



Duodenal lengthening in short bowel with dilated duodenum



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ABSTRACT

Although duodenal dilatation occurs in children with short bowel syndrome (SBS) facilitating dysmotility and bacterial overgrowth, the duodenum has been an untouchable intestinal segment for lengthening procedures owing to its close relationship with bilio-pancreatic structures and blood supply shared with the pancreas. Three children (age range, 0.5–7 years) with SBS and dilated duodenum underwent a novel surgical procedure of duodenal lengthening combined with a technical modification of serial transverse enteroplasty (STEP). Pre-STEP, jejunum length was 5, 35 and 45 cm, respectively. Duodenal lengthening was performed with sequential transverse applications of an endoscopic stapler on the anterior and posterior wall of the duodenum to avoid bilio-pancreatic structure injury. Two patients underwent 3 duodenal firings (stapler of 35 mm) and the third 5 firings (stapler of 45 mm). Duodenal firings were 17%, 21% and 83% of the total firings.

Results: No surgical complications occurred. One patient developed transient episodes of D-lactic acidosis. Two patients (5 and 45 cm) were weaned off parenteral nutrition at 12 months post-surgery and the remaining patient's (35 cm) parenteral calorie requirements have decreased by 60%.

Conclusion: Duodenal lengthening is effective since it tailors and increases the absorptive surface of the duodenum, even in cases of extreme SBS.

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Short bowel syndrome (SBS) is the principal cause of intestinal failure in children. After a massive intestinal resection, patients will require parenteral nutrition (PN) until sufficient intestinal adaptation is achieved. When severe PN complications occur in these children, in particular liver failure, intestinal transplantation is the only therapeutic option [1]. Bowel lengthening procedures may be beneficial in the subset of patients with SBS and dilatation of the remnant small bowel. The most accepted surgical techniques for bowel lengthening are longitudinal intestinal lengthening and tailoring, and serial transverse enteroplasty (STEP) [2,3]. The aims of surgery are to increase the mucosal surface area to permit improved nutrient absorption and taper the dilated intestine to improve bowel motility and reduce the risk for bacterial overgrowth. Both techniques taper the dilation of the small bowel beyond the ligament of Treitz. Nevertheless, on occasions, the duodenum is also dilated in continuity with the remnant dilated small bowel, interfering with the adaptation process before as well as after lengthening procedures. However, the duodenum has been a non-addressable intestinal segment to be lengthened owing its close relationship with the bilio-pancreatic structures and blood supply shared

with the pancreas. A review of the literature yielded only 1 case of duodenal STEP to treat refractory D-lactic acidosis in an 18-year-old woman with SBS and enteral autonomy [4]. However, there is no experience with serial transverse duodenoplasty to increase the overall length of the intestine combined with simultaneous STEP. Herein, we describe our experience in 3 children with SBS and dilated duodenum treated with a novel technique of duodenal lengthening combined with a technical modification of STEP.

1. Material and methods

After approval from the hospital institutional review board (IRB), a retrospective review of children with SBS who underwent bowel lengthening with the STEP procedure at our institution was performed. From June 2005 to February 2013, we performed 10 STEP in 9 patients with SBS, 3 of whom simultaneously underwent duodenal lengthening secondary to megaduodenum. All patients have PN dependency.

Preoperatively, as part of our protocol, an upper gastrointestinal radiographic series and barium enema to assess the presence of distal mechanical obstruction or stricture were performed in the 3 children.

1.1. Surgical operation procedure

Prophylactic preoperative antibiotics and i.v. fluconazole were administered to all patients. Written informed consent was obtained from all parents prior to the procedure. Under general anesthesia,

Abbreviations: SBS, Short bowel syndrome; STEP, Serial transverse enteroplasty; PN, Parenteral nutrition.

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an incision was made at the site of the previous scar. After all the bowel loops had been completely separated, the length of the small intestine was measured from the ligament of Treitz down to the colon. An extensive Kocher maneuver was used to mobilize the posterior wall of the second and third portions of the duodenum and head of the pancreas and permitted the identification of the superior mesenteric vessels. Division and mobilization of the left aspect of the duodeno-jejunal flexure and ligament of Treitz were also required to achieve full exposure of the duodenum. Once the duodenum and head of the pancreas had been reflected medially, the stapler firings (Endopath Stapler, Ethicon, Endosurgery, LLC Guaynabo, Puerto Rico, USA) were performed sequentially on the anatomical anterior and posterior wall of the duodenum perpendicular to the pancreas (Fig. 1). The first stapler line was placed anterior and distal to the hepatoduodenal ligament. This maneuver was performed with a no-touch pancreatic technique to avoid biliary and pancreatic duct injury (Fig. 2). The next firing of the stapler was similar from the opposite side, creating a channel of duodenum and being repeated as many times as the length of the dilated duodenum allowed. The channel diameter was adjusted to patient size and weight (minimum diameter, 2 cm). Distal firings were performed on each side of the superior mesenteric vessels to prevent their being damaged until the jejunum was reached. The STEP procedure was performed on the dilated jejunum with a technical variant of the standard technique described elsewhere [3]. We did not create any mesenteric defect to insert the stapler arm to avoid injury to the intestinal blood supply, and the mesenteric and antimesenteric firings described by Kim et al were changed to lateral firings (left and right, 90° to the mesenteric axis) in a similar fashion to that performed in the duodenum. Corners of the cutting line were inverted with 2 or 3 interrupted 4-0 silk sutures. The adhesion reduction fluid ADEP (Baxter, IL) was used before abdominal closure to reduce the adhesion formation between intestinal loops. A Jackson–Pratts drain was placed to detect postoperative leakages. All patients underwent a radiologic gastrointestinal contrast study on the seventh postoperative day to rule out stricture or leakage before the initiation of enteral nutrition. The Jackson–Pratts drain was removed if no leaks were detected. Antibiotics and i.v. fluconazole were administered postoperatively for 3 days.

