Colostomy

5

5.1 Introduction

Colostomy is a procedure designed to divert the fecal stream from the normal passage to the rectum, creating an opening between the colon and the abdominal wall. This procedure was created to relieve the obstruction of the colon produced by acquired or congenital conditions. Another indication is to avoid the passing of stool through an operated area, trying to prevent complications, such as infection and/or dehiscence [1–6].

Historically, it is considered that the first colostomy in pediatrics was performed in 1783 by Antoine Dubois in a 3-day-old infant with an imperforate anus [7].

A colostomy can be permanent, when it is considered that there is no way to reconstruct the colon distal to the stoma or there is no way to establish bowel control, and it is considered that the quality of life is better with a stoma as compared without stoma.

Temporary colostomies are those created for a period of time until the anatomic or functional circumstances of the patients allow the reestablishment of the colonic transit. Colostomies can be divided into two groups: totally diverting and partially diverting.

Totally diverting colostomies are those that divert the entire fecal stream and do not allow the spillage or passing of stool into the bowel distal to the stoma. In order to achieve total diversion of the stool, it is necessary to separate the proximal and distal bowel after the colon is divided and to separate both stomas enough, as to allow the proximal (functional) stoma to be covered by a stoma bag without including the distal stoma (Fig. 5.1). Another way to achieve a totally diverting procedure is by closing the distal end, a maneuver that is known as a "Hartmann pouch." The closure of the distal stoma leaves the patients with a completely closed blind loop distal bowel; this, in the absence of a fistula, creates a mucocele (accumulation of mucus) which will represent a serious problem for the patient, as most mucoceles eventually become infected. Mucoceles may also occur in cases in which the fistula that connects the colon with the urogenital tract is very narrow and does not allow the passing of mucus. In addition, patients with a Hartmann pouch cannot have contrast studies done through the distal stoma to evaluate their anatomy prior to reconstruction because there is no access to it. This is a serious deficiency, because we firmly believe the most valuable diagnostic test in patients with anorectal malformation consists in the injection of contrast material through the distal stoma (high-pressure distal colostogram) (see Chap. 6).

A partially diverting stoma, by definition, allows most of the stool to come out of the body, but some of the stool still may go into the distal colon. This happens when both stomas are together and covered by a single stoma bag, and the surgeons open a colostomy known as "loop colostomy" (Fig. 5.2).

The indication to divert the fecal stream totally or partially depends on the specific problem of

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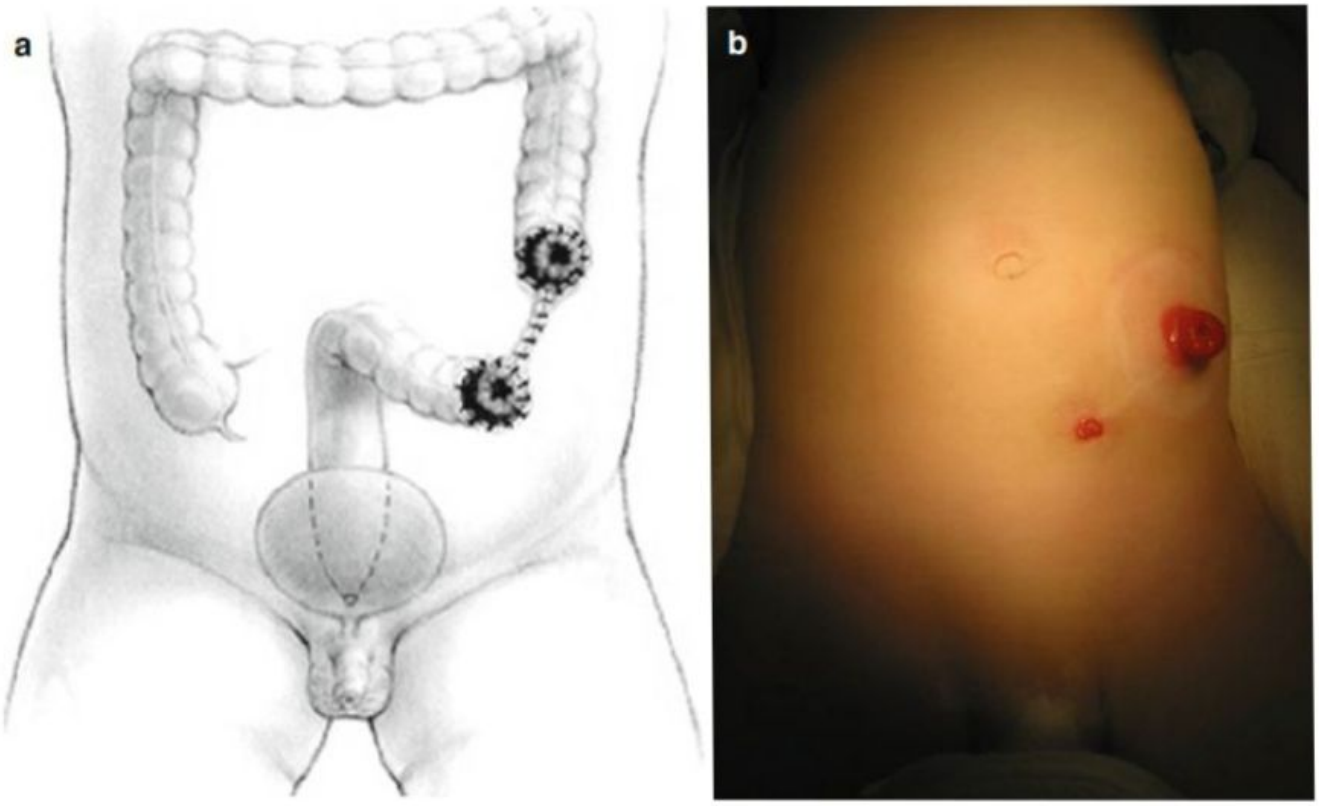

Fig. 5.1 Both stomas separated enough to cover only the proximal one with the stoma bag. (**a**) Diagram. (**b**) Picture

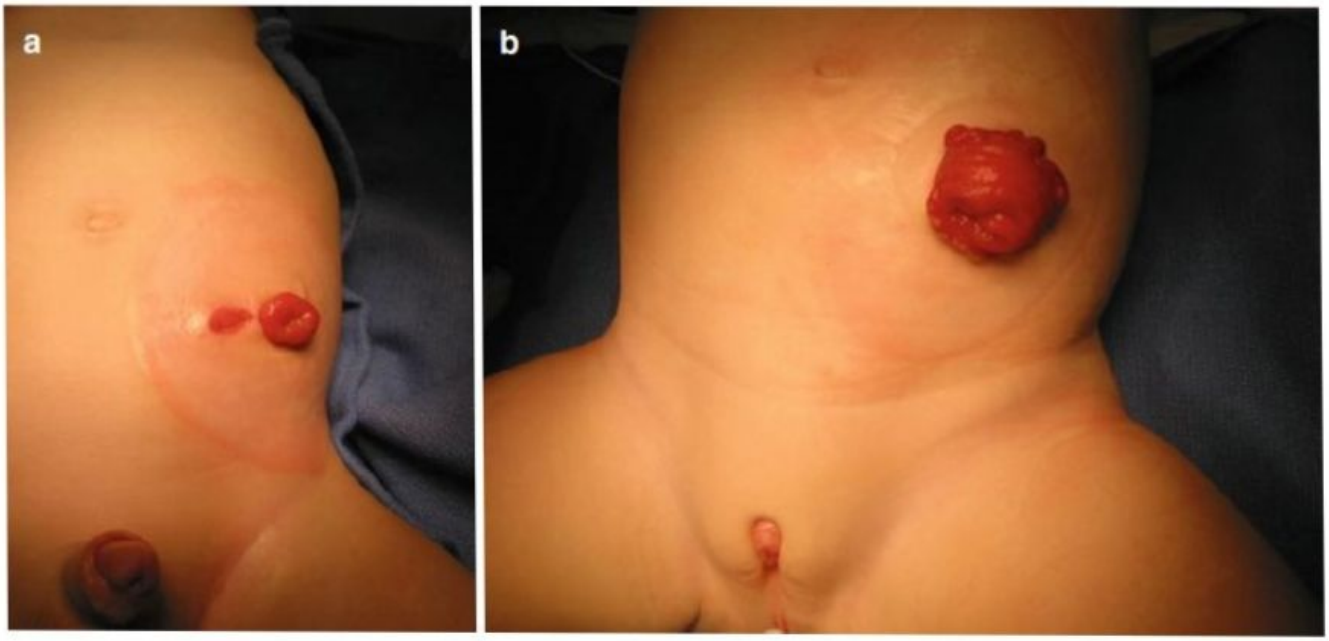

Fig. 5.2 Inadequate colostomy. (**a**) Both stomas located too close. (**b**) Loop colostomy

