Ileostomy and Colostomy

58

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In any age group, the creation of an intestinal stoma is a significant event with major physiologic, body image, lifestyle, and psychosocial implications. Management and indications for ostomies in infants and young children are often different than in adolescents and adults. This is a consequence of the differing diagnoses, physiology, size, growth and development issues, complications, and unique patient and parental adjustment concerns.

Intestinal stomas in children are more likely to be temporary adjuncts in the management of surgical emergencies and congenital anomalies. Permanent intestinal stomas are usually only formed for failures of management of some congenital disorders (anorectal malformations, myelomeningocele), inflammatory bowel disease, or, rarely, unresectable pelvic, abdominal, or intestinal tumors (desmoid tumor, giant neurofibroma, sarcoma) and then more commonly in older children after unsuccessful reconstructive procedures. Fortunately, small bowel and colonic stomas of all types are often reversed within a few months or years, and, with rare exception, every effort is made to eventually eliminate the need for another one. There are also several special types of ostomies rarely used outside of pediatric practice that are employed for certain conditions unique to pediatric surgical practice, including the Bishop–Koop ileostomy for meconium ileus and the divided descending–sigmoid colostomy for high imperforate anus.

Indications

The indications for an ostomy are dictated by the diagnosis and the desired function of the stoma (Table 58.1). The function of an ileostomy or colostomy is usually diversion of the fecal stream, decompression of dilated or obstructed bowel, or access for irrigation and evacuation of stool or inspissated meconium. Stomas commonly used for diversion and decompression include the end stoma, the double-barrel stoma, and the loop stoma and its variations (rodless end-loop stoma, divided loop ileostomy). Stomas for irrigation and evacuation include appendicostomies and catheterizable cecal conduits, tube cecostomy, and tube sigmoidostomy. Venting stomas with end-to-side anastomosis and distal vent (Bishop–Koop) or side-to-end anastomosis and proximal vent (Santulli) perform both diverting and irrigation functions and are still occasionally used in the management of meconium ileus.

In pediatric surgical practice, roughly 75 % of ostomies are placed in neonates and infants. In neonates, enterostomies are utilized in the management of diagnoses as diverse as necrotizing enterocolitis (NEC) with perforation, complicated intestinal atresia, volvulus, Hirschsprung disease, meconium ileus, imperforate anus, or cloaca. The young child or adolescent will sometimes require an ostomy for the management of medically refractory Crohn's disease, as part of the staged operative approach to ulcerative colitis, bowel perforation with extensive peritoneal contamination or ischemia (volvulus, trauma, inflammatory bowel disease), and failure of reconstruction and management of congenital anomalies (high imperforate anus, myelomeningocele, Hirschsprung disease).

When fashioning an ileostomy or colostomy, a decision must be made as to whether to use a loop or end stoma or a variant of these types (Fig. 58.1). The type of stoma is determined by a variety of factors, including the indication for diversion, anticipated length of time the stoma will be required, planned future procedures, underlying disease process, and anatomy. Loop ileostomy and colostomy are generally utilized when a temporary stoma is desired to protect a distal anastomosis or to relieve distal obstruction and decompress the proximal bowel prior to definitive surgical management of the obstruction. The main advantages of a loop ostomy are easy access to the distal bowel and ease of reversal. Loop stomas can be reversed with a localized procedure around the stoma, avoiding a full laparotomy. The marginal blood supply to the distal stoma is also more easily preserved with a loop stoma. A major disadvantage of a loop ostomy is a greater tendency