The percentage of calories from PN was calculated as the percentage of the total caloric intake provided by PN and its lipid component according to patient weight and age. Enteral autonomy was defined as full enteral nutrition with permanent discontinuation of PN support.

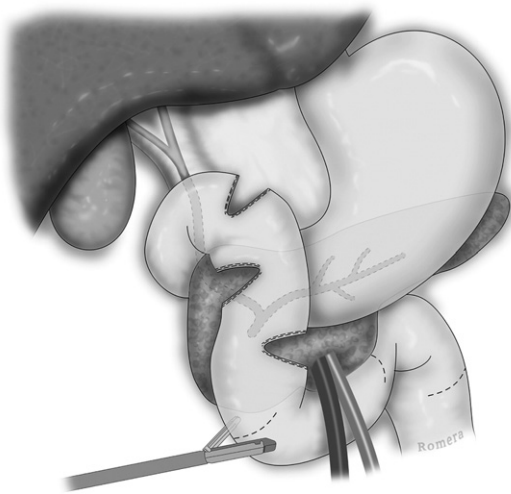


Fig. 1. After Kocher maneuver, the stapler applications were performed on the anatomical anterior and posterior wall of the duodenum perpendicular to the pancreas. The first stapler line was placed anterior and distal to the hepatoduodenal ligament. The next firing of the stapler was similar from the opposite side.

2. Results

Demographics, anatomical conditions, duodenal and total stapler firings as well as pre-STEP and post-STEP PN calorie requirements are shown in Table 1.

Case 1 The patient was a 7-year-old child with a history of midgut volvulus at 1 month of age, cardiac arrest and renal failure requiring hemodialysis. The patient underwent multiple laparotomies leaving a duodeno-colic (ascending colon) anastomosis. Only the 2 subclavian veins were patent for PN administration. Prior to surgery, bowel movements were 5 to 8 per day. Pre-STEP, the volume and total calorie requirements via the parenteral route were 2300 ml in 11 hours and 50%, respectively. The high PN volume needed was secondary to renal dysfunction (hyperfiltrate state with creatinine clearance of 38 ml/min/m²). The upper gastrointestinal radiographic series showed a dilated duodenum (Fig. 3). Owing to the high amount of enteral feedings tolerated (50%), vanishing central access and renal dysfunction, the lengthening procedure was considered. Following laparotomy, a small remnant of jejunum (5 cm) was found anastomosed to the ascending colon. The main diameter of the duodenum was 10 cm. The duodenum was stapled with 5 (83%) 45 mm firings and the jejunum with 1. From the first duodenal firing to the colon, the intestinal tract measured was 40 cm in length (previously 18 cm). Transit time (gastrointestinal series) improved from 55 minutes pre-STEP to 2 hours 45 minutes and 2 hours 15 minutes 1 week and 2 months post-surgery, respectively. The amount of i.v. fluids and calories by the parenteral route at 2 months post-STEP could be reduced to half (1200 ml and 25%, respectively). However, at that time the patient developed symptomatic lactic acidosis that required hospital admission and i.v. bicarbonate administration. A new episode of lactic acidosis occurred at the fifth month post-surgery. Lactic acidosis levels and the patient's condition improved over time with a low-carbohydrate diet and a scheduled antibiotic regimen. Currently, 17 months post-surgery, the patient weighs 20 kg and only requires i.v. fluids (500 ml/day administered in 4 hours) on alternate days. The number of daily bowel movements has been reduced to 3 and 5.

Case 2 A premature girl (26 weeks of gestational age, birth weight 680 g) had developed midgut volvulus at the age of 2 months. She required 4 abdominal surgeries leaving 19 cm of jejunum anastomosed to the sigmoid colon. Postoperatively, the patient developed incoercible vomits and feed intolerance, requiring 100% of calories by PN administered in 21 hours per day. The upper gastrointestinal radiologic series showed megaduodenum with dilated intestine. Owing to failure to thrive, the STEP procedure was scheduled at 6 months of age and 3.5 kg in weight. At surgery, duodenum diameter was 5 cm and jejunum length from the Treitz ligament to the sigmoid colon anastomosis was 35 cm. Fourteen 35 mm cartridges were used, 3 (21%) in the duodenum. A gastrostomy of Stamm was performed. Small bowel length post-STEP from the first firing was 90 cm. Immediately post-STEP, the vomits resolved. Three months after the procedure, the girl only required i.v. fluids (250 ml in 6 hours). However, the patient developed adenovirus enteritis in the fourth postoperative month resulting in several food allergies that required multiple hospital admissions owing to bloody diarrhea (14–15 bowel movements) and dehydration. Biopsies from the esophagus, stomach, jejunum and sigmoid colon demonstrated a severe eosinophilic infiltrate. Currently, 25 months after the lengthening procedure, she is on an elemental formula diet, with 40% of calories by PN administered in 14 hours per day and 4 bowel movements per day. Relapse of the intestinal dilatation has occurred.

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