the patient. In cases of anorectal malformations, the surgeon should keep in mind that over 85 % of all the patients have a connection between the distal colon and the urogenital tract. In addition, 5 % of the total group of anorectal malformations has a completely blind distal bowel. This is very important to remember, because a partially diverting colostomy (loop or both stomas located too close one to the other) exposes the patient to the passing of stool into the urinary tract and/or to a distal impaction of stool that cannot pass through a narrow fistula. Loop colostomies are very appealing for most surgeons. We think the reason for this is that it is an easy operation that

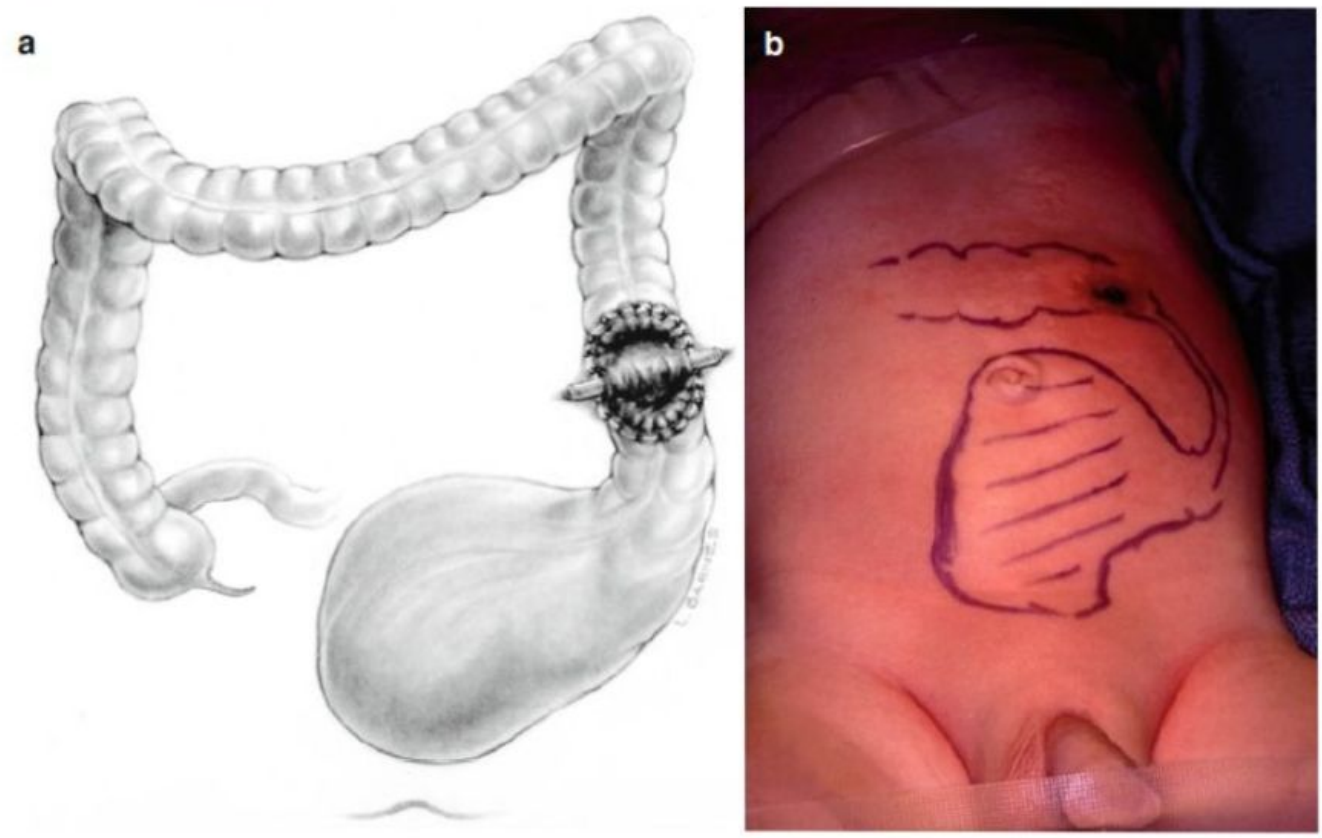

Fig. 5.3 Loop colostomy with distal fecal impaction. (**a**) Diagram. (**b**) Picture

can be done fast and also can be closed in a fast and easy way. However, we consider that loop colostomies are formally contraindicated in patients with anorectal malformations due to the following reasons:

- High chances of producing direct fecal contamination of the urinary tract
- High chances of producing distal fecal impaction, megarectum, and consecutive severe constipation after colostomy is closed (Fig. 5.3)
- Higher incidence of prolapse

5.2 Stoma Locations

The stoma can be opened in the abdomen in different locations. The most common locations are:

- Right transverse colostomy (right upper quadrant): Some surgeons prefer this type of stoma consisting in dividing the right portion of the transverse colon and diverting it through the right upper quadrant of the abdomen (Fig. 5.4).
- Left transverse colostomy: The left portion of the transverse colon is divided, and the