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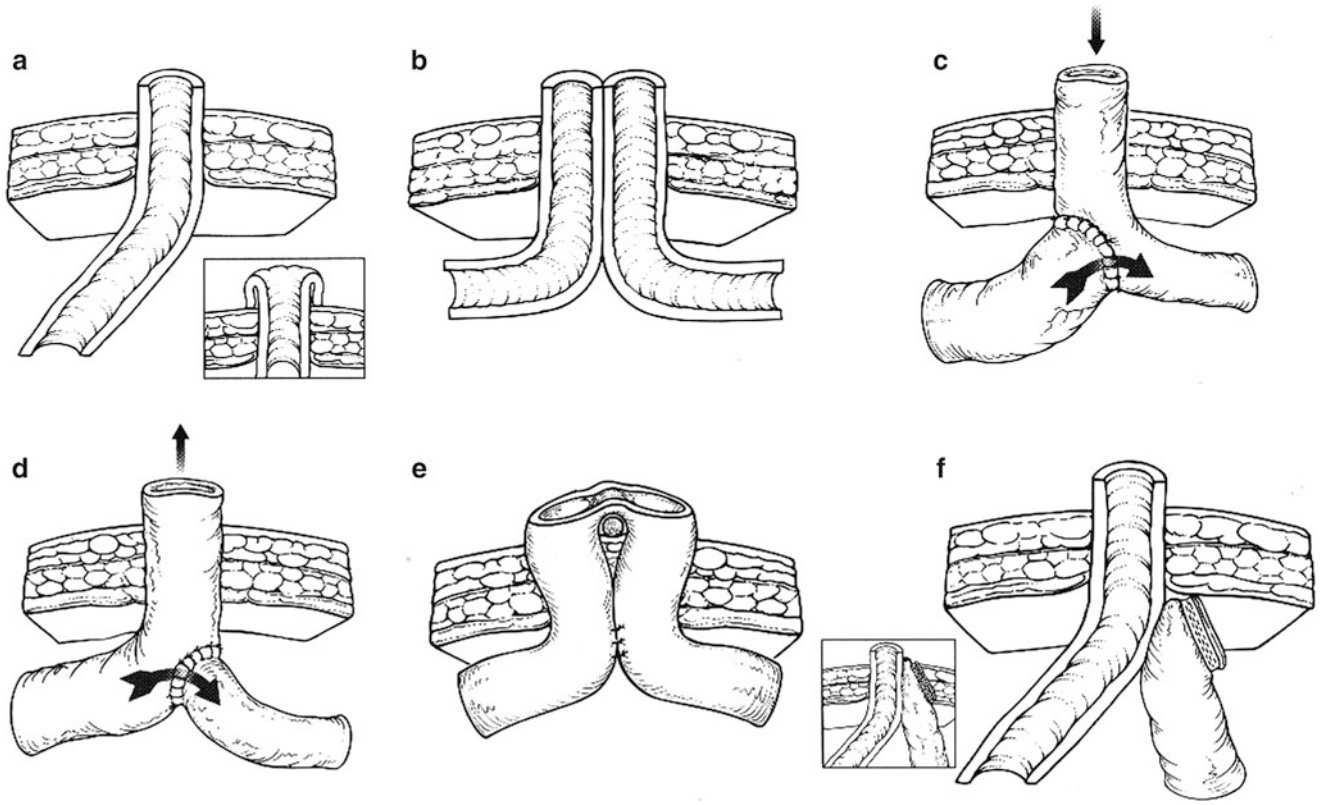

Fig. 58.1 Stoma variants. (**a**) End stoma and Brooke maturation (*inset*). (**b**) Double-barrel stoma. (**c**) Bishop–Koop: distal stoma with proximal end-to-side anastomosis. (**d**) Santulli: proximal stoma with side-to-end distal anastomosis. (**e**) Loop ostomy. (**f**) End stoma with Hartmann's closure and rodless end-loop variation (*inset*) (From Gauderer MWL. Stomas of the small and large intestine, Chapter 96. In: Grosfeld JL, O'Neill JA, Fonkalsrud EW, Coran AG, editors. Pediatric surgery. 6th ed. Philadelphia, PA: Mosby; 2006, with permission from Elsevier)

Table 58.1 Function and types of ileostomy and colostomy

Stomas for intestinal diversion and decompression
End ostomy
Loop ostomy and variants (rodless end-loop stoma)
Double-barrel ostomy
Stomas for irrigation and evacuation
Appendicostomy
Catheterizable cecal conduit
Tube cecostomy or sigmoidostomy
Stomas for both diversion and irrigation/evacuation
Distal venting ileostomy with end-to-side anastomosis
(Bishop–Koop)
Proximal venting ileostomy with side-to-end anastomosis (Santulli)
Divided descending–sigmoid colostomy for high imperforate anus

to prolapse, retract, or develop parastomal hernias, probably due to the larger fascial opening needed to bring out both ends of the bowel. A double-barrel stoma is similar to loop stoma, but the bowel is completely divided.

