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A Prospective Comparative Study of Open Verses Laparoscopic Correlation of Intestinal Malrotation in Paediatric Population

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Abstract:
Introduction: *Intestinal malrotation comprises a spectrum of rotational abnormalities that may lead to a variety of clinical symptoms in neonates, infants, and older children. Embryologically, intestinal nonrotation and incomplete rotation occur due to a narrow base of the mesentery.*
Materials and Methods: *This study was conducted in the Department of Paediatric Surgery, R.G Kar Medical College, Kolkata. The following technique has been adopted in all cases. The child is placed in a supine position. To avoid slipping during tilting the operation table, patient's legs are fixed with the table by adhesive tapes. The laparoscopic trolley containing monitor, camera-unit, insufflator, light source & power sources (monopolar , bipolar & Harmonic) is placed at the right side of the patient. The surgeon with one assistant stand to the left side of the table, the other assistant at right side, a scrub nurse at the leg end & the anesthetist at the head end of the patient.*
Results: *A total of 40 patients operated for malrotation of gut were studied (20 cases each of the laparoscopy and open procedures). Clinical profile, presentation, operative procedure & outcome of each baby were analyzed. Patients who had volvulus with compromised bowel, associated with other congenital anomalies (both gastrointestinal and other system), with sepsis and redo cases were excluded from this study.*
Conclusion: *Malrotation is a common cause of neonatal intestinal obstruction, but it may become symptomatic at any age. Although laparoscopy is feasible for correction of malrotation in all paediatric age group, we faced high conversion rate for younger children specially in infants due to difficult malrotation, concern for orientation, technical & other problems. We propose that laparoscopy is preferable when intestinal malrotation is suspected and it is appropriate for correction of malrotation provided a low threshold for conversion to open surgery is maintained.*
Key Words: *Intestinal malrotation, laparoscopy, Malrotation*

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I. Introduction

Intestinal malrotation comprises a spectrum of rotational abnormalities that may lead to a variety of clinical symptoms in neonates, infants, and older children. Embryologically, intestinal nonrotation and incomplete rotation occur due to a narrow base of the mesentery. In neonates and young children, this may lead to midgut volvulus and duodenal obstruction (due to Ladd's peritoneal bands or intrinsic duodenal obstruction), which can present acutely. In older children, intermittent volvulus and bowel obstruction can present with chronic abdominal symptoms.

The indication for surgical treatment in neonates & young children is straightforward. In older children, the diagnosis is more difficult because of chronic and vague complaints, and the treatment of incidentally discovered malrotation is more controversial.

Due to the potential for life threatening midgut volvulus and ischaemic insult to bowel, malrotation is corrected surgically as and when it is discovered. The general principles of treatment of a case of malrotation with or without volvulus are:

- Exploratory laparotomy/ laparoscopy
- Evisceration of the bowel including untwisting of volvulus, if present
- Division of abnormal peritoneal bands (Ladd's band)
- Widening of the mesenteric base
- After correction, the duodenum and the small bowel remain onthe right side of abdomen and caecum and colon remain on the left side in normal embryological position[5]
- Management of associated anomalies accordingly

- An incidental appendectomy may be performed as well.

The excellent visibility in laparoscopy& availability of laparoscopes of paediatric sizes have increased the scope of procedures performed laparoscopically. In a suspected case of malrotation without midgut volvulus, regardless of age, even in asymptomatic patients, laparoscopy provides a minimally invasive alternative method of treatment from both diagnostic & therapeutic point of view. In this study we are going to compare the laparoscopic versus open procedure of correction of malrotation of gut in neonates & children on the following aspects:

1. Confirmation of diagnosis
2. Comparison of the details of the operative procedures
3. Comparison of postoperative results
4. Comparison of the cases in follow up
5.

II. Materials And Methods

Study Area: Department of Paediatric Surgery, R.G Kar Medical College, Kolkata

Study population: Patients attending at Paediatric Surgery OPD/ ER and admitted to Pediatric Surgery Department of R.G Kar Medical College, Kolkata

Study period: January 2012 to December 2013.

Sample size: Total number of patients with intestinal malrotation admitted at Paediatric Surgery Department of R.G Kar Medical College, Kolkata during our study period. 40 cases (20 cases in each of the open and laparoscopic groups) are considered for this study.