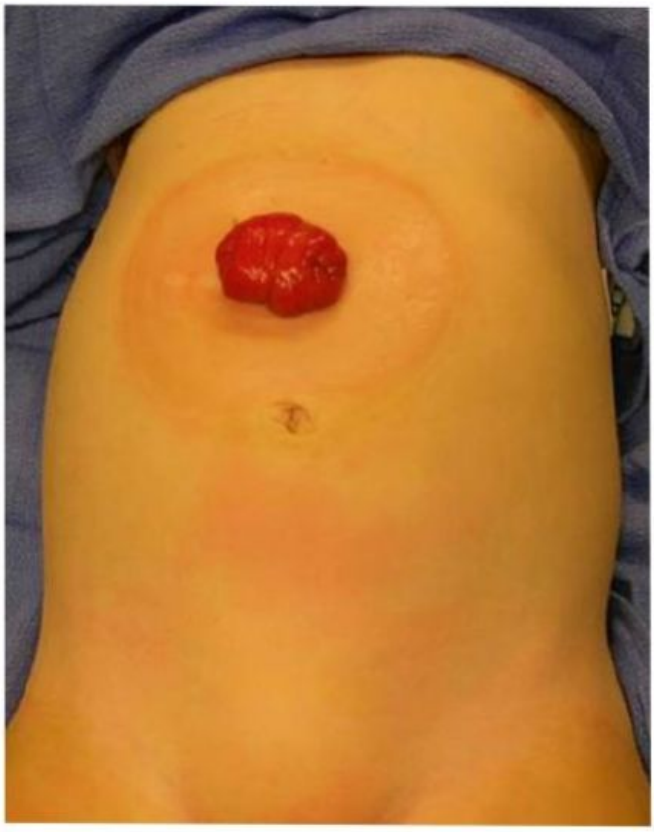

Fig. 5.4 Photograph of a right transverse colostomy

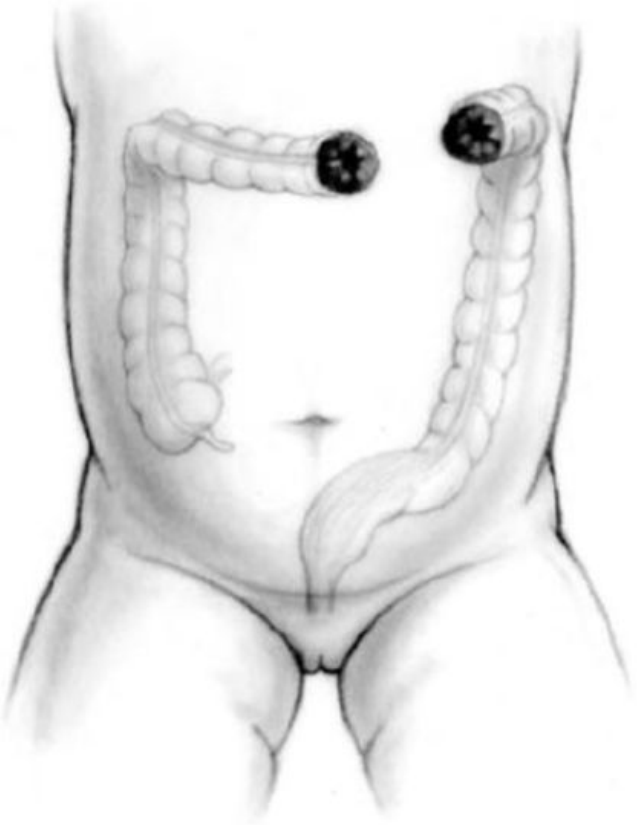

Fig. 5.5 Diagram of a left transverse colostomy

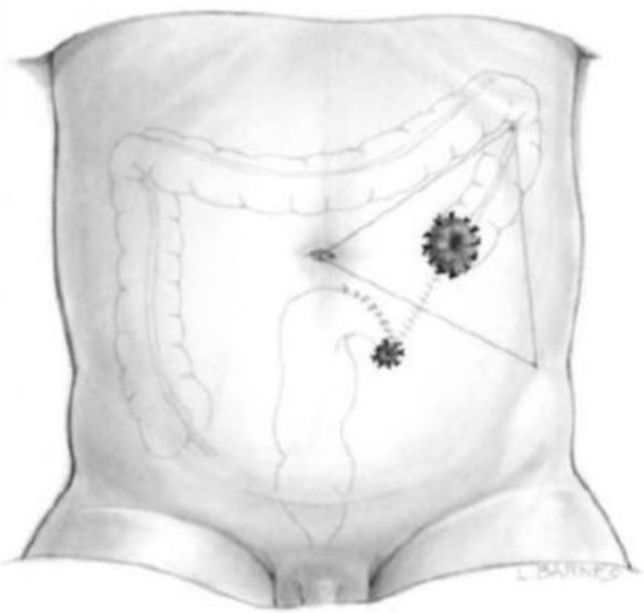

Fig. 5.6 Diagram showing a descending colostomy with separated stoma (preferred by the authors)

stoma(s) is opened in the left upper quadrant of the abdomen (Fig. 5.5).

- Descending colostomy: The bowel is divided immediately distal to the descending colon, in the first mobile portion of the sigmoid, and the stoma is usually opened in the left lower quadrant of the abdomen (Fig. 5.6). This is the type of colostomy that we recommend.
- Sigmoid colostomy: The sigmoid colon is divided, and the stomas are usually opened somewhere in the lower abdomen. The problem with this kind of colostomy is that there is a possibility of creating the stoma too distal in the colon, leaving a very short piece of bowel available for the pull-through (Fig. 5.7).

Fig. 5.7 Sigmoid colostomy, leaving a too short distal bowel that interferes with the pull-through

5.3 Ileostomies

Ileostomies are frequently performed in patients with colorectal problems. These are indicated when, for some specific reason, we cannot use the colon to perform the diversion. In other words, the entire colon does not function, such as in cases of total colonic aganglionosis or when the patient was born with no colon or has lost the entire colon. An ileostomy is sometimes used when a patient had a pull-through of the ascending colon, and therefore the patient needs a diversion proximal to this.

5.4 To Divert or Not to Divert, That Is the Question

In general, pediatric surgeons and general surgeons are looking for safe ways to perform colorectal procedures without a protective colostomy. By doing this, the patients are prevented from having two extra serious operations with significant morbidity (colostomy opening and colostomy closure). That is the reason why to perform colorectal surgery without a colostomy is always an attractive idea (see Chap. 4). Taking advantage of modern surgical technology, efficient methods to clean the colon, the possibility of keeping the patient with nothing by mouth for a period of time receiving parenteral nutrition, the use of sophisticated surgical techniques, and the availability of powerful antibiotics, allow, nowadays, to perform successful operations on the colorectal tract without a protective colostomy. Yet, catastrophic complications still happen [8]. It is true, the incidence of these complications is much less than in the past, but unfortunately they still occur. That is why the question whether "to divert or not to divert" is still unanswered and remains a matter of controversy.

In general, pediatric surgeons keep moving in the direction of doing more and more primary procedures without a protective colostomy. We believe that it is good to move in that direction, to save our patients from the potential morbidity associated with stomas that are still high [3, 9–30].

It is also very important to remember that in dealing with the treatment of anorectal malformations, a postoperative wound infection has consequences much more serious than in cases of other surgical conditions. A wound infection due to the repair of an anorectal malformation means not only that the patient will suffer the inconveniences and risks related with the infection itself, but, in addition, the final functional prognosis (bowel and urinary control) may be jeopardized.

We are against universal indications for a procedure. In other words, we believe that a colostomy is indicated under certain specific circumstances; a patient with a specific malformation may need a colostomy, and yet another patient with exactly the same type of defect, but under different surrounding circumstances, may not require a colostomy. This includes how sick the patient is, how severe are their associated defects, how advanced is the technology available for the patient, how much experience the surgeons have in the performance of primary procedures done without a colostomy, and how sophisticated is the infrastructure that surrounds the patient, including laboratory, intensive care, surgical technology, availability of central venous access, hyperalimentation, and a clean environment.

A colostomy definitely still has a recognized protective value in the postoperative course of most colorectal and anorectal operations. In other words, not opening a protective colostomy has a definite increased risk for the patient. Admittedly, many colorectal procedures can be done successfully without a protective colostomy, but cannot be done without the acceptance of a certain degree of risk.

Finally, we believe that when a surgeon is confronted with the difficult decision of whether to open or not to open a colostomy in a specific patient, he or she should always try to imagine what he would do if he was dealing with his own son or daughter.

Most of the patients, who come to us after the neonatal period, already have a colostomy, and therefore we do not have to deal with this dilemma.

In a full-term, newborn baby without severe associated defects, we do not open a colostomy if the baby has one of the following malformations: perineal fistula, vestibular fistula, imperforate anus with no fistula, and rectourethral bulbar fistula. In the case of the last two malformations (imperforate anus without fistula and rectourethral bulbar fistula), we expect to see the distal end of the rectum full of gas, located below the coccyx in a cross-table lateral film. Based on our experience, we can confidently operate primarily on these types of cases without a colostomy with good results. All other patients with anorectal malformations, at our institution, receive a colostomy, not only to protect the patient from the

operation to repair the malformation, but also for other reasons, including the fact that we need a stoma in order to do a high-pressure distal colostogram which we consider the most valuable diagnostic test in patients with anorectal malformations. Other sophisticated, state-of-the-art imaging modalities still cannot compete with the accuracy of the anatomic information that we obtain with a high-pressure distal colostogram. Most of the serious catastrophes we have seen occurred in cases that were surgically explored at other institutions without a high-pressure distal colostogram [8]. In addition, higher anorectal malformations have a higher incidence of serious associated defects, mainly urologic, cardiac, and gastrointestinal, which means higher-risk patients.