End stomas are selected in the setting of bowel resection, when a permanent or long duration stoma is anticipated, or complete fecal diversion is desired. End stomas are often employed in the setting of an abdominal surgical emergency, such as one involving bowel necrosis, ischemia, or perforation with gross contamination. An end stoma is usually chosen when a segment of bowel is resected and there is significant concern for leakage following a primary anastomosis (necrotizing enterocolitis with perforation, tenuous blood supply, systemic acidosis, or poor perfusion). It might also be chosen for anatomic considerations, such as limited mesenteric length, that preclude loop ostomies. The end stoma is generally formed at the site of resection. The distal bowel must be managed as either a Hartmann pouch or by the creation of a mucous fistula. In a Hartmann procedure, useful only when there is no risk of distal obstruction, the distal bowel segment is closed and dropped back into the abdomen. Future closure of the end stoma is usually facilitated by tacking the closed distal end to the side of the proximal bowel or to the fascia near the stoma.

If there is a risk of distal obstruction or if there is a reason to need access to the distal bowel segment, then a mucous

fistula is created. The advantage of the end stoma is that it is completely diverting and is less likely to prolapse. The main disadvantage of the end stoma is that it often requires a somewhat bigger operation to bring the two bowel ends together to form an anastomosis.

Several types of permanent stomas are used for daily irrigation of the colon in patients with failed reconstruction of high imperforate anus, Hirschsprung disease, chronic constipation, and overflow incontinence. These irrigating stomas serve to improve cleanliness and the quality of life for children with chronic soiling, poor control of defecation, and leakage of stool. They include intermittently catheterizable appendicostomy and cecal conduits, tube cecostomy, and sigmoidostomy. All are intended primarily to facilitate the instillation of an antegrade enema by intermittent catheterization or indwelling tube. A large-volume (15–20 mL/kg or more) warm tap water or saline colonic enema is given daily, usually in the evening, to achieve a daily bowel movement. The colon is then emptied nightly and allowed to function as a passive reservoir for stool until the next enema. The volume is titrated to effect. The saline enema solution is usually made at home by the caregiver, mixing 1½ teaspoons of table salt in 1000 mL of warm water. The intermittently catheterizable stomas have the advantage of enhanced body image because there is no appliance on the abdominal wall. The umbilical appendicostomy is fashioned by open or laparoscopic technique at the base of the umbilicus, where it is well hidden.

Continuously catheterized tube stomas, such as the cecostomy button (usually a standard gastrostomy button), endoscopically placed ("pull-type" percutaneous endoscopic gastrostomy (PEG)-style tube), or radiologically placed (Chait) tube, leave the patient with an external appliance that allows access to the GI tract. These types of tubes are prone to the usual gastrostomy tube complications (displacement, mechanical malfunction, infection, skin irritation and breakdown, peristomal fistula) and need to be replaced periodically. Intermittently catheterized stomas are complicated by stenosis, retraction, or perforation of the intestine by the intestinal tube. With time, neurologically intact older children and adolescents are often able to completely assume all of the care associated with administering enemas.

Preoperative Preparation

Siting a stoma is critical to good function, minimizing complications and maintaining a good quality of life. On the contrary, a poorly sited stoma is a source of misery for the surgeon, caregivers, and especially the patient. All elective stomas should be sited in the lower abdomen, perhaps as high as the umbilical line in young children, preferably with the help of an experienced enterostomal therapist. The site should be marked and remarked as necessary after watching the patient sit, stand, and lie down. It should not be too close to the anterior superior iliac spine or the umbilicus. Most adolescents prefer that it be lower than the pants line, but this is rarely feasible given the location of typical abdominal skin creases. It should be placed at the leading edge of the major lower abdominal fat bulge. Some prefer to bring it through the rectus sheath, others in a more lateral position if space allows. Ileostomies are generally placed in the right lower quadrant (RLQ), and sigmoid colostomies in the left lower quadrant (LLQ). Transverse colostomies are placed in the upper abdomen and for a number of medical and esthetic reasons should only be used when there is no other option available.