Sample design:

A. **Inclusion criteria**: All cases and varieties of intestinal malrotation in neonatal and paediatric population (from neonates up to 12 years of age).

B. **Exclusion criteria**:

a. Malrotation associated with diagnosed or suspected midgut volvulus with or without evidences of compromised bowel
b. Malrotation associated with other congenital Gastrointestinal and / or other system anomalies
c. Patients with septicemia
d. Redo cases of malrotation of gut

Study design: Institution based Prospective & Comparative study.

Parameters to be studied:

e. Age at presentation
f. History of the patient
g. Diagnostic modalities and their results
h. Operative procedure – laparoscopic, open or laparoscopy converted to open procedures (duration of surgery with procedural comparisons)
i. Per operative findings
j. Post-operative morbidity and mortality (if any)
k. Post-operative hospital stay
l. Redo operations required after – primary laparoscopic procedure or primary open procedure

Method of laparoscopic treatment: The following technique has been adopted in all cases. The child is placed in a supine position. To avoid slipping during tilting the operation table, patient's legs are fixed with the table by adhesive tapes. The laparoscopic trolley containing monitor, camera-unit, insufflator, light source & power sources (monopolar , bipolar & Harmonic) is placed at the right side of the patient.The surgeon with one assistant stand to the left side of the table, the other assistant at right side, a scrub nurse at the leg end & the anesthetist at the head end of the patient.

Four 5-mm lightweight trocars are inserted: the first in an open manner through the superior umbilical fold for a 5-mm laparoscope and three others at the right iliac fossa (working port for surgeon's left hand), at left hypochondrium (for scissors, forceps, power source etc - surgeon's right hand) and the last one at right lumbar region for liver retraction & subsequent drain placement. Carbondioxide gas (CO_2) is insufflated at an initial flow of 0.5litre/min & a maintenance flow of 2 litres/min. Pressure is limited to 5-6 mm Hg in neonates & 8-10 mm Hg in older children. All the ports are fitted with the rubber guards which are fixed to the skin, to avoid frequent port displacement. It may help if the trocar holding the 5-mm endoscope is lifted by the assistant to allow maximal visibility within the small abdominal space. Urinary bladder is catheterized in all cases preoperatively.

It is usually not difficult to confirm the diagnosis of intestinal malrotation laparoscopically: cecum and appendix are at a high and rather medial position below the liver, to which they are fixed by peritoneal bands. The second part of the duodenum looks long and tortuous.

Regarding therapy, it is very important to concentrate on the stalk of the anomaly and not on the loops of bowel. After overall inspection of the abdomen, the peritoneal bands fixing the cecum to the liver are severed, and the cecum is pushed to the left. The liver is retracted upwards. The stomach, pylorus are identified & followed up to identify duodenum. The second part of duodenum is mobilized. It is very important to stick to the duodenum and to mobilize the distal duodenum further and further while pulling on the more proximal part. During this mobilization, a peritoneal band in the shape of a ring encircling the duodenum becomes apparent and should be transected anteriorly. This band marks the end of the retroperitoneal part of the duodenum. The proximal jejunum now comes into view. By gentle walking with bowel graspers, small bowel is freed along its whole length &ceco-appendiceal region comes in view. The whole jejunum continuous with straightened duodenum is positioned on the right side of abdomen below the liver. By using this technique, the bowel is positioned like the nonrotated one.

The stalk of the anomaly (the cecocolic region approximate closely with duodenum), however, remain still narrow, and they lie side by side. By transecting the anterior peritoneal band between both structures and pushing the cecum to the left, the mesenteric stalk is broadened. After checking the trocar sides for eventual bleeding, the scope is removed, and the trocar holes are closed in the usual manner.