5.5 Recommended Types of Colostomies

5.5.1 Newborn Babies with Anorectal Malformations

In newborn babies with anorectal malformations, in whom we consider that a colostomy is indicated, we prefer to open a descending colostomy, with widely separated stomas, located in the left lower quadrant of the abdomen (Fig. 5.6) [1, 30].

In our series of 2,032 patients, only 75 of them had a colostomy done at our institution. Over 200 cases underwent a primary repair without a colostomy; most of those suffered from perineal or vestibular fistula. All of the others came to our institution with a colostomy already open. As the reader can imagine, that means that we have seen almost all kinds of colostomies and have learned the advantages and disadvantages of each type. That gave us an illuminating experience related to colostomies [30]. Based on that experience, we concluded that a descending colostomy with separated stomas is the best one, for the following reasons:

(a) It effectively diverts the entire fecal stream.
(b) It significantly decreases the chances of urinary tract infection.
(c) It avoids the formation of megarectosigmoid because it allows the irrigation and cleaning of the distal bowel and avoids distal fecal spillage.
(d) It virtually eliminates the chances of hyperchloremic acidosis from resorption of urine [31, 32].
(e) It does not interfere with the pull-through.
(f) It will not prolapse when done properly.

Transverse colostomies are not recommended in anorectal malformations for several reasons:

(a) It is impossible to irrigate the distal colon that remains full of meconium for the weeks or months after the colostomy is created.
(b) It has a tendency to provoke a severe megarectosigmoid, as a consequence of the presence of meconium that was never removed, plus the accumulation of mucus produced by the entire defunctionalized colon and desquamation of mucosa cells.

In fact, the longer the period of time between the colostomy opening and the final repair, the greater the megarectosigmoid (Fig. 5.8). This will translate eventually into severe constipation, difficult to manage, after the repair of the malformation.

(c) Patients with recto-urinary fistulas not only have a tendency to pass meconium from the colon into the urinary tract, but also they tend to pass urine into the colon, which is absorbed, producing metabolic hyperchloremic acidosis [33, 34]. The long defunctionalized segment allows this to occur.
(d) The incidence of urinary tract infection is higher than in cases with descending colostomies.
(e) The high-pressure distal colostogram (the most valuable diagnostic study in anorectal malformations) is difficult to do, may not be accurate, and is risky. It is not accurate, because it is very difficult to exert enough hydrostatic pressure, when the injection of contrast material is done from the transverse colon to fill up and to demonstrate the fistula site, located all the way down to the rectum. In an attempt to demonstrate the location of the fistula, the colon may perforate. We have had two cases with such a complication. This incident has never happened in patients with descending colostomies.

The opening of a loop colostomy in the transverse colon is perhaps the worst type of colostomy

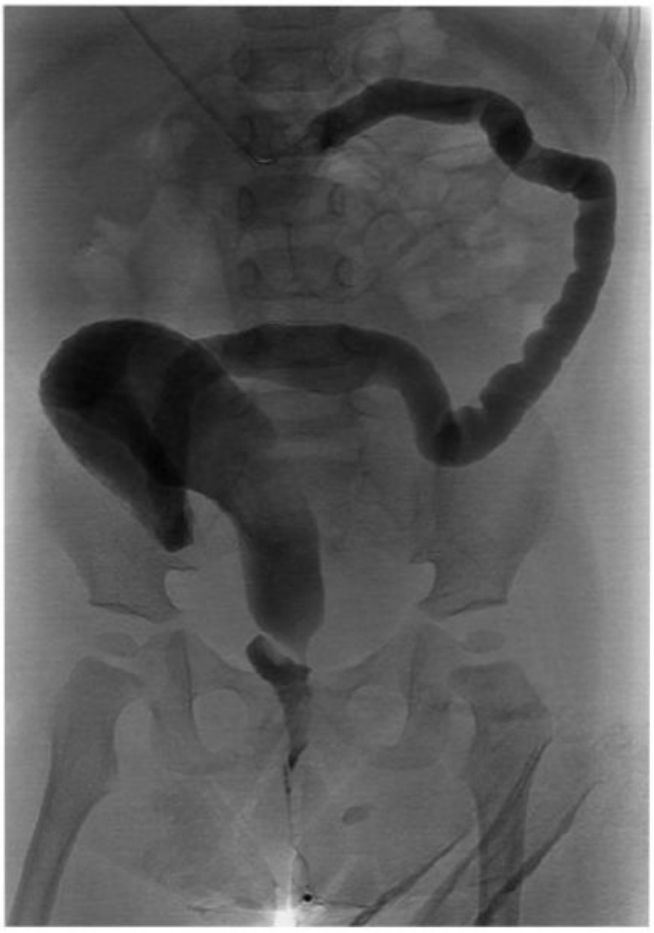

Fig. 5.8 Colostogram in a patient with transverse colostomy, showing the characteristic narrow (non-used) distal colon, with a megarectosigmoid

that we have seen, because in addition to all of the problems that we have seen with transverse colostomies, the patients pass stool into the distal bowel which increases the chance of urinary tract infection and frequently produces fecal impaction in the distal stoma. Figure 5.8 shows the characteristic situation of a patient that had a bad loop transverse colostomy with fecal impaction in the distal bowel. Those fecal impactions cannot be relieved by washing the colon. It is sometimes necessary to perform a laparotomy to remove the hard stool from the distal bowel prior to the main repair. Loop colostomies, in general, also have a greater tendency to prolapse (Fig. 5.9).

5.6 Left Transverse Colostomy

The complications that we mentioned about right transverse colostomies are similar in a left transverse colostomy.

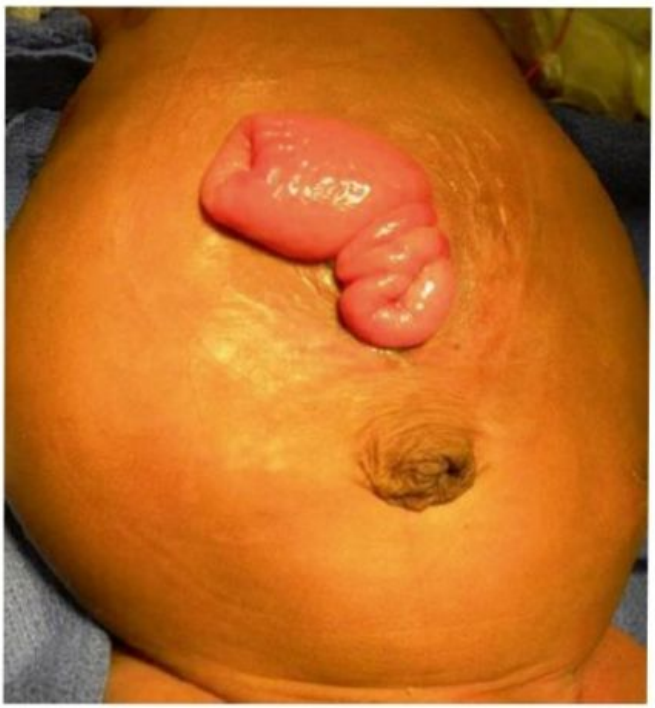

Fig. 5.9 Prolapsed transverse colostomy

5.7 Cecostomies

Opening of colostomies in the cecum, in general, has no indication in anorectal malformations. All of the problems mentioned when discussing right transverse colostomies are more serious in cases of cecostomies.