Intestinal stomas in the children are much more likely to be created in the management of unexpected abdominal surgical emergencies and congenital anomalies. As such, the opportunity for preoperative counseling and parental preparation might be limited but should be undertaken whenever possible. A notable exception is in patients undergoing elective or semi-elective procedures for inflammatory bowel disease (IBD), imperforate anus, or Hirschsprung disease. In this setting, preoperative consultation with an enterostomal therapist is useful for counseling, stoma site marking, and education. Discussion of the possible need for an ostomy should be part of the informed consent prior to any procedure likely to involve a bowel resection.

In the case of elective formation or closure of an ileostomy or colostomy, many surgeons still prefer to perform preoperative mechanical bowel preparation for children outside of the neonatal period. At minimum, an oral clear liquids diet is given for 24 h prior to surgery. We prefer a traditional bowel preparation, particularly for colon surgery, in children older than 1 year, who are usually admitted the day before surgery. A slender nasogastric feeding tube (6 Fr) is placed, and polyethylene glycol (PEG) solution is administered at a rate of 25 mL/kg/h until the output is clear. Adolescents can undergo bowel preparation at home with a standard regimen (sodium phosphates oral solution or PEG) used for adult surgery. Sodium phosphate oral solution is sometimes better tolerated by adolescents because a lower volume is needed than for PEG solution. Neonates and infants undergoing ileostomy and colostomy formation or closure require only preoperative clear liquids with or without retrograde distal intestinal irrigation on the floor or in the operating room prior to incision.

Mechanical bowel preparation is usually not possible when there is obstruction or perforation. Three doses of oral antibiotics (erythromycin 15 mg/kg/dose and neomycin 30 mg/kg/dose or metronidazole 7 mg/kg/dose, up to adult dose) are still given by some surgeons, particularly for older children and adolescents, as is distal tap water or 1 % neomycin enemas. Appropriate perioperative intravenous antibiotics are always used in every age group, prior to incision

and for up to 24 h postoperatively. Preoperative contrast studies of the distal bowel (rectal contrast enema, ileostomy injection, or colostogram) are generally indicated prior to elective closure of enterostomies, especially in the setting of previous NEC, ischemia, volvulus, and atresia due to the risk of distal stricture.

Ileostomy

In newborns and infants, an ileostomy is usually performed when an anastomosis is judged to be unsafe during an operation for NEC, meconium ileus, complex intestinal atresia, or volvulus with necrosis. These are most commonly end ileostomies and a mucous fistula is usually created as well. They can be brought up through the primary incision or a separate incision. Using the primary incision has the disadvantage of a higher risk of wound complications and infection. The distal end is also sometimes tacked to the proximal end or the fascia to make later closure easier. In the setting of extensive patchy NEC or multiple atresias, multiple ostomies can be formed to salvage segments of bowel that cannot be safely anastomosed, to preserve bowel length, and to mitigate short bowel syndrome.

When the functional end of the bowel is brought through or close to the laparotomy incision and peritoneal contamination is minimal, we close the remainder of the primary incision with cyanoacrylate topical skin adhesive, which acts as an effective barrier. The bowel is secured to the fascia or skin with interrupted 4–0 polyglycolic acid sutures. In neonates, where possible, at least 1 cm of ileum should be allowed to protrude. The bowel is tacked to the skin edges with partial-thickness 4-0 polyglycolic acid sutures. Maturation of the end of the stoma and mucocutaneous sutures are avoided in small premature infants, in whom the end of the bowel is fragile and easily traumatized. Within 2 weeks, the end of the small bowel will spontaneously roll back to mature itself. In full-term newborns and older infants, a few fine interrupted absorbable sutures should be placed to form a Brooke ileostomy. In the situation where there is concern about additional atresias or the possibility of late strictures, exteriorization of the distal segment as a mucous fistula has the added advantage of facilitating contrast studies of the distal end segment prior to reestablishing intestinal continuity.