FIGURE 1: Straight X-ray abdomen shows distended stomach gas shadow with paucity of gas distally

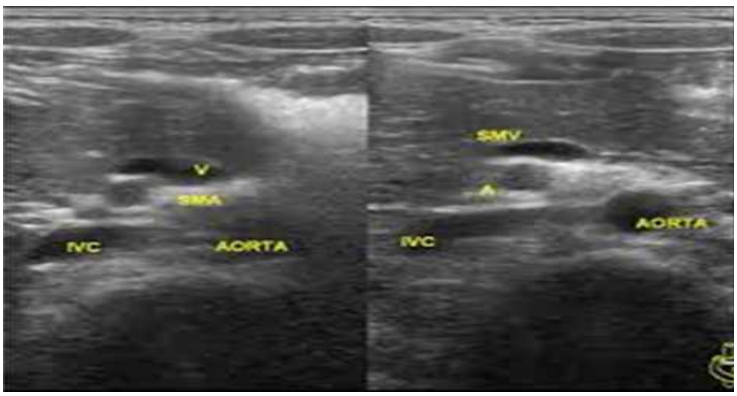

FIGURE 2: USG shows altered SMA/SMV relationship

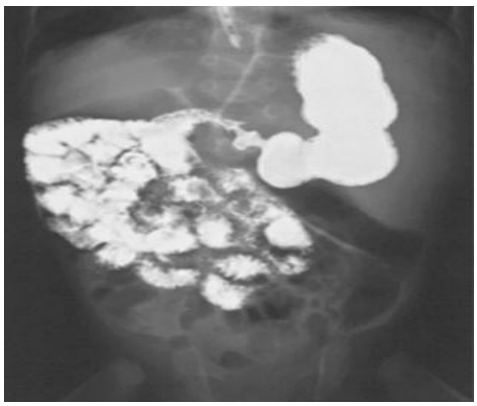

FIGURE 3: UGI contrast shows abnormal duodenojejunal junction position

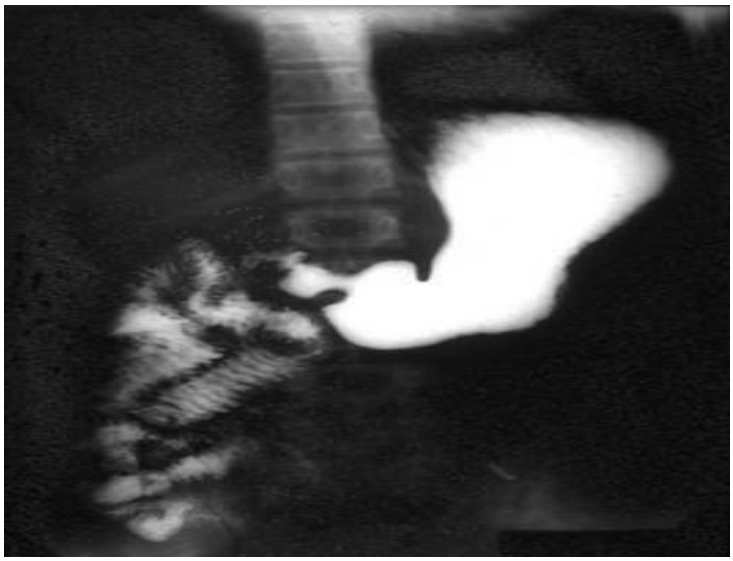

FIGURE 4: UGI contrast shows abnormal jejunal position

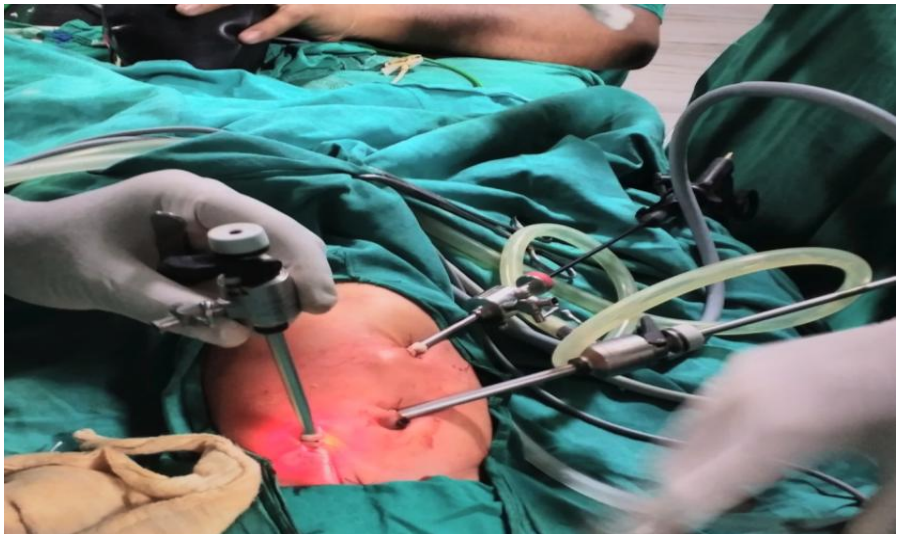

FIGURE 5: Ports are being positioned

FIGURE 6: Initial appearance of malrotation of gut laparoscopically

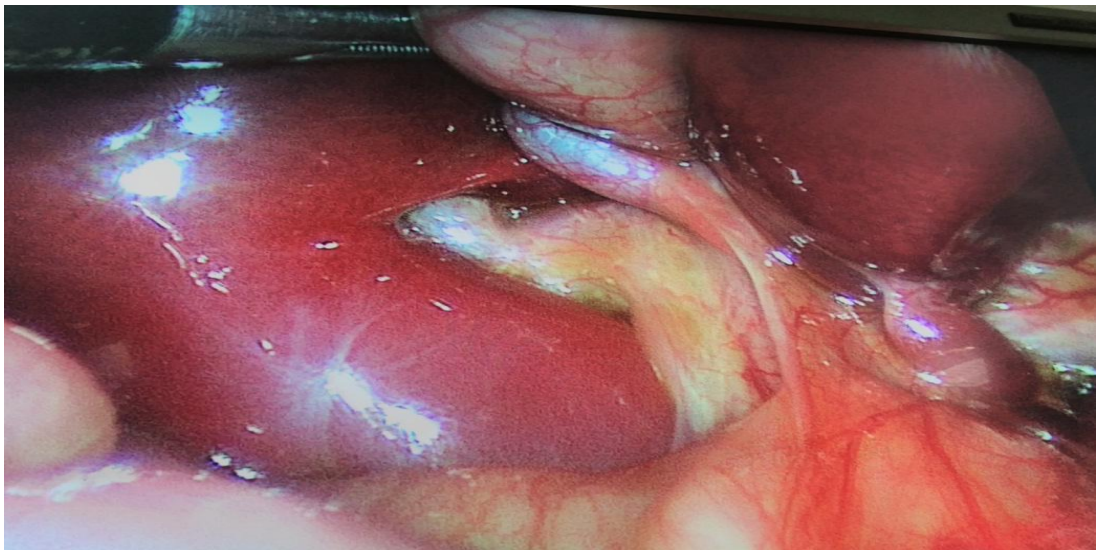

FIGURE 7: The liver is being retracted

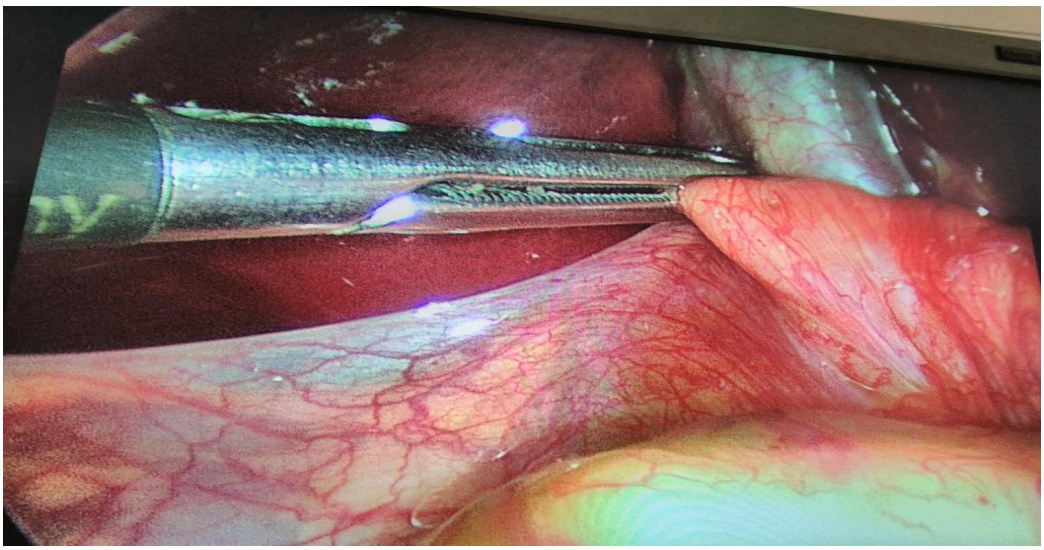

FIGURE 8: Laparoscopic view of Ladd's bands

