Original Article

# Metabolic Profile and Outcome of Pre- and Post-Ampullary Gastrointestinal Obstruction in Children: Conventional or Unconventional Wisdom

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## Abstract

**Background:** Conventionally, it is well accepted that the intestinal obstructions in children, especially gastric outlet obstruction are associated with significant metabolic derangement which has impact on its outcome. The study aimed to compare the metabolic profile and treatment outcome of pre- and post-ampullary gastrointestinal obstruction in children at a tertiary care setting. **Materials and Methods:** A prospective observational study was conducted on 30 children with intestinal obstruction and categorised into Group 1 (pre-ampullary, $n = 11$) and Group 2 (post-ampullary, $n = 19$) as per their anatomical site of pathology. Patients were evaluated at both pre- and post-operative period (Day 1 and 10) with haematological, biochemical and blood gas. The pre- and post-operative metabolic profile, resuscitative time and outcome were compared in two groups. **Results:** Except mild leucocytosis (Group II > I), rest of the pre-operative and post-operative haematological parameters were within normal range and statistically comparable among groups. Although the pre-operative sodium values were within the normal limit in both groups, it was relatively higher in Group I (Group I = 137.82 ± 4.238 vs. Group II = 134.26 ± 4.653), ($P = 0.04$). The mean bicarbonate values were within the normal limit in both groups (22.49 and 19.34), but the difference was statistically significant ($P = 0.031$). Mean partial pressure of carbon dioxide level was higher than normal range in Group I (38.464 ± 20.6493) but was comparable with Group II ($P = 0.15$). The time required for pre-operative resuscitation was 16.6 versus 24.87 h in Group I versus Group II ($P = 0.02$). In Group I, all children were improved, whereas four children expired in Group II. **Conclusion:** Metabolic profile in both pre- and post-ampullary intestinal obstruction was found to be normal in majority of the scenario. Children with post-ampullary obstruction need extensive pre-operative resuscitation and have relatively poor outcome.

**Keywords:** Gastrointestinal obstruction, metabolic profile, post-ampullary, pre-ampullary

## Introduction

The ampulla of Vater is an important landmark, halfway along the second part of the duodenum that marks the anatomical transition from the foregut to midgut.[1] The composition of gastrointestinal (GIT) secretion in the pre-ampullary and post-ampullary segment of the bowel is different,[2] thus metabolic abnormalities resulting from loss of secretions in pre- and post-ampullary intestinal obstruction are unlikely to be same. Among plethora of aetiology of intestinal obstruction in children, congenital hypertrophic pyloric stenosis (CHPS), pyloric duplications, duodenal atresia, annular pancreas and malrotation of gut with mid-gut volvulus were common causes of pre-ampullary, whereas jejunoileal atresia, meconium ileus, meconium plug, intussusception and Hirschsprung's disease with or without necrotising enterocolitis were common causes of post-ampullary obstruction. Literature regarding metabolic abnormalities in intestinal obstruction is conflicting and mostly related to pyloric stenosis. Older literature supported classical hypokalaemic hypochloremic metabolic alkalosis[3-5] in pre-ampullary obstruction like in CHPS, recent evidence suggested that hypokalaemia is uncommon

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in this group of children.[6] Literature related to metabolic abnormalities in post-ampullary intestinal obstruction is sparse and inconclusive, though some authors have mentioned distal intestinal obstruction had hyponatraemia and normokalaemia.[7] Although literature reported the excellent outcome in CHPS,[5,6] evidence about overall outcome related to intestinal obstruction in children is lacking, especially in the Indian scenario. It is very important to understand the pathophysiology and spectrum of metabolic changes in paediatric intestinal obstruction for timely resuscitation and satisfactory surgical outcome. With this background, we aimed this study to define and compare the peri-operative metabolic profile and treatment outcome of pre- and post-ampullary gastrointestinal obstruction in children at a tertiary care setting from Northern India.

## Materials and Methods

A prospective observational study was conducted during November 2013–March 2016; on 30 children (<12 years) with intestinal obstruction at our tertiary teaching institute after ethical clearance obtained from the Institutional Review Board. The study populations were divided into two groups according to the anatomical location of obstruction: group I (pre-ampullary, $n$ = 11) and Group II (post-ampullary, $n$ = 19). The diagnosis of intestinal obstruction was based on the history, clinical examination and radiological studies which included X-ray abdomen erect, ultrasonography (USG) abdomen (GE Voluson E6 system, frequency 5–12 Hz, linear transducer machine), barium study as indicated and contrast computerised tomographic (CT) scan abdomen in selected cases.