A mucous fistula also allows refeeding of stoma effluent to improve nutrient absorption and as a trophic stimulant for bowel growth and adaptation. The intestine distal to an atresia is often diminutive and the proximal end so dilated that an anastomosis between the two, though mechanically patent, is functionally obstructed. A period of diversion with refeeding will allow for growth and salvage of the distal intestine and a better size match later.

A loop ileostomy is commonly used for postoperative diversion following total colectomy and ileal pouch–anal anastomosis for ulcerative colitis or transabdominal endorectal pull-through for Hirschsprung disease. It can also be used to decompress a massively dilated distal colon prior to redo endorectal pull-through procedures for Hirschsprung disease or anastomotic stenosis. The advantages of a loop ileostomy in this setting are the avoidance of the risk of compromise of the marginal colonic blood supply that could occur with the formation of a colostomy and decompression of and access to the distal segment for follow-up contrast studies. Furthermore, the loop ileostomy used to protect the distal colo-anal anastomosis will already have been formed. Another clinical situation in which a loop ileostomy is useful is when total colonic Hirschsprung disease is unexpectedly encountered.

There are several ileostomy variants employed in pediatric surgery for special situations. The Bishop–Koop or double-barrel Mikulicz stomas are sometimes used specifically in the management of obstruction related to meconium ileus. These stomas allow irrigation of the distal intestinal segment to disimpact the inspissated meconium. In the rare situation where a feeding jejunostomy is needed in an infant (multiple failed fundoplications for reflux in the setting of congenital diaphragmatic hernia (CDH) or long-gap esophageal atresia), a Roux-en-Y feeding jejunostomy can be employed. In infants, the application of the Witzel technique can narrow the bowel lumen significantly when the jejunostomy tube is imbricated to form the tunnel. The Roux-en-Y feeding jejunostomy obviates this problem in small diameter bowel. The Roux-en-Y feeding jejunostomy also allows the use of a conventional balloon enterostomy feeding tube or button in larger children, without obstruction of the small bowel lumen by the balloon.

Colostomy

Colostomies formed in the management of NEC, volvulus, or perforation in neonates require the same technical considerations as ileostomy in this age group. Colostomies for Hirschsprung disease and imperforate anus are special categories. In patients with rectosigmoid Hirschsprung disease, colostomy is now rarely performed because of the popularity of single-stage transanal primary endorectal pull-through procedures with or without laparoscopic assistance. In the event that a colostomy is chosen as the initial treatment, a “leveling” colostomy is made in the normal colon just proximal to the level of the transition zone. A loop sigmoid colostomy or end-sigmoid colostomy and mucous fistula are created. The access to the distal colonic segment afforded by a loop colostomy or mucous fistula is preferred so as to allow the passage of mucus or irrigation of the distal colon. The colostomy is generally performed as distal as possible within the normal bowel, taking great care to be well above the transition zone.

In patients with high imperforate anus, a divided descending colostomy is employed. This colostomy has the advantage of decompressing the congenitally obstructed bowel, completely diverting the fecal stream from the fistula to the urinary tract in males and allowing sufficient space on the abdominal wall to apply a proper ostomy appliance. It also allows performance of a distal colostogram and drainage of any urine from the fistula, minimizing its reabsorption and subsequent metabolic acidosis. This ostomy is generally left in place following anorectal reconstruction by posterior sagittal or laparoscopic technique. Unlike the sigmoid colostomy in Hirschsprung disease, care is taken not to perform this colostomy too distally, so as to avoid tethering of the rectosigmoid colon during the anorectal reconstruction.

