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A Retrospective Analysis of Duodenal and Jejunoileal Atresia: Five-Year Experience from a Tertiary Care Pediatric Surgery Center in Western India

V Shankar Raman [1], Vivek K Singh [1], Vipin Venugopal Nair [2*], R Nagamahendran [2], Deepak Dwivedi [1], Vinay Baunthiyal [2]

1. Department of Pediatric Surgery, Command Hospital (Southern Command), Pune, Maharashtra, India.
2. Department of Surgery; Armed Forces Medical College, Pune, Maharashtra, India.

*Corresponding Author: Dr. Vipin Venugopal Nair;
Address: Department of Surgery Armed Forces Medical College Solapur Road, Wanwadi, Pune, 411040, India.
Tel: +91 2026346016 E-mail: vipinvenugopalnair@gmail.com

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ABSTRACT

Background and Objective: Intestinal atresia is a life-threatening problem requiring early active intervention. The aim of the study was to compare management outcomes between Duodenal-Atresia (DA) and Jejunoileal-Atresias (JIA).

Methods: Retrospective descriptive analysis of patients operated between March 2015 to February 2020 in a tertiary-care Pediatric Surgery unit of Armed Forces Medical College Pune, India. The data was obtained from the hospital records, operation theatre notes, discharge summary and follow-up notes. Demographic and clinical information and data were analyzed with SPSS version 26 with appropriate statistical tools.

Findings: Forty-eight neonates were included (DA=23; JIA=25).There were 18 (37.5%) males and 30 (62.5%) females. The mean age, mean birth weight, and time to feed were statistically significant and better in JIA compared to DA. A total of 45% of newborns had associated anomalies. The primary surgery performed in patients with DA was Kimura's duodenoduodenostomy, while Resection-anastomosis with or without tapering enteroplasty was performed in JIA patients. In the subgroup analysis of JIA, the length of hospital stay in the tapering enteroplasty was statistically significant compared to resection anastomosis.(p=0.048). The average weight gain and survival in Jejunoileal-atresia at six months is statistically significant compared to Duodenal-atresia.

Conclusion: The management of intestinal atresias is challenging and requires a dedicated team in a specialized neonatal intensive-care unit. Intensive investigation of other congenital anomalies associated with the condition is equally critical and in the subgroup analysis of JejunoIlial -atresia, the patients undergoing tapering enterostomy showed better survival compared to resection and end to end anastomosis only.

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Introduction

Intestinal atresia (IA) is one of the main causes of intestinal obstruction in neonates. The major subtypes of IA are duodenal atresia (DA), Jejuno-intestinal atresia (JIA), and colonic atresia. The incidence varies from 1:5000 for duodenal and jejunal atresia to 1:20,000 for colonic atresia. Approximately 45-65% is associated with congenital anomalies and about 50% of these cases have Trisomy 21. The two theories of Tandler's concept of a lack of vacuolization at the solid cord stage of intestinal development and Louw and Barnard's theory of late intrauterine mesenteric vascular accident are the most often quoted etiological explanations of this entity. Earlier the management was challenging and required a team of experts [1, 2]. Presently, the outcomes have become better with the recent advances in prenatal diagnosis, surgical technique, and better post-op care. The aim of the study was to compare the demographics of the age of presentation, gestational age, sex ratio, birth weight, the time to feed post-surgery and the length of hospital stay between DA and JIA. The secondary objective was to find the difference between time to feed and length of hospital stay in JIA patients who underwent tapering enteroplasty and end to end anastomosis and those who underwent only end to end anastomosis.

Methods

Study design and participant

This study was a retrospective descriptive analysis of all neonates diagnosed and managed as a case of IA at Department of Pediatric Surgery, Armed Forces Medical College, Pune, India. The study period was from March 2015 to February 2020. The demographic and clinical data were obtained from the hospital records. Additional data was obtained by a telephonic conversation with the parents. Follow-up notes at 6 months, 9 months and one year were evaluated for evidence of complications and overall weight gain. The inclusion criteria was all cases of small intestinal atresia presenting to the Pediatric surgery department during the study period and exclusion criteria was colonic atresia, distal intestinal strictures, and anorectal anomalies.

All neonates with IA were admitted to the Neonatal Intensive Care Unit [NICU]. Resuscitation was initiated with intravenous 0.18% NaCl in 10% dextrose as per Holliday and Segar formula and institutional protocol. Nasogastric decompression was achieved with an infant feeding tube size 6 French. Broad-spectrum intravenous antibiotics (injection Cefotaxime 100 mg per kg body weight and injection Metronidazole 25 mg per kg divided into three doses) was administered for all neonates. Pre-operative hematological, biochemical, and radiological investigations were carried out (Fig 1).