After diagnosis, patient underwent complete metabolic and biochemical evaluation, including complete electrolyte and metabolic profile, which includes complete blood count, coagulation profile (prothrombin time, activated partial thromboplastin time and international normalised ratio), renal function tests, liver function tests, serum electrolytes (serum sodium and potassium) and arterial blood gas analysis. Stabilisation and resuscitative measures were taken before surgery according to metabolic abnormality and subsequently child underwent definitive surgery according to the nature of the disease. Post-operative electrolyte profile and metabolic profile were recorded on the first and tenth post-operative day. The final outcome was defined as improved or expired. Children on chronic medication like hormonal treatment (steroid, etc.) for other untreated disorders were excluded from the study.

The pre-operative and post-operative metabolic profile, resuscitative time and outcome (in terms of improved or expired) were compared in two groups.

### Statistical method

Data compiling and statistical analysis were done using Microsoft Excel 2013. Mean, median and proportion were used to describe the results. Independent $t$-test was used to compare the variables of pre- and post-ampullary groups. $P < 0.05$ was considered to be statistically significant.

## Results

The most common aetiology for obstruction in Group I was CHPS (37%) as compared to Meckel's diverticulum (21%) in Group II. The detail demographic profile and aetiology of intestinal obstruction were tabulated in Tables 1 and 2. Baseline demographic data of both groups were comparable [Table 1].

Apart from routine X-ray abdomen, USG was done in selected cases as indicated and was found to be diagnostic in four cases of CHPS (100%). In the rest of cases, USG showed non-specific dilatation of bowel loops. Barium study was done selectively in our study and was diagnostic in case of duodenal atresia, malrotation of gut and Hirschsprung's disease. Contrast-enhanced computerised tomographic scan (CECT) was done in seven children with diagnostic dilemma and was found to be helpful in the diagnosis of malrotation of gut [Figure 1], eventration of the diaphragm [Figure 2] and other rare causes of obstruction like trichobezoar.

Except mild leucocytosis which was more evident in Group II (Group I = 11.75 ± 2.70 and Group II = 13.13 ± 4.22), rest of pre-operative as well as post-operative haematological parameters were within the normal range and statistically comparable in both the groups [Table 3]. On post-operative day 1, mean haemoglobin (Hb) values were 10.54 g % in Group I versus 10.94 g % in Group II. There was a significant drop (1.8 g in Group I and 1 g in Group II) in Hb level as compare to pre-operative value (Group I, $P$ = 0.03 and Group II, $P$ = 0.05) in both the groups.

Although the pre-operative sodium values were within the normal limit in both groups, it was relatively higher in Group I (Group I = 137.82 ± 4.238 vs. Group II = 134.26 ± 4.653) which was statistically significant ($P$ = 0.04) [Table 3].

Except borderline hyperbilirubinaemia in both groups in the peri-operative period, rest of the biochemical parameters were normal and statistically comparable in both pre- and post-operative period [Table 3]. Among blood gas profile in the pre-operative period, the mean bicarbonate ($HCO_3^-$) values were within the normal limit in both groups (22.49 and 19.34), but there was statistically significant difference ($P$ = 0.031), as they were distributed near the two extremes of normal range. The mean partial pressure of carbon dioxide level was higher than normal range in Group I (38.464 ± 20.6493), but it was statistically comparable with Group II (31.063 ± 6.5780) ($P$ = 0.15) [Table 3].

The time required for pre-operative resuscitation before surgical intervention was 16.6 versus 24.87 h in Group I versus Group II which was statistically significant ($P$ = 0.02). In Group I, all the children survived and improved postoperatively whereas in Group II ,four children expired in the post operative period [Figure 3].

## Discussion

In this study, we have evaluated various aspects with special focus on metabolic consequences and outcome of pre- and post-ampullary intestinal obstruction in children. On systematic search of PubMed, Medline and ScienceDirect, no study was available in the Western as well as in the Indian literature, directly evaluating the similar spectrum in the setting of pre- and post-ampullary intestinal obstruction in children (<12 years) and hence it is difficult to compare our findings with evidence-based literature in head-to-head manner.