Colostomies for fecal diversion in older children and adolescents are generally formed using the same techniques as for adults in the settings of perforation, necrosis, or IBD. Some children with Crohn's colitis or ulcerative colitis (UC) benefit from diverting ileostomy, which allows the colon to rest while medical therapy is optimized, some of which can take weeks or months to start to work. While the vast majority of stomas in children are likely to be temporary, children with refractory and severe Crohn's colitis or proctitis are more likely to require permanent ileostomy for colostomy. They are also prone to more complications including dehiscence, fistulas, abscesses, hernias, and Crohn's disease of the stoma itself, all of which require frequent surgical revisions of the stoma over the course of years. Patients with UC often require an ileostomy diversion as part of a staged approach to colectomy and J pouch ileoanal reconstruction. They rarely require a permanent ileostomy diversion for severe and refractory pouchitis or pouch failure.

Stoma Closure

Contrast studies of the distal intestine are generally performed prior to takedown of an enterostomy to detect unanticipated obstruction or stricture, particularly when a full laparotomy with inspection of the distal bowel and lysis of adhesions is not planned. In infants and young children, the ostomy closure anastomosis is generally performed with a single-layer hand-sewn inverting technique because of the small size of the bowel. A single-layer technique with interrupted fine polyglycolic acid sutures is preferred to avoid narrowing of the anastomosis by excessive imbrication of the bowel ends that can occur with a double-layer closure. In adolescents and adults, the anastomosis may be hand-sewn in one or two layers or with the use of a surgical stapling device, according to the surgeon's preference. Loop stomas are closed after local mobilization and anastomosis of the intestinal ends without a larger laparotomy.

Postoperative Care

Parental concerns and education require substantial time and support from the surgeon and an enterostomal therapist. Successful management of an ostomy by a parent at home requires attention to their concerns. Few parents of young children will have had any experience in such home care. Failure to support these needs and provide sufficient education prior to discharge sometimes results in unnecessary readmission and frequent return visits as an outpatient. Parents and patients, when age appropriate, must be instructed in care of an ostomy appliance and recognition of ostomy complications (Table 58.2).

The most important and serious complications include high stoma output with dehydration and electrolyte disturbances, prolapse, and stenosis. Infants and young children, because of their small size, can become rapidly dehydrated from gastroenteritis or overfeeding in the setting of malabsorption. Several weeks of postoperative inpatient feeding titration are required, particularly in the newborn with a very proximal stoma. Neonates with mid-level or high jejunostomies can sometimes be managed successfully on home parenteral nutritional therapy but more typically require inpatient care until the ostomy is reversed. High output from a stoma is generally defined as an output of greater than 30–40 mL/kg/day. This is most likely to occur in the patient with a high jejunostomy. Postoperative advancement of feeding in patients with ileostomy or jejunostomy should be slow, especially once output approaches 30 mL/kg/day, to avoid overwhelming the absorptive capacity of the intestine.

Agents to reduce ostomy output such as loperamide (0.1 mg/kg/dose 3–4 times daily) can be used with variable success. Cholestyramine can be added to the feeds of patients with a colostomy and short small intestinal length, where unresorbed bile acids in the colon produce diarrhea. The

Table 58.2 Complications of ileostomy/jejunostomy and colostomy

Fluid and electrolyte disturbances
Prolapse
Retraction
Ischemia
Stenosis
Parastomal hernia
Peristomal skin excoriation/candidiasis
Fistula
Granulation tissue
Catheter-related perforation
Ostomy appliance complications
Intestinal volvulus
Technical errors (exteriorization of incorrect end)
Spillover of stool into mucous fistula with subsequent stool impaction (Hirschsprung disease, imperforate anus)

ostomy output should be checked for pH and reducing substances. Low pH (<5.5) or positive reducing substances indicate malabsorption. When output exceeds 30–40 mL/kg/day, feeds should be held completely for 12–24 h to allow nonabsorbed sugars to clear. Simply slowing the feed rate will result in continued high output due to the presence of nonabsorbed and osmotically active sugars within the intestinal lumen.

Permanent stomas are relatively rare in pediatric practice. Prolapse or stenosis is most often managed by closure of the temporary stoma. In the event of prolapse, retraction, parastomal hernia, or stenosis of a permanent enterostomy, revision and resiting of the stoma is sometimes necessary.