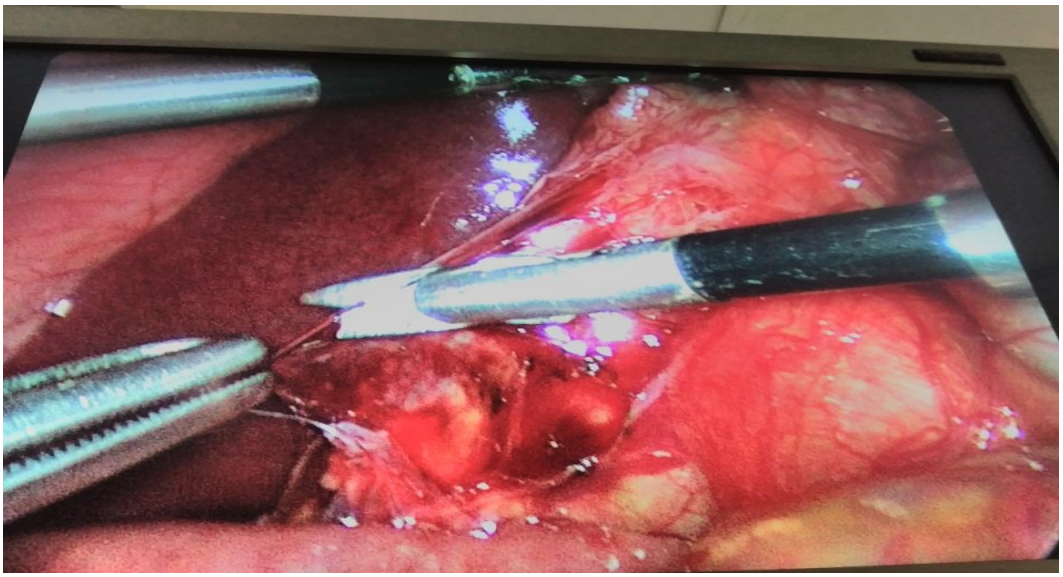

FIGURE 9: Ladd's bands are being severed

FIGURE 10: Final appearance after placement of drain

III. Results

A total of 40 patients operated for malrotation of gut were studied (20 cases each of the laparoscopy and open procedures). Clinical profile, presentation, operative procedure & outcome of each baby were analyzed. Patients who had volvulus with compromised bowel, associated with other congenital anomalies (both gastrointestinal and other system), with sepsis and redo cases were excluded from this study.

Analysis of data has been done on the following parameters:

a. Age & sex at presentation
b. History of the patient
c. Diagnostic modalities and their results
d. Operative procedure – laparoscopic, open or laparoscopy converted to open procedures (duration of surgery with procedural comparisons)
e. Per operative findings
f. Post-operative morbidity and mortality (if any)
g. Post-operative hospital stay
h. Redo operations required after – primary laparoscopy procedure or primary open procedure

AGE:

TABLE 1: AGE DISTRIBUTION

Age	<2months	2months-1year	>1year
Laparoscopic procedure	10(50%)	3(15%)	7(35%)
Open procedure	16(80%)	2(10%)	2(10%)
Total	26(65%)	5(12.5%)	9(22.5%)

From the above table it is noted that maximum number of patients presented below two months of age. Maximum patients above one year of age were operated by laparoscopic method.

