**Aim of the Study:** The aim of this study is to assess the role of early feeding after elective colorectal surgery in children and compare the outcome of feeding practice early versus traditional feeding.

**Study Design:** A randomized controlled, single-center study was conducted over a period of 3 years (November 2015–October 2018) at a tertiary care center.

**Materials and Methods:** Patients ($n = 147$), after colostomy closure (as elective colorectal surgery), were randomly selected for postoperative feeding initiation and were divided into two groups, namely the control (traditional feeding) group and study group (early feeding). In early group, feeding was initiated on the postoperative day 1 after the removal of nasogastric tube (removed after 16 h of surgery). Postoperative hospital stay and complications were compared among them.

**Statistical Analysis Used:** Data were tabulated and analyzed in Microsoft Excel 2010.

**Results:** Among 147 patients (boys 70 and girls 77), the average age of colostomy closure was 4.36 years. Forty-five patients had early feeding and 102 traditional feeding. Average postoperative hospital stay was noted 5.62 ± 1.11 days for “Study group” and 8.1 ± 1.04 days for “Control group.” Postoperative complications were found in 17 patients; 11 (7.5%) superficial surgical site infection (9 [8.8%] in control and 2 [4.4%] in study group) and 6 (4%) minor fecal fistulae (5 [4.9%] in control group and 1 [2.2%] in study group). None required any further surgical intervention. No mortality was reported.

**Conclusions:** Early feeding initiation after elective colorectal surgery is safe, and postoperative hospital stay is significantly reduced. It is definitely a step forward in the era of fast track surgery in pediatric population.

**Keywords:** Colostomy closure, complications after colorectal surgery, nasogastric tube, postoperative feeding
hand, there are a lot of justified reasons to believe that it is functionally possible to begin early feeding, in the POD 1.\textsuperscript{[4,10,11]} Even if we do not give oral feeding, about 1.5–2 L of gastrointestinal (GI) and pancreatic secretions enter and pass through the distal bowel, and after absorption, a significant amount transit through the anastomosis site, thus feeding has no additional adverse effect on anastomosis site.\textsuperscript{[10]} Early enteral feeding has been shown by various clinical trials as having benefits in the reduction of postoperative ileus and hospital stay. Postoperative dysmotility predominantly affects the stomach and colon, with the small bowel recovering normal function 4–8 h after laparotomy. It is evident from different studies that after surgery the return of bowel function and motility occurs within 6–12 h in the small bowel, 12–24 h in the stomach, and within 48–72 h in the large bowel.\textsuperscript{[12]} From clinical studies, it is evident that starting early feeding is advantageous in postoperative patients, whereas postoperative starvation changes the metabolism of the body within 24 h by increasing insulin resistance and reducing muscle function.\textsuperscript{[13]} Feeding within 24 h after laparotomy is tolerated and “feed” is absorbed.\textsuperscript{[9]}

Children and infants are always eager to take food early after the operation. As there has been a history of one or more operations previously in case of anorectal malformation, the nutritional status of those patients is usually not satisfactory. GI blood flow is reduced in patients after various types of critical illnesses and conditions. Manipulation of the intestine initiates the pathogenesis of intestinal edema, which might be involved in alteration in GI blood flow and promote inflammatory response using the activation of macrophages and invasion of neutrophils\textsuperscript{[14,16]} Many investigators have reported that enteral nutrition (EN) may dampen the inflammatory response and thereby reduce postoperative inflammation, whereas another mechanism may be the stimulation of bowel movements by the input of nutritional liquids.\textsuperscript{[15,16]} Hence, early oral feeding improves the nutritional status of patients and helps healing of the wound properly. Early feeding also reduces the postoperative complications.