Editor's Comment

In children, stomas should be rare and reversible. Although the decision to create a stoma is to some degree always a matter of judgment, there are some indications that are largely technical (high imperforate anus, long-segment Hirschsprung disease, and first stage of ileal pouch–anal anastomosis), some that are somewhat obvious because an anastomosis would clearly be unsafe (NEC with necrotic bowel, fecal peritonitis with sepsis), and finally some that are more or less a matter of style or preference on the basis of experience and training of the surgeon. These decisions often serve to define a surgeon as "conservative" or "progressive." Regardless, because stomas are not without complications and make life difficult for the patients and their parents, the decision to create a stoma should not be taken lightly and the surgeon should always be able to justify the decision in that particular patient in that particular circumstance. It is clear that many of the traditional indications for creation of a stoma are historical and based on habit and training. Though data are lacking, luckily there are surgeons with the courage to challenge dogma who have generated a large collective experience that supports the informed and thoughtful decision to avoid a stoma under most circumstances.

The Bishop–Koop ileostomy was a major advance in the surgical treatment of meconium ileus when it was first introduced several decades ago, and some pediatric surgeons might still use it occasionally. But intraoperative evacuation of the inspissated meconium by irrigating through an enterotomy made in the dilated portion of the ileum that is then closed primarily works well and avoids the issues related to the care and closure of a stoma. Stomas should almost never be necessary in healthy children after ileocecectomy for intussusception, appendicitis, or Crohn's disease. Leveling colostomy in healthy infants with short-segment Hirschsprung disease should rarely be necessary as primary repair in newborns is clearly safe and effective. Bowel perforations after blunt or penetrating trauma can almost always be repaired primarily without a stoma unless there is a significant delay in diagnosis, severe chemical peritonitis, or profound sepsis. In the end, a surgeon should be able to justify stoma creation in a child with more than a defensive "this is how I've always done it."

All stomas are essentially either end stomas, in which case they should be matured in the manner of a Brooke ileostomy or some modification of the loop ileostomy. End colostomies can be flush but function better and are easier to care for when they are Brooked slightly. There is rarely a need to use a rod or tube to secure a loop stoma, as proper suture placement and a small but adequate fascial opening should be enough to prevent retraction of the stoma. In the case of Hirschsprung disease or imperforate anus, the mucous fistula should probably be brought up separately so as to avoid spillover and subsequent impaction of stool. To prevent prolapse mucous fistulas should not be matured and in fact are probably best made flush and rather small, by just opening the corner of a staple line. In most other cases, a Turnbull stoma should be used, which involves Brooking the proximal end and leaving the distal end flush with the skin. Most of the other stomas described in the past were designed to allow closure at the bedside because a trip to the operation room was so dangerous. There is little need to use these old-fashioned constructs today.

Complications of stomas are relatively common but largely preventable. Parastomal hernias are often due to an excessively large fascial opening and improper suture fixation of the bowel. The bowel should be tacked to the fascia circumferentially, and when creating a loop ileostomy, the space between the loops should be obliterated with strategic sutures. Prolapse is one of the more frustrating complications of stomas and is more common in mucous fistulas, probably due to the effect of peristalsis—maturing the mucous fistula makes it worse because of the everted bowel peristalses in the direction of prolapse. Prolapse of the proximal segment usually occurs in stomas created when the bowel was extremely dilated and has now decompressed to a more normal size. In these cases, it is probably best to either find a way to remove the stoma or to completely resite it. Proximal jejunal stomas should be avoided if at all possible because of the fluid and electrolyte and skin care problems that arise from the high output. Whenever possible, all stomas should be placed in the lower abdomen at a site that has been carefully chosen by an experienced surgeon or enterostomal therapist. Transverse colostomies should also be abandoned, as they are ugly, prone to prolapse, despised by patients, and almost never the only good option. Bowel obstruction frequently occurs at or near ostomies, sometimes due to adhesions or occasionally due to volvulus around the stoma. Operation should not be delayed simply because the surgeon is convinced that "the stoma is patent" based on digital exam or intubation of the stoma. Finally, an examining finger should rarely if ever be placed in a child's ileostomy due to the significant risk of circumferential injury to the bowel or its blood supply.

Suggested Reading

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