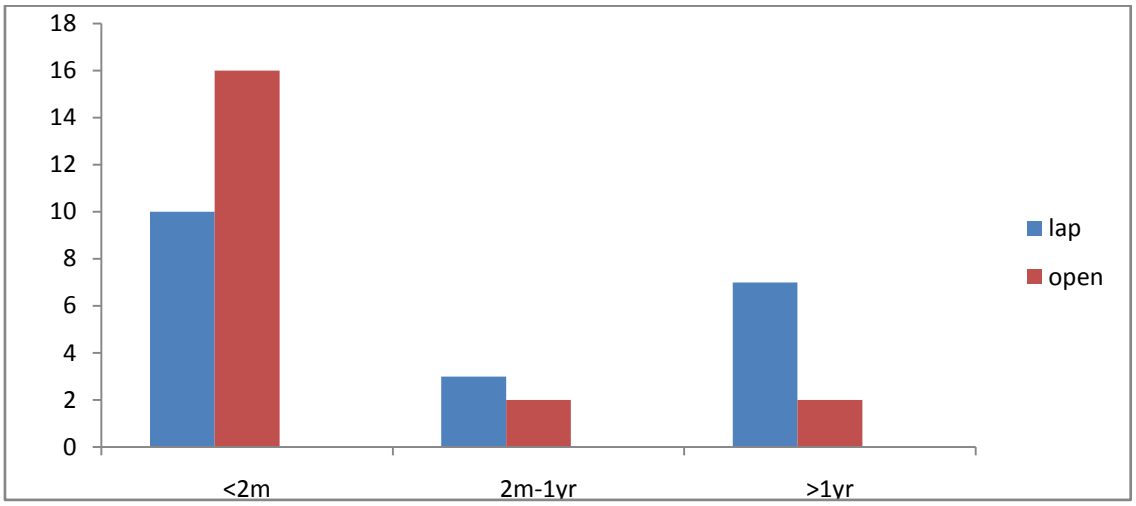

DIAGRAM1: Bar diagram of laparoscopic& open procedure in different age group

Youngest patient operated by laparoscopic method was of 4days and by open method was of 2days. Eldest patient operated by laparoscopic method was of 12years and by open method was of 7years.

SEX:

TABLE 2: SEX DISTRIBUTION

	MALE	FEMALE
Laparoscopic procedure	14(70%)	6(30%)
Open procedure	12(60%)	8(40%)
Total	26(65%)	14(35%)

From the above table it is noted males are more affected with malrotation (65%) and male : female ratio in this study is 1.85:1.

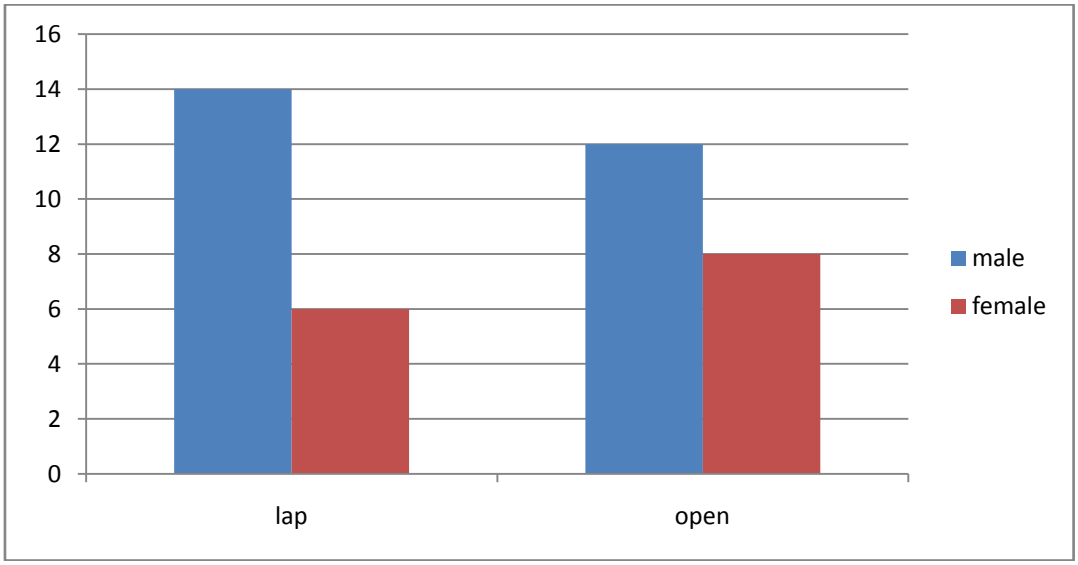

DIAGRAM 2: Bar diagram of sex distribution in this study

CLINICAL PRESENTATION:

Of 40 cases, 26 patients were below 2 months of age. Presenting symptoms were to some extent different in younger age group than older age group.