Long stay in the hospital increases the hospital-acquired infections such as upper respiratory tract infection and diarrhea which are present more in delayed fed patients.\textsuperscript{[17]} Hence, early feeding helps the patients to reduce postoperative hospital stay and nosocomial infection. In our hospital, we have noticed that postoperative children are restless if they are deprived of food. It is also difficult to establish and maintain intravenous access for these children for long. There are few studies aiming at the effect of early feeding but mostly are performed in the retrospective group.\textsuperscript{[8,18]}

**Materials and Methods**

**Study place, duration, type, and study population**

This study was performed in the department of pediatric surgery at a tertiary care center in Kolkata, India, during the period of 3 years (November 2015–October 2018). In this single institute-based randomized control study, all patients were chosen randomly from all the three units of the department for postoperative feeding initiation and they were divided in two groups, namely Group A for traditional feeding (chosen from two units) or “control group” and Group B for early enteral feeding patients (chosen from a single unit) – “study group.”

**Protocol of feeding after colostomy closure**

**Group A (control group)**

Patients were kept nothing by the mouth until the documentation of bowel function, which meant a passage of flatus or feces, usually earliest on the 3\textsuperscript{rd} POD. A nasogastric tube was kept in situ until the content reduced and turned clear.

**Group B (study group)**

Enteral diet was started in the next morning within 16–24 h of the 1\textsuperscript{st} POD. Feeding was started with clear water. Then, breast milk and other liquid diet were allowed with 3–4 h interval. Usual diet was started on the 3\textsuperscript{rd} POD. The nasogastric tube was removed in the morning of the 1\textsuperscript{st} POD [Table 1].

**Criteria for nasogastric tube reinsertion**

The NG tube was reinserted dependent on two episodes of vomiting >100 ml within 24 h in the absence of bowel movements.

| Table 1: Protocol of feeding after surgery |
|-----------------------------------------|
| **Study group**                           | **Control group**                           |
| POD 0  Cessation of enteral feeding       | Nothing per mouth                           |
| NG tubes inserted into the fundus of stomach through the nose | NG tube insertion                           |
| POD 1  NG tube removal (16 h after surgery) | NG tube kept in situ until content reduced and turned clear |
| Clear fluid only                         | Initiation of enteral feeding after documentation of bowel movement - Passage of flatus and stool in a gradual manner |
| 3–4 h after liquid diet/breast milk      |                                             |
| POD 2-3 Progress to normal diet on basis of tolerance |                                             |

POD: Postoperative day, NG: Nasogastric
End of the study
Postoperative establishment of full-enteral feeding and discharging without complication from the hospital was marked as the end point of the study in both groups. Hence, the duration was calculated from the date of surgery to date of discharge.

Data analysis
Data were tabulated and calculated for age, sex of patient, initiation of postoperative feeding, complications, and postoperative hospital stay. All statistical data analysis were conducted in Microsoft Excel 2010.

Inclusion criteria
Children with status colostomy who underwent elective colostomy closure after adequate proximal mechanical bowel washing with polyethylene glycol and nonresidue diet for 2 days and clear water and liquids (oral rehydration salt) for 1 day before surgery along with distal mechanical bowel wash with normal saline (0.9%) till the visibility of a clear effluent were strictly followed.

Exclusion criteria
Patients with associated comorbidities such as seizure disorder, cardiovascular defect, complications in previous surgeries, multiple (>2) abdominal surgeries, adhesions leading to long-operating time and during surgery gross luminal disparity between the proximal and distal colon were excluded from the study. The present study was also terminated if postoperative ileus or major anastomotic leak had been a suspect.

Consent for surgery, postoperative feeding, and data collection
For the study, permission from the Institutional Ethics Committee had been obtained. In addition to that, written consent in the language of patient’s parent/guardian (Bengali/English/Hindi) was taken before each surgery separately.

Results
In our study, 147 patients were selected, of which 70 were boys and 77 were girls. Twenty-three boys and 22 girls had “early feeding,” and the rest had “traditional feeding” [Table 2]. Minimum age of surgery was 1 year, and maximum of 12 years with an average of 4.36 years. Mean age of “early feeding” group was 4.48 ± 1.27 years and “traditional feeding” group 4.3 ± 2.1 years. However, this difference is not statistically significant (P = 0.115). Two-third of patients (98) has been operated within 4 years of age (66.67%) [Chart 1].

Postoperative early enteral feeding was initiated in Group B or “study group,” and number of patients was 45. Traditional feeding was started in Group A or “control group” and total number was 102 [Chart 2].