Data Collection

All patients underwent emergency laparotomy by pediatric surgeon after informed consent by the parents. The abdomen was accessed with a right upper transverse abdominal incision in all cases. Kimura's Duodenostomy was performed in all DA patients. JIA was managed by either tapering enterostoplasty (TE) followed by resection and end to end anastomosis or the dilated proximal bowel was excised entirely till a normal calibre bowel was available for end to end anastomosis, a decision which was made on table based on the length of proximal bowel available for safe resection (Fig 2-3).

After surgery, all babies were kept nil by mouth and gastric decompression continued with a nasogastric tube. Once the baby passed stools and nasal aspirates become minimal, expressed milk was fed through the feeding tube. Once the baby gained normal oral reflexes, breastfeeding was initiated. Patients requiring a longer period of nutritional care or inability to start early feed within 5 days were started on total parenteral nutrition [TPN]. TPN was started using antecubital/ popliteal peripherally inserted central catheter [PICC] as per fluid and calorie requirement. Once the baby was on full oral feed and weight gain was adequate as per age, the baby was discharged.

The data regarding antenatal diagnosis, maturity, birth weight, gender, symptoms and signs, age at presentation, associated anomalies, the timing of

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surgery, intra-op findings, location and type of IA (duodenal, jejunoileal), surgical procedure done, length of hospital stay [LOHS], the timing of feed, complications and redo surgery if required were retrieved. The data was collected by two general surgery senior residents attached with the pediatric surgery department. All patients were admitted and managed in the neonatal intensive care unit (NICU), jointly by a team of Pediatric Surgeons and Neonatologists.

Statistical Analysis

The data was entered into Microsoft Excel for Mac (Version 16.47). Statistical Analysis was done using IBM SPSS version 26.Mean was measured for data with normal distribution and mode for data with outliners. For data with a normal distribution, Levene's test of equity of variance was done. Continuous variables were analysed using Students t test and Mann-Whitney U test and categorical data were analysed using the Chi-square test. A p-value of < 0.05 was considered statistically significant.

Results

A total of 48 (n=48) neonates met the inclusion criteria, out of which 48% patients (n=23) had DA and 52% (n=25) had JIA. In our study, 18 patients were male and 30 patients were females. Seventy-two percent of the males had DA and 28% had JIA. Out of the female 67% had JIA and the remaining 33% had DA.

The mean age at surgery was 12.91±6.72 days for DA and 5.16±4.02 days in JIA, which was statistically significant with a p-value of <0.05. However, due to outlines, the mean was skewed and the mode was calculated. DA (both complete and partial) showed a mode of one and JIA a mode of four, with a statistically significant p-value of 0.001. Ten patients had term delivery whereas 38 patients had preterm delivery. Out of the 10 term deliveries, 80% had DA and 20% had JIA. Out of 38 preterm deliveries, 39% had DA and 61% had JIA. The birth weight was 2.63±0.31kg in DA and 2.01±0.34kg in JIA, which was statistically significant ($p<0.05$).

In our study, 45% (n=22) had associated anomalies. Out of these 22 neonates, 41% (n=9) had DA and the rest 59% (n=13) had JIA. In the DA group, the most common associated anomaly noted was six cases of Patent Ductus Arteriosus (PDA) and one case each of Atrial Septal Defect (ASD), Ventricular Septal Defect (VSD), and Down syndrome. In JIA, the associated anomalies were seven cases of Small ASD followed by VSD in three patients, ASD + VSD in two patients and PDA in one patient. The primary surgery performed in patients with DA was Kimura's duodenoduodenostomy.

In JIA, Proximal tapering enteroplasty (TE) was carried out in 15 patients and the rest underwent excision of the diseased segment and end to end anastomosis. Bowel exteriorization with ileostomy was performed in two patients with subsequent restoration of bowel continuity after four-six weeks.

The time to feed in the DA group was 4.91±0.51 days and in the JIA group 5.52± 1.19 which was statistically insignificant with a 'p-value of 0.24. The length of hospital stay (LOHS) was 15.07±6.93 in DA and 15.48± 7.90 in the JIA group which was not significant (p=0.428) either. Post-operative weight was recorded at six months and 12 months after the primary surgery. In the DA group, the mean weight gain at six months was 3.29±0.26 kg and 3.81± 0.17 kg in JIA, which was found to be statistically significant (p =0.007). However, at 12 months the weight gain was statistically insignificant with a mean weight of 5.63±0.34 kg in DA and 5.71±0.28 kg in JIA (table 1).