TABLE 3: CLINICAL PRESENTATION

Presentation	<2m (n=26)	2m-1yr (n=5)	>1yr (n=9)	Laparoscopic method (n=20)	Open method (n=20)
Bilious vomiting	26	5	3	16(80%)	18(90%)
Chronic abdominal pain(±intermittent nonbilious vomiting)	-	-	9	7(35%)	2(10%)
Failure to thrive	-	3	6	6(30%)	3(15%)

Bilious vomiting was the most frequent presenting symptom and it was always seen in the patients with less than 2 months of age. Whereas older patients presented mainly with chronic abdominal pain & failure to thrive, and infants (<1year of age) presented mostly with bilious vomiting (intermittent) and failure to thrive.

RADIOLOGICAL DIAGNOSIS

Straight X ray abdomen – most common initial study performed. It was performed in all cases. Among the patients presenting at less than 2 months of age, 20 out of 26 plates showed pattern suggestive of malrotation (distended stomach with paucity/scanty bowel gas shadow). The remaining X-rays demonstrated gastric distension or nonspecific gas pattern. The patients who presented beyond the 2 months of age, only 6 out of 14 plates were suggestive of duodenal obstruction, the remainder being nonspecific.

Ultrasonography was performed in all cases. The diagnosis of malrotation (altered SMA /SMV relationship) was made in 35cases. In one case, diagnosed as cholelithiasis in USG, malrotation was diagnosed during laparoscopic procedure.

Upper GI contrast study was performed in 18 patients. Out of them 15 studies showed abnormal position of duodenojejunal junction.

TABLE 4: RADIOLOGICAL INVESTIGATION

Investigation	Performed (n=40)	Age <2m	Suggestive of malrotation	age>2m	Suggestive of malrotation
Straight Xray abdomen	40	26	20 (76.9%)	14	6 (42.8%)
USG abdomen	40	26	23 (88.4%)	14	12 (85.7%)
Upper GI contrast	18	4	3 (75%)	14	12 (85.7%)

DURATION OF OPERATION

Patients who were operated by laparoscopic method had a mean time of operation of 95minutes (ranging from 85minutes to 125minutes). Patients operated by open method had a mean time of operation of 77 minutes (ranging from 70minutes to 90minutes).

OPERATIVE PROCEDURE

Total 40 cases of malrotation of gut were operated (**Ladd's procedure**) – 20 cases by laparoscopic approach and 20 cases by open (laparotomy) method.

TABLE 5: Laparoscopic cases (20 cases)

	No of cases (total cases)	Percentage
Laparoscopy completed successfully	13(20)	65%
Laparoscopy converted to open(laparotomy)	7(20)	35%

Open (laparotomy) procedure- 20 cases.

From the above table it is noted that 7 out of 20 cases done by laparoscopic approach required conversion to open laparotomy. In our study conversion were required mainly due to following reasons:

- Difficult encountered during correction of malrotation
- Due to concern for orientation
- Due to technical/other problems

TABLE 6: Laparoscopy conversion statistics

Age	No of conversion (no of patient)	Percentage of Conversion
<2m	5(10)	50%
2m-1yr	1(3)	33.3%
>1yr	1(7)	14.3%
Total	7(20)	35%

From the above table it is noted that conversion rate was decreasing with increasing age of the patient. Minimum age of the patient who was corrected successfully by laparoscopic method was 4 days. The conversion rates were 50% in less than 2 months of age, 33.3% in 2months to one year & 14.3% in more than one year of age. Overall conversion rate in this study was 35% (7 out of 20 cases).

None of our patients in open or laparoscopy groups needed blood transfusion as intraoperative blood loss was within accepted limits. Only redo cases needed blood transfusion.

TABLE 7: REDO OPERATION

Procedure (no of cases)	No of redo case (n=4)	Cause for Redo operation
Successfully operated by laparoscopy(13)	1	Partially corrected
Laparoscopy converted to open(7)	1	Burst abdomen
Open (laparotomy) (20)	2	Burst abdomen & adhesive obstruction

From the above table, it is noted that in 1 case reoperation was requireddue to partial correction of malrotation in an initially successful laparoscopic procedure. One case of laparoscopy converted to open(laparotomy) needed redo procedure due to burst abdomen. In open(laparotomy) group , 2 cases needed reoperation : one due to burst abdomen and the other due to adhesive intestinal obstruction.