In the type of descending colostomy that we recommend, the proximal stoma will not prolapse due to the fact that it belongs to the fixed portion of the descending colon. On the other hand, the distal stoma belongs to the mobile portion of the sigmoid, and therefore it has a higher risk of prolapse. To avoid that, we specifically recommend creating a very small (about 3 mm diameter) distal stoma (mucous fistula) (Fig. 5.6).

5.8 Creation of a Colostomy

5.8.1 Surgical Technique

In a newborn baby with anorectal malformation, we try to perform a colostomy not before 24 h after the baby is born. In the chapter dedicated to the management of a newborn with an anorectal malformation, we explain in detail the reasons

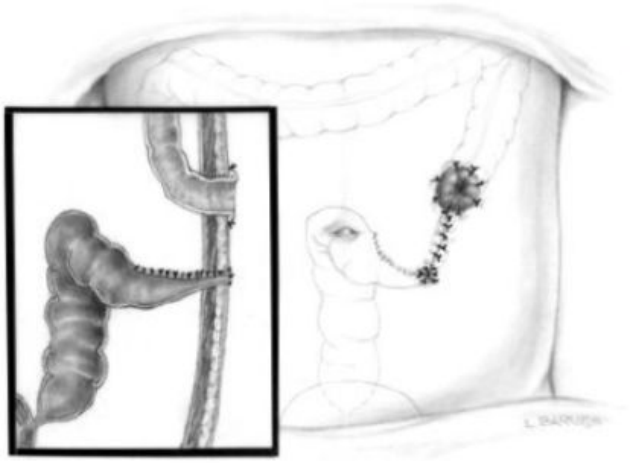

Fig. 5.10 Diagram showing an oblique preferred incision for a neonatal colostomy

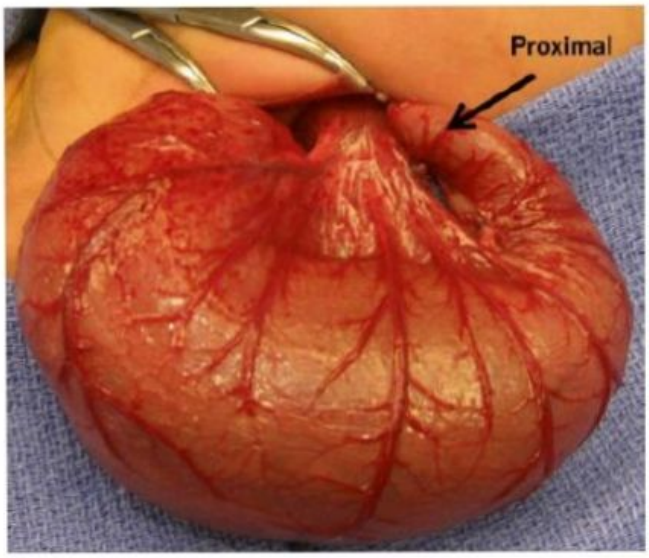

Fig. 5.11 Trans-operatory picture, a dilated sigmoid colon, full of meconium, is seen

why we want to wait 24 h. However, we do not want to wait much more than that time, because perforations of the bowel have been reported to occur in patients after 24 h of life. It is true that occasionally, patients can live many days passing meconium through the recto-urinary fistula without perforation, but that is an exception. There are reports of catastrophes that occurred in patients who suffered colon perforation and died because a colostomy was not done on time (see Chap. 4). The patient is taken to the operating room, and under general anesthesia, the abdominal wall is washed, prepped, and draped in the usual manner. The incision that we recommend is an oblique one, running from the left flank down to the left lower quadrant of the abdomen (Fig. 5.10). The upper part of the incision is located at the same site where we expect to create the proximal stoma. This point is located at equal distance between the umbilicus, the ribs, and the anterior superior iliac crest. We intentionally want the proximal, functional stoma to be surrounded by normal skin and to be located as far away as possible from a prominence, irregularity, or structure that may interfere with the placement of a stoma bag. These structures are the umbilicus, the rib cage, and the iliac bone. When the stomas are open too close to one of these structures, the stoma therapist, the nurses, and the mothers struggle trying to place a stoma bag that lays flat, avoiding leakage of stool and resultant skin irritation.

The lower and medial end of the incision represents the location of the mucous fistula site, which we create intentionally very small (Fig. 5.10) to avoid prolapse. Both stomas must be separated enough so as to be able to use a stoma bag only on the proximal stoma, away from the mucous fistula.

The abdomen is opened, and it becomes very obvious that there is a big, dark loop of bowel (Fig. 5.11) that represents a very dilated sigmoid full of meconium. One should not try to manipulate this very tense, dilated sigmoid loop of bowel, because this may result in injuries to the seromuscular layer. Also, one should not try to create the stoma in the most dilated part of this colon, because that would make a huge stoma difficult to manage and more prone to suffer prolapse. We rather should look for the less-dilated descending colon, normally fixed to the left retroperitoneum. The descending colon detaches from the left parieto-colic space and becomes mobile (Fig. 5.12). At that particular point, we select a portion of the bowel, long and mobile enough, to comfortably reach the anterior abdominal wall. Before we divide the bowel at the selected location, we specifically suggest putting a purse-string suture with a 5-0 suture. In the center of the purse-string suture, we make an opening in the bowel wall and introduce a 12 Foley catheter into the lumen of the very dilated colon with meconium. The purse-string suture is tied to avoid

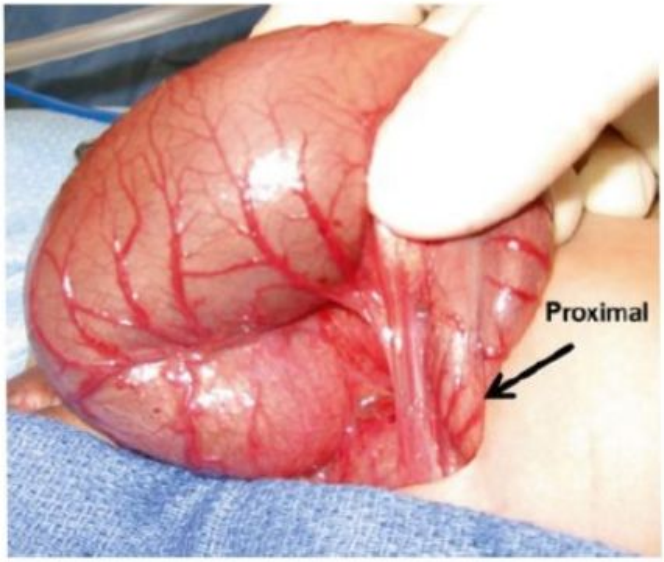

Fig. 5.12 The proximal stoma must be created using the first mobile portion of the descending colon

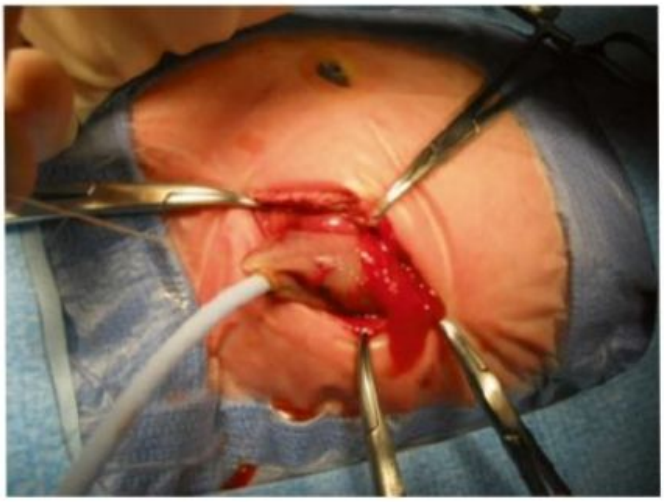

Fig. 5.14 A catheter is introduced through the center of the purse string to irrigate and remove all the meconium. The bowel collapses and is well perfused