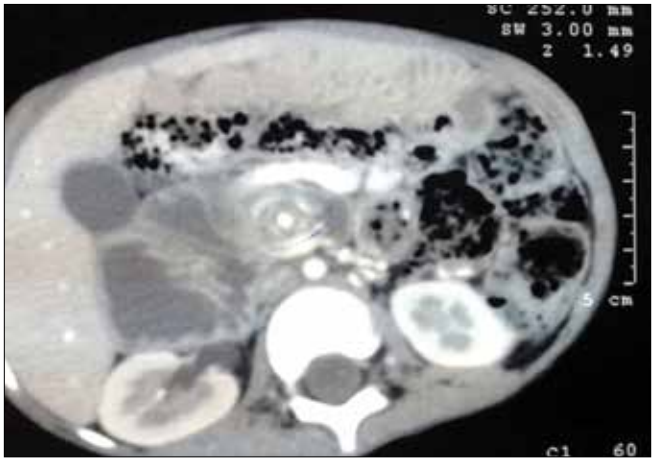

**Figure 1:** Contrast-enhanced computerised tomographic scan showing classical whirlpool sign (arrow), duodenojejunal flexure on the right side, fluid-filled distended duodenum with thickened bowel loops found in malrotation of gut

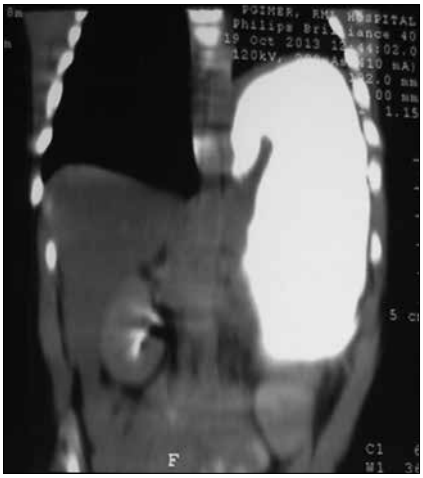

**Figure 2:** Eventration of the diaphragm

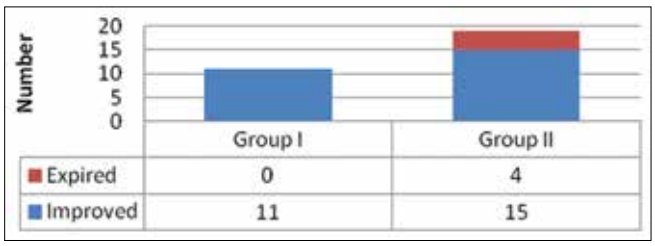


**Figure 3:** Outcome in both the groups

The mean age of the children was 59.28 ± 47.5 months in a study done by Mir *et al*.[8] in children of mechanical small-bowel obstruction. Our children have comparatively lower age probably because many of our children had congenital atresia and CHPS as a cause of obstruction who presented in early infancy as compared mechanical aetiology.

The sex ratio (male: female) in both groups was statistically comparable ($P = 0.70$). Although CHPS is seen predominantly in boys,[9] our study group has heterogeneous aetiologies which may explain similar boy's and girl's ratio [Table 1].

In the current study, we found most common cause in pre-ampullary intestinal obstruction is CHPS (now called idiopathic hypertrophic pyloric stenosis) and malrotation of the gut with duodenal obstruction. As reported by Cohen *et al*.,[9] hypertrophic pyloric stenosis is a major cause of non-bilious vomiting in the non-septic child during the first few months of life. Escobar *et al*.[10] in their retrospective review of patients found duodenal atresia or stenosis frequent cause of congenital intestinal obstruction.

