonrotation, reverse rotation, and internal herniation), lack of space for bowel manipulation, difficulty in orientation, and associated anomalies. At the same time, early postoperative recovery, reduced time to full feeds, reduced morbidity, and lesser hospital stay are the advantages of successful LL. In small series with relatively older children complication and conversion rates were very low.<sup>8,17</sup>

Hagendoorn et al. reported conversion rate of 25% and postoperative clinical relapse of 19% with 22 of 37 patients below the age of 22 months.<sup>18</sup> In 2009, Fraser et al's report of 33% conversion rate of 43 patients highlighted the need for strict selection criteria for LL to avoid conversion. Stanfill et al. have reported only 8.3% conversion rate without increase in complications in their series of 36 children. In the series of

**Table 2:** Review of literature comparing conversion and complication rates

Study (year)	Total number of patients	Conversion to open (%)	Complication requiring reoperation (%)
Fraser et al. (2009) <sup>11</sup>	43	33%	2.4%
Hagendoorn et al. (2011) <sup>18</sup>	37	25%	19%
Stanfill et al. (2010) <sup>16</sup>	36	8.3%	5.6%
Draus et al. (2007) <sup>10</sup>	9	11%	11%
Kalfa et al. (2004) <sup>19</sup>	5	20%	20%
Palanivelu et al. (2007) <sup>17</sup>	7	Nil	Nil
Present study (2013)	12	Nil	8%

12 patients, thanks to the strict selection criteria, none of the patients were converted, no recurrences, and only one patient had late postoperative adhesions, which required an open surgery. Hence, by going through the results of the authors own series and also of the series with relatively older children, it is clear that LL is very safe and complications including recurrence are very minimal in uncomplicated cases of malrotation.

## CONCLUSION

The authors conclude that LL procedure can be safely performed in infants and children and should be considered as a first-line approach in all patients with uncomplicated malrotation excluding neonates.

## CONFLICT OF INTEREST

Authors have no conflict of interest or financial ties to disclose.

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