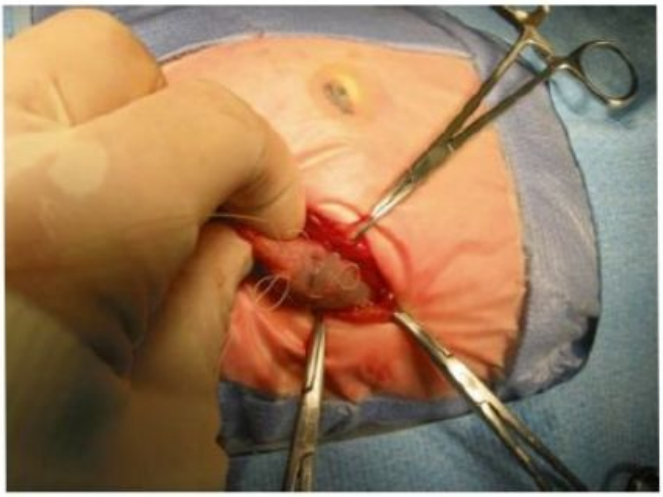

Fig. 5.13 A purse-string suture is placed on the anterior wall of the selected loop of the colon, where the stoma will be located

leakage of meconium in the operative field (Fig. 5.13). The dilated colon is then irrigated with warm saline solution for a period of about 10–15 min until the entire sigmoid is completely decompressed and free of meconium. This maneuver is extremely valuable for several reasons. First, because it will allow the surgeon to manipulate a collapsed, well-perfused bowel (Fig. 5.14) and to perform a neat operation preserving the bowel integrity. In addition, the patient will have a clean, collapsed colon for the rest of the weeks or months before the pull-through or main repair is done. We have evidence to believe that this helps to avoid the formation of a megarectosigmoid and therefore decreases the incidence of severe constipation in these patients. In the same place where the purse-string suture was placed, we apply two Baby Allen clamps to divide the bowel (Fig. 5.15). Special care and attention must be given to the preservation of the colonic vascular arcade during the division of the bowel. The preservation of the arcade allows manipulating and mobilizing the distal bowel, at the time of the main repair, preserving a good blood supply. The proximal bowel will be exteriorized as a functional stoma at the left upper corner of our incision and the mucous fistula in the lower and medial end of the incision. The last 2 or 3 cm of the distal bowel is tapered, creating a little stoma (mucous fistula) of approximately 3–4 mm diameter (Fig. 5.15). The mucous fistula is necessary to do irrigations of the distal bowel if indicated and also to allow access to the distal stoma to perform a high-pressure distal colostogram. For this, we do not need a large stoma that may bleed and interfere with the quality of life of the patient. The tiny lumen also helps to avoid prolapse.

The proximal stoma must be meticulously constructed. The bowel is sutured to the fascia and peritoneum, being sure not to produce a stricture and/or ischemia and being sure that it is perfectly open and patent. There are no concerns about prolapse because this stoma is placed at the first mobile portion of the sigmoid after the

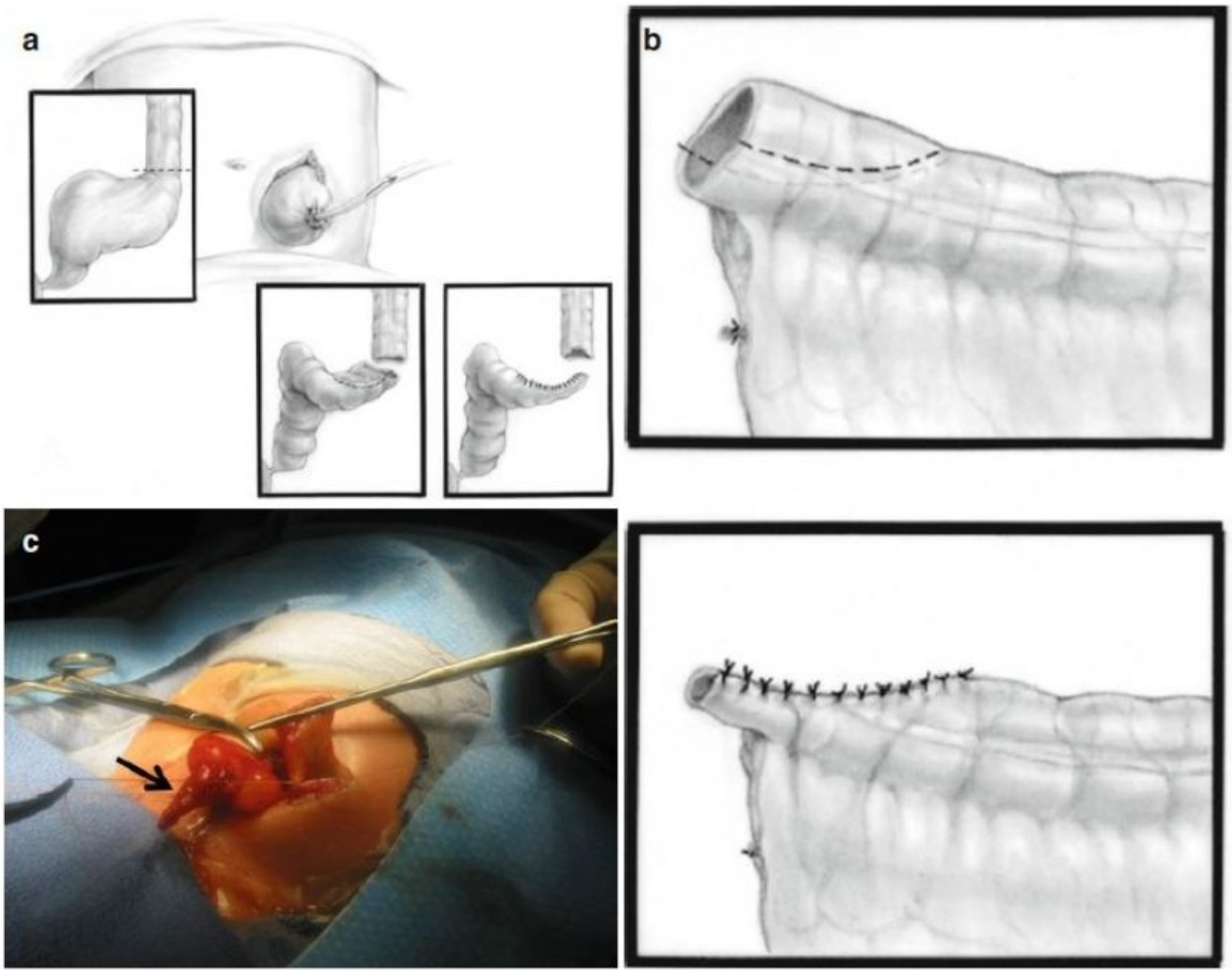

Fig. 5.15 The colon is divided at the same location of the purse-string suture, and the distal bowel is tapered. (**a**) Diagram showing the division of the colon. (**b**) Diagram showing the tapering of the distal bowel. (**c**) Intraoperative view. *Arrow* showing tapered distal bowel

descending colon, which is normally fixed. The peritoneum and aponeurosis between both stomas are sutured together with long-term, absorbable sutures (5-0 Vicryl) (Fig. 5.16). The anterior aponeurosis is closed with the same suture material, as well as the subcutaneous tissue and Scarpa fascia. Both stomas, proximal and distal, are matured with 6-0 long-term absorbable sutures taking the skin edge, the bowel wall, and the bowel edge (Fig. 5.17).