POST OPERATIVE COMPLICATIONS

TABLE 8: Post-operative complications in different procedures

complication	Laparoscopic Ladd's procedure(n=13)	Laparoscopy converted to open procedure(n=7)	Open Ladd's procedure (n=20)
Wound infection	-	1(14.2%)	3(15%)
Burst abdomen	-	1(14.2%)	1(5%)
Sepsis	2(15.3%)	1(14.2%)	3(15%)
Dyselectrolytemia	1(7.7%)	-	-
Postoperative intestinal obstruction	1(7.7%)	-	1(5%)

POSTOPERATIVE FEEDING &HOSPITAL STAY

TABLE 9: Post-operative feeding & length of stay at hospital (average day)

	Laparoscopically approached cases(20)	Open Ladd's procedure (20)
Days to start feeds	3	4
Days to full feeds	5	6
Postoperative hospital stay	7	8

Overall, patients treated by laparoscopy had a mean length of hospital stay of 7days (with a range of 5 to 15 days) . In cases of open procedure, length of stay at hospital was 9days (with a range of 6 to 20 days).

FOLLOW UP

All the patients were followed up at regular interval .Follow up protocol was as follows

- 1st follow up -1week after discharge
- 2nd follow up – after 1month
- 3rd follow up – after 3months
- 4th follow up – after 6months

Follow up assessment was done on the basis of symptomatic & clinical improvement (including weight gain & linear growth), and straight X-ray abdomen in selected cases.

MORTALITY:

TABLE 10: Mortality and their causes

	Mortality	Cause
Laparoscopically approached cases (n=20)	2	1- Sepsis 1-dyselectrolytemia
Open Ladd's procedure	2	2-sepsis

2 out of 20cases, which were approached laparoscopically, expired – one due to sepsis and the other due to dyselectrolytemia. Two of the open cases expired due to sepsis. All the expired cases were of less than two months of age. We have encountered no mortality in any of our cases which were more than 2 months of age.

SUMMARY OF OUTCOMES

TABLE 11: SUMMARY OF OUTCOMES IN THIS STUDY

	Laparoscopic Ladd's	Open Ladd's
No of cases	20	20
Average operative time	95mins	77mins
Conversion	7(35%)	-
Redo operation	2(10%)	2(10%)
Days to full feeds	5	6
Postoperative hospital stay	7	8
Mortality	2(10%)	2(10%)

IV. Discussion

Our study was carried out in the Department of Paediatric Surgery, R.G Kar Medical College, Kolkata. The study period was from January 2012 to December 2013 (24 months). Total 40 cases were included in this study. In our study, we excluded the cases of malrotation with volvulus (with compromised bowel), with other congenital anomalies (both gastrointestinal & other system), with septicemia or redo cases.

Fraser et al, Palanivelu et al ,Mazziotti et al did laparoscopic malrotation correction in older paediatric patients and average age of the patients in their studies were 5.7years, 7-12years & 7years respectively [88,91,79].Kalfa et al & Bass et al did laparoscopic malrotation correction at a very lower age group and average age of their studies was 9days & 5days-4months respectively [90,80]. Age range of patients operated laparoscopically in this study is 4days to 12years.

In our study 26 cases were male and 14 cases were female. Ratio of male : female was 1.85:1. Larger studies also show cases of malrotation in male predominate over females (ratio 2:1). Hagendoorn et al found 22boys & 15girls in their study with a male: female ratio of 1.46:1[92].

Bilious vomiting was the most common presentation of malrotation in infants. The diagnosis of malrotation is often difficult and delayed when it presents beyond the neonatal period because of the wider and more obscure constellation of clinical symptoms observed in older children. In the newborn, bilious emesis is the most frequent presenting symptom, reported in 71-100% of patients [76]. In infants &children older than 2 months, bilious and nonbilious emesis occur at equal rate (49%).

V. Conclusion

Malrotation is a common cause of neonatal intestinal obstruction, but it may become symptomatic at any age. Although laparoscopy is feasible for correction of malrotation in all paediatric age group, we faced high conversion rate for younger children specially in infants due to difficult malrotation, concern for orientation, technical & other problems. We propose that laparoscopy is preferable when intestinal malrotation is suspected and it is appropriate for correction of malrotation provided a low threshold for conversion to open surgery is maintained. In future, laparoscopy can be the method of choice in all cases of malrotation, both from diagnostic & therapeutic point of view. After tiding over the learning curve, it can be designated as 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.

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