Postoperative hospital stay (in days) has been calculated, and the result analyzed in four groups. In patients with “early feeding” group, minimum stay was 4 days and maximum 8 days with an average stay of 5.62 days, and in “traditional feeding” group, minimum stay was 6 days and maximum stay 13 days with an average stay of 8.1 days [Table 3]. Among all, complications have been found in 17 patients – superficial surgical site infection (SSSI) in 11 and fecal fistula in six patients. None required any postoperative surgical intervention, and all were treated conservatively. In “early fed” group patients (n = 45), postoperative complication was found in only 3, and in “traditional fed” group (n = 102), it was in 14 patients. “Early feeding” and “traditional feeding” group had minor anastomotic leak in one and five patients, respectively, which were treated conservatively. The results are statistically significant [Table 4].

Following postoperative feeding initiation, no patient required reinsertion of NG tube according to the “clinical criteria for reinsertion.”

Discussion
This study was made to assess the outcome of early initiation of postoperative feeding and their effect on postoperative hospital stay and complications. It has already been demonstrated that mucosal epithelium of the bowel is perfectly sealed after the first 24 h of the postoperative period.[6] In our study, we started early feeding at 16–24 h. It has been also shown that early feeding accelerates the wound and anastomosis healing in the animal model.[19] Early feeding reverses the mucosal atrophy induced by the starvation and increases anastomotic collagen deposition and strength.[20-22] There are two end points of our study. First is to look for postoperative ileus and time taken for first defecation after surgery and the second end point is its clinical outcome by means of postoperative complication and length of hospital stay.

Early feeding delays postoperative ileus, helps in wound healing and reduction of sepsis.[13] Postoperative ileus had been an important reason for patients kept

Table 2: Demographic data of patients

|                      | Early feeding (n=45) | Traditional feeding (n=102) | P     |
|----------------------|----------------------|-----------------------------|-------|
| Age                  | 4.48±1.27            | 4.3±2.1                     | 0.115 |
| Sex                  |                      |                             |       |
| Boys                 | 23                   | 47                          | 0.195 |
| Girls                | 22                   | 55                          |       |
nothing per oral (NPO) in the postoperative period. To assess the postoperative ileus, first, the NG tube is removed on the morning of POD 1 and followed up carefully. It was strictly maintained that NG tube should be reinserted when the two episodes of vomiting >100 ml within 24 h. This recommendation was the outcome of another study.[23]

Postoperative nutrition is another important factor to support clinical end point, i.e. postoperative complication and the length of hospital stay. Nutrition care protocol is followed as per recommended by the another study.[14] In our study, we did not use total parenteral nutrition (PN) during the initial postoperative period in any patients. We inserted NG tube up to the stomach only not up to first loop of the jejunum as per the previous study.

Early EN may also reduce the inflammatory response and thereby reduce anastomotic leakage. In the experimental setting, EN prevents adverse structural and functional alterations of the anastomotic position by improving the intestinal blood flow and modulating the systemic and local immune response.[24] Our study confirms that only 2.2% children had anastomotic dehiscence (minor leak) which was treated conservatively compared to 4.9% in “Control Group.”

We also noticed SSSI is higher (7.5%) than “early fed” Group (2%). Hence, the contention that early feeding will jeopardize healing and cause anastomotic leak is refuted. Adhesiolysis can delay the return of peristalsis as intestinal adhesion and prolong gut handling lead to ischemic bowel injury and decreased blood flow. According to another study, EN may also improve splanchnic blood flow and ischemic injury. In fact, although feeding increases GI oxygen consumption, the concomitant increase in oxygen delivery leads to better “delivery to consumption ratio” in the “fed” versus the “unfed” state. Histological evidence has proven that EN preserved the gut flora architecture, prevented GI mucosa atrophy, and inhibited microbial translocation from the gut to the blood stream leading to postoperative complications.[25] All patients with complications were treated conservatively, and no mortality was there.