In sub-group analysis of JIA neonates requiring TE and RA, the data revealed the following details. The mean age of the patients who underwent TE was 7.2±1.4 days and RA was 3.8±0.96 days, which was statistically significant with a p-value of 0.019. The mean birth weight was 1.82±0.73 in the TE arm and 2.14±0.94 in the RA arm which was statistically significant (p= 0.017). The weight gain at six months in the TE arm was 3.85±0.36 and 3.73±0.28 in the RA arm which was statistically significant (p=0.048). However, no statistically significant difference was noted in the weight gain in both arms at 12 months of age. The LOHS was 18.5±7.2 in the RA arm and 15.73±6.73 in the TE arm, which was statistically significant (p=0.048). However, there was no difference in the amount of time it took to feed after primary surgery (table 2).

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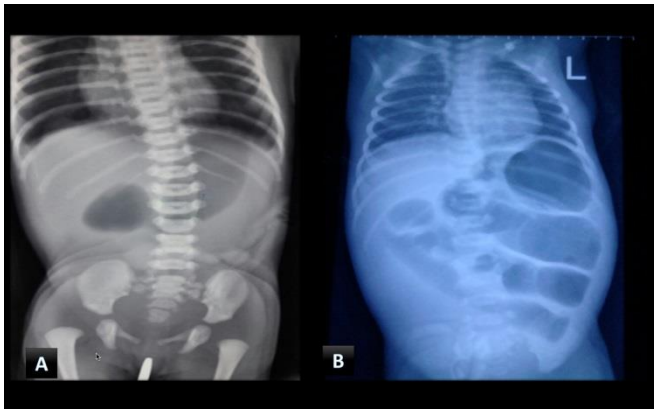

Fig 1. A- X-ray showing Double Bubble in a case of Duodenal Atresia; B- X-Ray showing Dilated proximal bowel loops and absence of distal gas shadow in a case of Ileal atresia

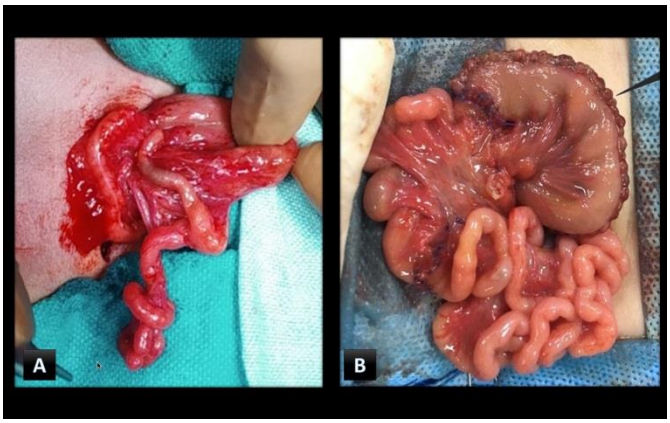

Fig 2. A- A rare variant of Jejunoileal Atresia Type IIIb (Apple-peel atresia); B- Intra-operative photograph with arrow showing tapering enteroplasty in a case of Jejunoileal atresia

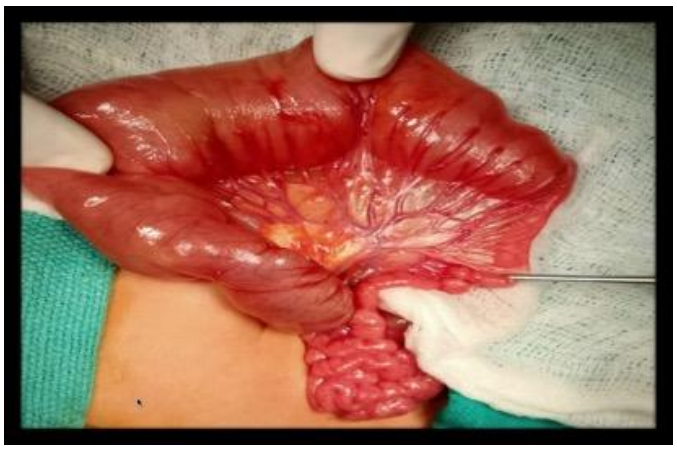

Fig 3. Intra-operative photograph showing Type I Jejunoileal atresia with intact bowel wall and its mesentery and grossly dilated proximal bowel