The skin in between both stomas is closed with subcuticular 5-0, absorbable monofilament. We try to leave a smooth surface between both stomas to facilitate the use of a stoma bag (Fig. 5.17).

Many surgeons do not like this kind of colostomy. They insist in saying that these patients have a tendency to suffer from infection and dehiscence of the wound between both stomas.

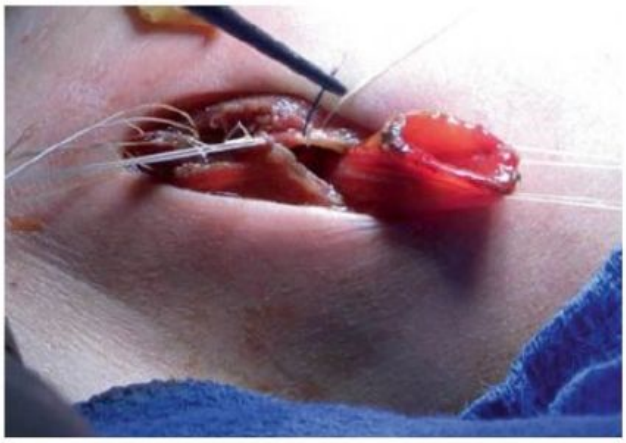

Fig. 5.16 Fixing the proximal stoma to the peritoneum and fascia. Closing the wound in between both stomas

This may be true in other hands; yet, we are very proud of our results, and we believe that the key for success depends on the observation of a

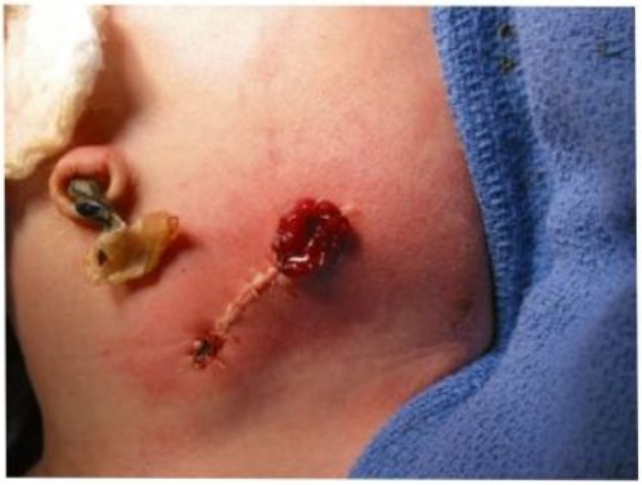

Fig. 5.17 Both stomas are meticulously "matured." The operation is finished

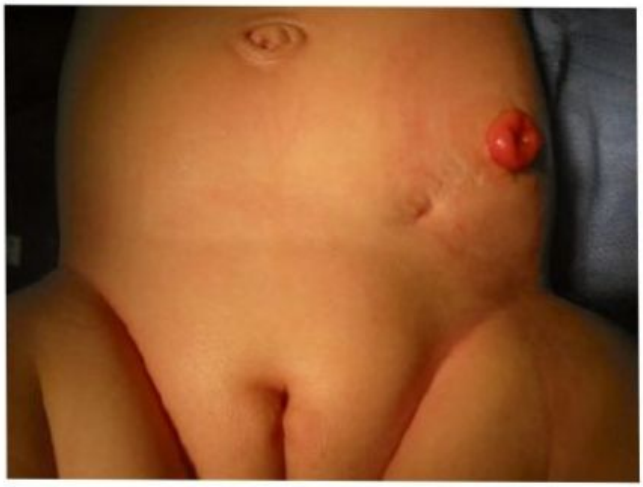

Fig. 5.18 Colostomy aspect weeks after operation

meticulous technique, delicate care of the tissues, and irrigation of every layer of the wound closure. The final result is cosmetically adequate, and the stomas are easy to manage by the mothers. Our incidence of prolapse in this kind of colostomy is zero (Fig. 5.18).

When we open a technically correct type of colostomy and place a stoma bag, usually there is no need to change the bag for the following 3 days. The first removal of the bag must be done very gently. When it is difficult to apply a bag, or there are frequent episodes of leakage of stool, this probably means that the colostomy was not done correctly. The mucous fistula must be protected from contact with the diaper with a little piece of Vaseline gauze.

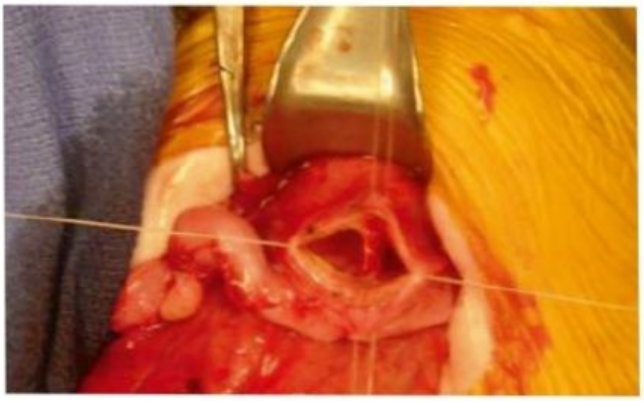

Fig. 5.19 Creation of a window in the vaginal septum of a case with bilateral hydrocolpos

5.9 Colostomy in Cases of Cloaca with Hydrocolpos

When a baby is born with a cloaca and we have evidence of the presence of hydrocolpos, which happens in about 29 % of our patients (see Chap. 16), the surgeon must be prepared not only to open a colostomy but also to drain the hydrocolpos. This represents an interesting technical challenge. If the hydrocolpos is large enough, the surgeon may consider the possibility of connecting the vaginal wall directly to the abdominal wall, like in the case of a colostomy. However, the surgeon must keep in mind that many patients with hydrocolpos have two hemivaginas; in other words, the hydrocolpos is bilateral. In fact, about 60 % of all patients with a cloaca have two hemivaginas (see Chap. 16). A tube placed into one vagina does not necessarily drain the other one. Therefore, the recommendation in cases of two hemivaginas is to be ready to open one of the dilated vaginas and create a window in the vaginal septum to be sure that both large hemivaginas (hydrocolpos) are drained through a simple stoma or with a single catheter (Fig. 5.19).

When the hydrocolpos is not large enough to reach the anterior abdominal wall, then it must be drained with a catheter. We like to use a Pezzer or a pigtail catheter that is exteriorized through the abdominal wall (Fig. 5.20). The pigtail is helpful because over the next several weeks, all the swelling of the vagina decreases, the vagina then tends to move away from the abdominal wall, and the catheters frequently come out. The "pigtail" catheter