In our study, Meckel's diverticulum followed by Hirschsprung's disease [Table 2] was the most common cause of post-ampullary intestinal obstruction. The main complications caused by

**Table 1: Demographic profile**

| Variables | Group I (pre-ampullary) | Group II | *P* |
|---|---|---|---|
| *n* | 11 | 19 | - |
| Mean age (months) | 44.11±54.62 | 43.34±48.15 | 0.86 |
| Sex (male:female) | 5:6 | 10:9 | 0.70 |
| Mean weight (kg) (at admission) | 9.68±9.8 | 11.07±6.87 | 0.26 |
| Mean weight (kg) (at discharge) | 9.85±9.6 | 11.25±6.65 | 0.30 |

**Table 2: Aetiology of obstruction**

| Aetiology | *n* (%) |
|---|---|
| Pre-ampullary (Group I) | |
| CHPS | 4 (37) |
| Duodenal obstruction | 3 (27) |
| Malrotation of gut with proximal gut obstruction | 3 (27) |
| Mesentroaxial volvulus with left-sided eventration of the diaphragm | 1 (9) |
| Post-ampullary (Group II) | |
| Meckel's diverticulum | 4 (21) |
| HD | 3 (16) |
| Ileocecal intussusception | 3 (16) |
| Jejunal obstruction | 3 (16) |
| Ileal obstruction | 2 (11) |
| Malrotation of gut | 2 (10) |
| NEC | 1 (5) |
| Ileosigmoid knotting | 1 (5) |

CHPS: Congenital hypertrophic pyloric stenosis, HD: Hirschsprung's disease, NEC: Necrotising enterocolitis

Meckel's diverticulum, include intussusceptions and volvulus in adolescents and acute bleeding in adults.[11] However, Meckel's diverticulum causing small-bowel obstruction is not uncommon in children.[12-15] In a large series by St. Vil *et al*.,[16] of the 117 symptomatic patients of Meckel's diverticulum, 49 (42%) presented with bowel obstruction. Their findings support the high incidence Meckel's diverticulum in this study.

While evaluating the children with intestinal obstruction, apart from clinical history and examination, various radiological aids are available to ascertain the diagnosis. A plain radiograph is a useful and most inexpensive tool in the evaluation of the neonate with gastrointestinal obstruction.[17,18]

In four cases, it was correctly defining the level of obstruction or which included two cases of duodenal obstruction, one CHPS and one case of eventration of the diaphragm with gastric volvulus. Similar to existing evidence,[17] we found that USG is highly accurate in the diagnosis of hypertrophic pyloric stenosis and useful in the investigation of mass lesions such as enteric duplication cysts and mesenteric or omental cyst. As reported in the literature,[19,20] barium meal study was helpful in diagnosis of selected cases such as malrotation and CHPS. Parallel to reported literature,[20] in our study, barium enema has been found to be diagnostic of Hirschsprung's disease, especially in short-segment disease. Although CECT abdomen is not a desired modality in children due to risk of radiation exposure and need for sedation, still it is sensitive and specific modality to rule out small as well as large bowel obstruction in children. As mentioned by Jabra *et al*., the CT scan has a sensitivity of 87%, the specificity of 86% and accuracy of 86% for diagnosing small intestinal obstruction and concluded that CT is both sensitive and specific for use in diagnosing small-bowel obstruction in children, especially in children older than 2 years.[21] In our study group, CECT scan was diagnostic in three cases, including eventration of the diaphragm, malrotation of the gut and trichobezoar [Figures 1 and 2].

Mild leucocytosis on pre operative haematological findings in both groups can be easily explained by associated infection t among the both groups. In Group II, five children had definitive evidence of sepsis which explain comparatively higher leucocytes and polymorph counts than that of Group I. On post-operative day 1, there was a significant drop in Hb level as compare to pre-operative value in both groups, probably because of intraoperative blood loss and haemodilutional effect of fluid resuscitation.

The current study found that in pre-ampullary group which include cases of CHPS has normal electrolytes distribution which is not the rule always so far evidence-based literature are concerned. As reported by Miozzari *et al*.,[5] there was trend towards hypokalaemia in infantile pyloric stenosis. However, a recent report by Tutay *et al*.[6] found that hypokalaemia was present only in 8% of children, rest had either hyperkalaemia or normokalaemia. Hence, classical hypokalaemia is an uncommon finding as recent reports suggested which was similar to our study. Our findings of normal sodium and potassium in Group I may be partly due to early reporting to tertiary centre in an urban setup with relatively easier accessibility of healthcare facilities before significant abnormality has been established.

In the pre-operative period, the post-ampullary group which included cases of intestinal obstruction, all the biochemical parameters were within the normal range except the sodium value which was marginally lower (134.26 mEq/L). As mentioned by Kaul and Vaida that the majority of patients with intestinal obstruction had hyponatraemia and normokalaemia.[7] They found the degree of hyponatraemia correlated with duration of obstruction. In our children of Group II, electrolytes were in the normal range, probably because children have been reported at the early stage of obstruction as ready mentioned.