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Table 1. Comparison between Duodenal Atresia and JejunoIntestinal Atresia

Variables		Duodenal Atresia	Jejunal Atresia	P value
Age (Days) (Mean ± SD)		12.91±16.72	5.16±4.02	**0.015**
Birth Weight (Kg)		2.63±0.31	2.01±0.34	**0.0005**
Time to Feed (Days)		4.91±0.51	5.52±1.19	**0.0146**
Length of Hospital Stay (LOHS-Days)		15.07±6.93	15.48±7.90	0.428
Variables	**Total**	**Duodenal Atresia**	**Jejunal Atresia**	**P value**
Number (n)	48 (100%)	23 (47.92%)	25 (52.08%)	0.8654
Male	18	13 (72%)	5 (28%)	**0.002**
Female	30	10 (33%)	20 (67%)	**0.018**
Range (Days)		1 to 50	1 to 15	
Term	10	8 (80%)	2 (20%)	0.543
Pre-term	38	15 (39%)	23 (61%)	**0.022**
Associated Anomalies	22	9 (41%)	13 (59%)	-
		PDA -06	Small ASD - 07	-
		ASD-01	VSD - 03	-
		ASD + VSD-01	PDA - 01	-
		Down's Syndrome-01	ASD + VSD - 02	-
Need for TPN	3	1	2	-
Surgery	-	Kimura's Duodenostomy-23	Resection and Anastomosis-25	-
Additional Surgery	-	Heinecke Mickuliz Pyloroplasty - 01	Proximal Tapering Enteroplasty - 15	-
	-	Ligation and Division of Fistula - 02	Ileostomy - 02	-
	-	Repair of Esophageal Atresia - 01	-	-

Table 2. Comparison between Tapering enteroplasty only and Resection Anastomosis in JejunoIntestinal Atresia

Jejunointestinal atresia data	Tapering enteroplasty (TA)	Resection and end to end anastomosis only (EA)	P value
AGE (Days)	7.2 ± 1.4	3.8 ± 0.96	**0.019**
Mean Birth Weight (Kg)	1.82 ± 0.73	2.14 ± 0.94	**0.017**
Time to feed (Days)	5.5 ± 1.17	5.53 ±1.7	0.473
Length of Hospital Stay -LOHS (Days)	18.5 ±7.2	15.73 ±6.73	**0.048**

Discussion

The main results of this study conclude that out of 48 neonates the incidence of DA and JIA are nearly equal. The average weight during presentation and mean age of surgery was lower in JIA. JIA neonates were also associated with more concomitant anomalies. Post-surgery the JIA neonates showed better wait gain and overall survival. In JIA subgroup TE showed early discharge from hospital but was similar in all variables compared to RA.

Pediatricians and Pediatric surgeons worldwide face the challenge of intestinal atresia regularly. In nearly one-third of all congenital bowel obstructions, it is one of the most common causes of neonatal intestinal obstruction [3, 4]. Our study aimed to find the difference between DA and JIA in neonates. In a large group meta-analysis of 68 studies and more than 1000 patients, Black et al found that males had a higher prevalence than females in IA with a p-value of 0.001 and equal incidence in DA [3]. In our study, we found that female patients were predominant, with a sex ratio of 1: 4 in the JIA group and 1: 1 in the DA group. As a result of the higher number of female neonates, the sex ratio was more skewed towards females.

Bourjonrappa et al compared 130 cases between 1982 and 2007 and found that the mean birth weight was 2.380±0.99 in DA and 2.814±0.76 in JIA. They

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concluded that proximal atresias had a significantly lower birth weight than distal atresias [4]. In our series the DA group had higher birth weight compared to JIA with a significant 'p-value.

All neonates presented with features of intestinal obstruction after birth. A simple Xray abdomen showing proximal bowel distension and collapsed distal gut is all that is required to make a diagnosis. Preterm ultrasonography can reveal intestinal obstruction in 29-50% of cases and helps us in early diagnosis [5]. It is also documented that a CT scan doesn't have any additional advantage in diagnosis [6]. Presence of the associated "Double bubble" sign in abdominal radiography is strongly suggestive of DA. Approximately 31% of patients with small bowel atresia can be diagnosed on prenatal ultrasound with greater reliability for the detection of DA than JIA [7].