In a study by Nematihonar et al., the patients with “early feeding” expressed greater overall satisfaction with treatment process based on the Visual Analogue Scale criteria compared to patients with “late feeding.”[11] The overall duration of hospital stay had a remarkable effect on patient satisfaction with the treatment procedure and costs. We also observed a marked difference in postoperative hospital stay in “Study group.” According to feeding protocol, NG tube was removed in POD

### Table 3: Postoperative hospital stay statistics

| Feeding group | Number of patients | Minimum stay (days) | Maximum stay (days) | Mean value of postoperative stay (days) | Average postoperative stay (mean±SD)* | P* |
|---------------|--------------------|---------------------|---------------------|----------------------------------------|--------------------------------------|----|
| Early feeding | 45                 | 4                   | 8                   | 5.62*                                  | 5.62±1.11                             | 0.007 (significant as P<0.01) |
| Traditional feeding | 102             | 6                   | 13                  | 8.1                                    | 8.1±1.04                              |    |

*Data calculated by Microsoft Excel 2010. SD: Standard deviation

### Table 4: Postoperative complications

| Complications         | Total | Early feeding (n=45) | Traditional feeding (n=102) | P* |
|-----------------------|-------|----------------------|----------------------------|----|
| Anastomotic leak      | 6     | 1                    | 5                          | <0.0001 |
| SSSI                  | 11    | 2                    | 9                          | <0.0001 |

*Data calculated by Microsoft Excel 2010. SSSI: Superficial surgical site infection

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**Chart 1:** Age distribution of patients

**Chart 2:** Feeding pattern distribution among all patients
Table 5: Comparison of various parameters of the present study with different other studies

| Parameter                  | Present study (n=147) | Mittal et al.[26] n=30 | Wani et al.[27] n=40 | Burch et al.[28] n=65 | Garude et al.[29] n=73 | Hussain et al.[30] n=24 | Khan et al.[31] n=28 |
|----------------------------|-----------------------|------------------------|----------------------|-----------------------|------------------------|------------------------|----------------------|
| Hospital stay in days (mean) | 7.4 (4-13)            | 12.8                   | 7 (6-12)             | 7.9                   | 12                     | -                      | -                    |
| Anastomotic leak with percentage | 6 (4)                 | 2 (6.67)               | 1 (2.5)              | 2 (3.1)               | 4 (5.4)                | 1 (4.2)                | 1 (6)                |
| Wound infection             | 11 (7.5)              | 5 (16.67)              | 4 (10)               | -                     | -                      | 2 (8.3)                | -                    |
| Mortality                  | 0                     | 0                      | 0                    | 0                     | 0                      | 0                      | 0                    |

1 (at 16 h postoperative), and liquid was initiated on day 1, subsequent diet was established from POD 2–3 onward. As a result, we noticed an average hospital stay after the surgery in “Study group” 5.62 days and in “Control group” 8.1 days. This result is compared with a study in Bangladesh, Paul et al. where average postoperative stay shown to be 4.14 and 8.09 days, respectively.[4] Hence, early feeding practice has definite advantage over traditional feeding in terms of postoperative hospital stay and complication rate. Positive psychological impact of feeding after surgery may have an important role in the recovery process.[5]

We have analyzed different large-scale studies in the world literature and compared our study with respect to the postoperative hospital stay and complications (anastomotic leak and wound infection) with them[26-31] [Table 5].

As per definition, a coordinated perioperative approach aimed at reducing surgical stress and postoperative recovery is termed as fast-track (FT) surgery.[32] Our study enhances the application of FT surgery in the pediatric population.

So, this study adds
- Early feeding is SAFE even in children after colostomy closure most of which are <4 years
- Early feeding in form of clear water can be started even after 16–24 h of surgery (less than a day)
- Septic complications and postoperative hospital stay are significantly reduced in children who received early enteral feeding
- Strengthens the concept of FT surgery in children.

CONCLUSIONS

Like different studies in adult population, our study in pediatric population, also support the concept of early initiation of enteral feeding postoperatively. In elective colorectal surgeries, considering the safety and uneventful recovery of children after colostomy closure, we recommend early start of feeding with clear fluid at POD 1 after the removal of NG tube early in the morning. Subsequent enteral feeding (usual diet) can be established POD 2–3 onward on the basis of tolerance. This must lead to a happy and satisfactory recovery for the child and definitely a step forward to “FT Surgery” in the pediatric population.

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Conflicts of interest
There are no conflicts of interest.

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