In the pre-operative period, though the mean $HCO_3^-$ values were within the normal limit in both groups (22.49 and 19.34), there was statistically significant difference ($P = 0.031$) as they were distributed near the two extremes of normal range [Table 3]. The trend towards metabolic acidosis can be well explained by the evidence of frank sepsis in few children of Group II. Touloukian and Higgins have reported the metabolic alkalosis is a common finding in pre-ampullary obstruction like CHPS.[22,23] Tutay *et al*. found that normal laboratory values are the most common finding in CHPS and that metabolic alkalosis was found more common in older infants.[6] As discussed earlier, the classical metabolic abnormalities in CHPS is not a common finding in the recent literature, and also in the current study probably because of better understanding of pathophysiology of disease and wide availability of sonological evaluation to detect the disease in its early course.

**Table 3: Pre-operative metabolic parameters in both groups**

| Variables (mean) | Group I | Group II | *P* |
|---|---|---|---|
| Hb (%) | 12.39±2.57 | 11.98±2.27 | 0.67 |
| TLC | 11.75±2.70 | 13.13±4.22 | 0.285 |
| Polymorph | 62.0±15.93 | 66.05±18.3 | 0.532 |
| Platelets | 2.96±1.08 | 2.73±1.20 | 0.602 |
| Urea | 25.36±7.5 | 33.82±12.63 | 0.195 |
| creatinine | 0.58±0.28 | 0.84±0.75 | 0.23 |
| $Na^+$ | 137.82±4.238 | 134.26±4.653 | 0.044 |
| $K^+$ | 4.455±0.7147 | 4.668±0.7250 | 0.441 |
| SGOT | 39.00±11.46 | 46.68±23.159 | 0.31 |
| SGPT | 40.00±21.02 | 31.53±11.06 | 0.15 |
| Bilirubin | 1.66±2.44 | 1.28±1.51 | 0.324 |
| Alkaline phosphatase | 123.9±25.56 | 131.58±82.17 | 0.766 |
| RBS | 94.55±16.70 | 99.84±36.82 | 0.62 |
| pH | 7.415±0.0682 | 7.404±0.0411 | 0.627 |
| $PO_2$ | 97.909±0.7006 | 97.105±2.6012 | 0.32 |
| $PCO_2$ | 38.464±20.6493 | 31.063±6.5780 | 0.15 |
| $HCO_3^-$ | 22.491±5.3793 | 19.347±2.1732 | 0.031 |

Hb: Haemoglobin, TLC: Total leucocytes count, $Na^+$: Sodium, $K^+$: Potassium, SGOT: Serum glutamic oxaloacetic transaminase, SGPT: Serum glutamic-pyruvic transaminase, $PO_2$: Partial pressure of oxygen, $PCO_2$: Partial pressure of carbon dioxide, $HCO_3^-$: Bicarbonate, RBS: Random blood sugar

In Group I, all the children survived and improved postoperatively whereas in Group II ,four children expired in the post operative period [Figure 3]. As already discussed, it signifies more complex obstruction in Group II, which leads to sepsis and poor overall condition. Thus, the final outcome of Group II was poor as compared to Group I.

This study is very relevant and unique in varied sense. This study has focused on metabolic abnormalities of the wide spectrum of gastrointestinal obstruction including pre-ampullary and post-ampullary group which itself is unique in a sense of its categorisation and pathophysiology. More importantly, this study has focused on very relevant issue of related metabolic changes in these groups of children where literature is spare and confusing.

Certain limitations of this study should have been mentioned, like small number of cases with variable aetiologies prevented us to make any conclusion on specific disease. Being a tertiary centre at an urban city of India where children are referred early or reported early may not be true representation of rest of the country where the majority of the population stay in rural part of the country.

## Conclusion

Contrary to common belief, children of pre-ampullary and post-ampullary intestinal obstruction have normal metabolic profile or mild derangement which is easily correctable. However, children with post-ampullary obstruction need extensive pre-operative resuscitation and have relatively poor outcome, whereas pre-ampullary group had an excellent final outcome. However, further multicentre study with large sample size is required to establish above facts.

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### Conflicts of interest

There are no conflicts of interest.

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