The prevalence of associated anomalies with duodenal atresia is about 50%, with the most common resulting in cardiac and renal abnormalities, which require a preoperative 2D echo and ultrasonography of the KUB (kidney urinary bladder). Nearly one-third (33%) of these neonates have Down's syndrome, but their prognosis is no worse than those without the condition [8- 10]. In our series, the incidence of associated anomalies was 48% of patients which 19 % occurred in DA and 27% in JIA. Bourjonrappa et al noticed associated anomalies in 76% DA and 52% in JIA [4]. Zhu et al conducted a retrospective analysis of 39 neonates from 2008 to 2017 comparing outcomes of different types of IA variants and concluded that Apple peels Atresia had excellent long-term outcomes. Associated anomalies and low birth weight are independent risk factors [11]. In our series there were 41% and 59% associated anomalies in DA and IA, respectively. Most of the anomalies were cardiac septal defects followed by PDA and Downs syndrome.

There are many other pathological entities associated with IA. Fukuta et al reported the occurrence of mesenteric lymphangioma in a preterm baby which was successfully managed [12]. Bishop et al demonstrated the association of Trisomy 21 and Heterotaxy Syndrome with IA. Prenatal ZIC3 mutations and microdeletion of 4q22.3 need to be considered when evaluating IA [13]. Other associated anomalies that need to be kept in mind are volvulus, anal stenosis, microcolon, annular pancreas gastroschisis, duplication, and meconium cysts [14- 16]. Finally, the apple peel variant of IA is associated with left-sided cardiac obstructive lesions. Diligo et al found an association between c.2734C>T (p.Arg912Trp) NOTCH1 gene mutation and IA [17]. A duplication of the gall bladder associated with DA has also been reported [18]. In our study, 41 % of patients of DA had concomitant anomalies, of which the majority were cardiac and renal anomalies. The incidence of DA combined with EA varies between 3% and 6% in the literature. We observed an incidence of 13%, which may have been due to the small sample size. We had one case of DA associated with pure EA and one associated with EA with TEF, anorectal malformation, and annular pancreas. In our series, only one patient (2%) was diagnosed with Down's syndrome.

In another study cohort group of 140 cases, DA reported that the incidence of associated IA is around 7%. They studied the difference between the open and laparoscopic approaches in managing these cases and came to the conclusion that during laparoscopy the chance of missing an associated IA was 2.9±2.4%. Hence open surgery is preferred for better management [19]. In our series there was no DA associated with JIA.

The most commonly performed surgical procedure for DA is Kimura's diamond-shaped Duodenoduodenostomy and in Type I DA with duodenal web, duodenotomy with excision of the web. Kimura Duodenoduodenostomy was used in all cases of DA. Surgical procedure for JIA is based on-site and type of atresia, degree of dilatation of the proximal segment, length of remaining bowel, and pre-operative general condition of the patient (Fig 5). Preservation of as much bowel length as possible is attempted to avoid short bowel syndrome. An endeavour to decrease the diameter of the grossly dilated proximal bowel to prevent dysmotility and functional obstruction in the post-op period should always be considered. On the other hand, preservation of as much bowel length as possible at the risk of having a poorly functioning anastomosis can lead to significant morbidity and

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mortality. This should be avoided [20]. Tapering enteroplasty (TE) is a length-preserving surgery that helps in minimizing short bowel syndrome as compared to resection anastomosis (RA). Dewberry et al in their decade-long retrospective review compared both TE and RA in IA. The study concluded that TE as an initial surgery has a statistically similar outcome to the length of hospital stay and time to full enteral feeds. An added benefit is the presence of extra length in the intestine [21]. In our center, 60% of neonates (n=15) were patients with JIA and grossly dilated proximal segment. Partial excision of the grossly dilated proximal segment and tapering the remaining portion of the dilated segment were used for anastomosis. For tapering, we insert a 22 Fr Foley catheter in the dilated bowel and excise the excess bowel wall on the ante-mesenteric border using a linear cutting stapler leaving a small-calibre bowel for anastomosis resulting ineffective peristalsis. This technique has resulted in a relatively earlier start of enteral feed with potentially lesser morbidity as compared to parenteral feed.

In the perioperative period, the main decision is whether to perform a surgical closure or create an ostomy. Hillyer et al compared primary anastomosis to secondary anastomosis in a retrospective cohort of 92 patients from 2005 to 2015. Their results showed that the primary anastomosis group had shorter hospital stays, fewer TPN requirements, and fewer readmissions. The utilization of primary anastomosis at the surgeon level varied from 43.5-to 100%. Hence, they concluded that when possible primary anastomosis should be preferred [22]. We managed most of the cases without an ostomy. Five (10%) required an ostomy, three in DA and two in JIA.

The number of revision surgeries in our series was 9 (18.75%). Anastomotic leak 5 (10%) and functional obstruction due to proximal perforation were the most common complications requiring revision. Five surgeries were done for ostomy closure which was not included in the revision surgeries. Other complications encountered were aspiration pneumonitis, electrolyte imbalance, and wound infection. However, there was no data available for better analysis. In their series described by Bonjourrappa, Eight patients with DA and nine patients with JIA underwent repeat surgery and the most common cause was bowel obstruction due to adhesions. The study highlights the requirement of early diagnosis of the primary disease and associated anomalies, modified surgical techniques, and the use of parenteral nutrition for optimal survival.

The median time to full oral feeding after surgery was 18 days in DA and 20 days in JIA [4]. However, in our series, the time to feed was around the fifth day and most of the neonates were accepting feeds. Total parenteral nutrition may be required in a few cases in the post-operative period to tide over the period of dysmotility and impaired anastomotic function. In our study, two patients (4.1%); first with jejunal atresia and large intra-abdominal cyst (intrauterine volvulus) and the second with ileal atresia type IIIb (apple-peel atresia) had developed short bowel syndrome post-operatively. Frequent small feeds with supplementation resulted in the optimum thriving of the intrauterine volvulus patient but the other patient with IA type IIIb received parenteral nutrition (PN) to thrive. This result is in line with a large series analyzing 118 patients with IA. Nusinovich et al stated that 17% of IA patients continued to require Parenteral Nutrition after initial hospital discharge [23]. The authors of another recent article Sharma et al recommended the use of a trans-anastomotic tube for 6 weeks, which can lead to better outcomes post-surgery [24]. Zang et al also supported early surgery and hence better long-term outcomes [25].

Sholadoye et al reported that the length of hospital stay in the Nigerian population post-surgery was 2-44 days with a median of 13 days [26]. The study by Dewberry et al in their 10-year series, studied the difference between tapering enteroplasty and resection anastomosis in intestinal atresia patients and concluded that TE as an initial procedure preserves bowel length and had a fairly similar outcome to RA in regard to LOHS and time to feed. In our series, the LOHS was similar with an average of 15 days. The length of hospital stay was also statistically significant in TE cases with a p-value of 0.04. There was also a statistically

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significant weight gain at 6 months compared to 12 months with a p-value of 0.041 [21].

The overall survival rates were very low at the beginning of the last century. Gupta et al in their study reported 63 % overall survival in a busy center in Northwest India [27]. The reasons for the poor outcome cited were functional obstruction, septicaemia, overcrowding of the intensive care unit, anastomotic leak, and septicaemia. Due to advances in medical science, the overall survival rate has improved to more than 90% [28]. Chanda et al had reported that the overall survival rate in IA had improved over time. He also stressed that, in their 46 patients, they were able to achieve a survival rate of 82% despite many technical challenges and a lack of TPN. The reason for improved survival as early identification of the disease, adequate fluid resuscitation, meticulous surgical intervention, and early recognition of complications. According to our study, all neonates were alive after one year even with multiple comorbidities [29]. The success of our study depended upon all these factors and the availability of TPN. Apart from better survival, the weight gain at 6 months and one year was satisfactory.

Strengths and Limitations of the Study

The limitations of our study were that it was a single-center study with a relatively small sample size and a limited follow-up of one year. We had an early survival rate of 100%, which has not been reported earlier, albeit two of our cases required TPN.

Interestingly, we had an excellent early survival rate as well, which could be attributed to the fact that none of our patients had accompanying severe cardiac or renal anomalies. Most of the studies involving IA in developing countries have less satisfactory outcomes with significant peri-op and post-op morbidity and mortality. This is primarily attributable to the lack of good health care facilities and timely referrals. The sparse availability of neonatal surgeons and neonatologists, neonatal intensive care units, and trained nursing staff also provide poorer outcomes.

Conclusion

The management of intestinal atresias is challenging and requires a dedicated medical team in a well-equipped neonatal Intensive care unit. An early intensive search for other associated congenital anomalies is equally critical. The average weight gain and survival in Jejunoileal atresia is better compared to duodenal atresia . Additionally, in a subgroup analysis of Jejunoileal atresia, patients undergoing tapering enterostomy showed better survival compared to resection and end-to-end anastomosis.

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Conflict of interest

The authors declare that there is no conflict of interest.

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