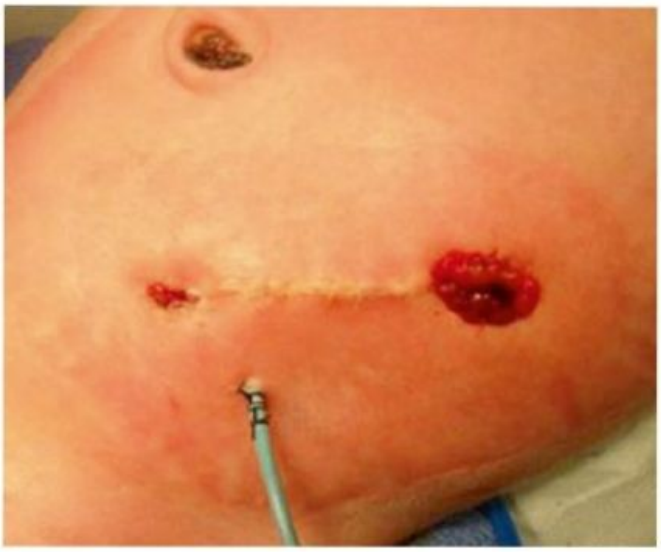

Fig. 5.20 Catheter drainage of a newborn with hydrocolpos

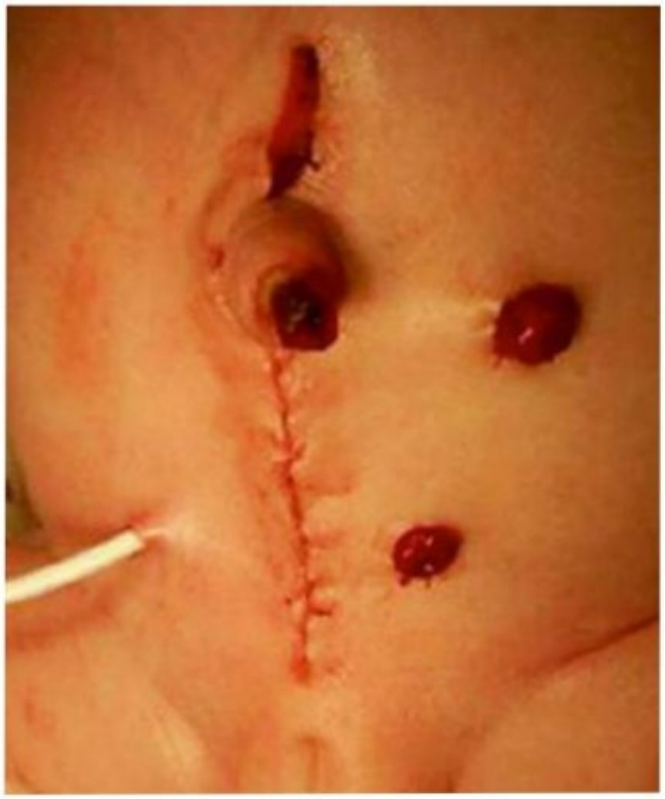

Fig. 5.21 Subumbilical midline incision used in cases of large bilateral hydrocolpos. The stomas are separated, and there is no incision in between them

will remain in place. In order to drain the hydrocolpos at the same time of the colostomy opening, it is necessary to open the abdomen with an incision that allows us to do both things (colostomy opening and drainage of a hydrocolpos). In these cases, we recommend a midline subumbilical incision (Fig. 5.21). This incision provides an excellent exposure to the pelvic anatomy and allows the surgeon to perform the diversion of the hydrocolpos. For the colostomy, we recommend creating two separate orifices, one for each stoma, in the abdominal wall, one in the left flank and the other one located lower and medial; both orifices are separated enough, to be able to adapt a stoma bag covering only the proximal stoma. In this way, there will be no incision in between both stomas, but rather healthy, normal skin (Fig. 5.21). For this kind of colostomy, the descending colon has to be divided through the midline subumbilical incision.

5.10 Other Types of Colostomies

Sometimes the surgeons feel that the patient does not need a totally diverting stoma. It may be the case of a reoperation, during which the surgeon feels very confident about the successful healing of the sutured tissues; the colostomy in such case is simply an extra precaution. We feel that in general, in colorectal surgery, we must work feeling free to open a colostomy when we think it is to the benefit of the patient. That is one of the reasons why, in general, we recommend the use of midline abdominal incisions in pediatric patients with colorectal problems. These types of incisions allow preserving both upper and lower quadrants of the abdomen in case the patient needs a stoma. In cases in which the surgeon feels that the colostomy does not necessarily need to be totally diverting, we recommend opening an orifice in the selected quadrant, resecting skin, subcutaneous tissue aponeurosis muscle, and peritoneum. Through that orifice, we exteriorize the selected piece of colon. We divide the bowel outside the skin and taper the distal end to create a little, 3-mm-diameter stoma, mucous fistula attached next to the proximal stoma (Fig. 5.22). This is a kind of a loop colostomy but with a reduced size mucous fistula lumen, which reduces the chances of stool spillage into the distal part.

5.11 Colostomy Care

The postoperative care of the colostomy is easy when the colostomy was made technically correct. Colostomies done in a technically incorrect manner represent a challenge and a nightmare for

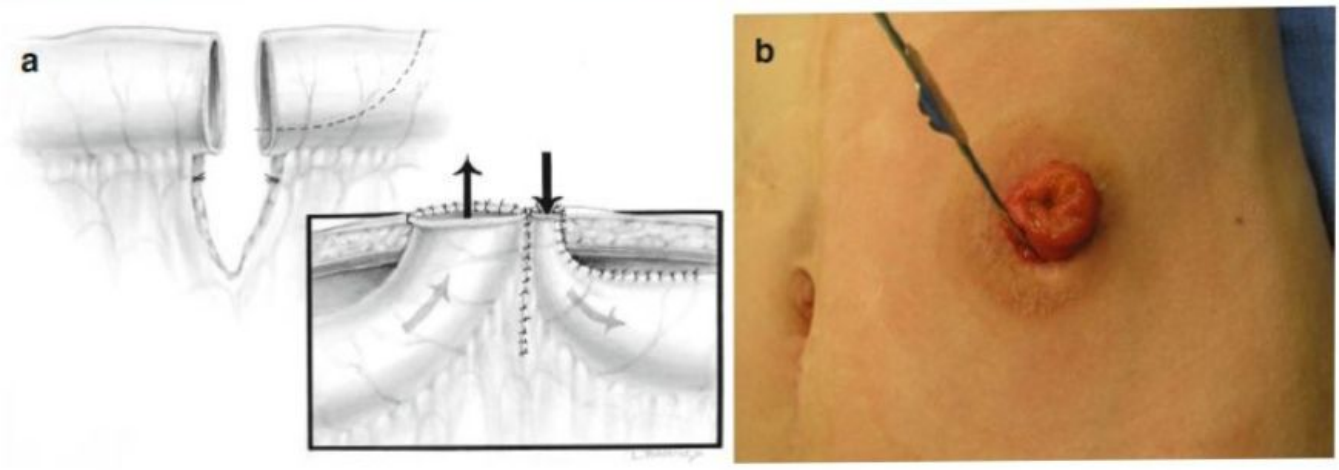

Fig. 5.22 Stoma with a very small mucous fistula, placed together. (a) Diagram. (b) Photograph

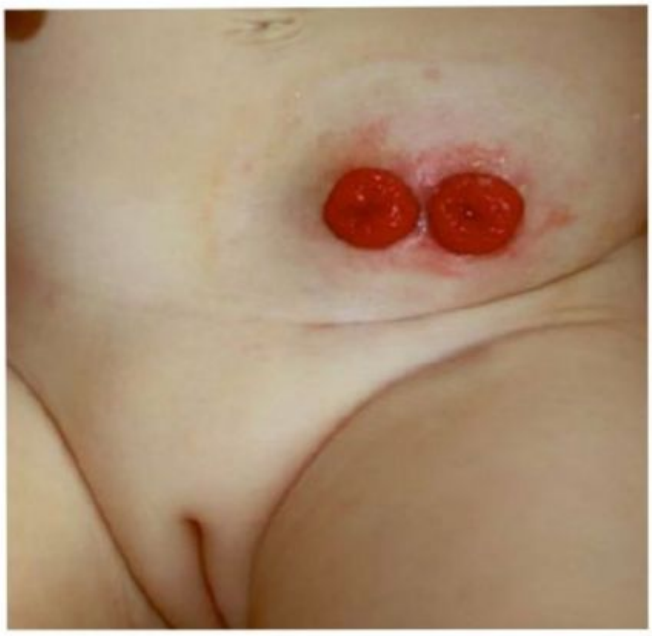

Fig. 5.23 Defective colostomy. Unable to adapt a stoma bag

stoma therapists, nurses, and mothers. It is almost impossible to adapt a stoma bag in a case of stoma that has irregularities in the surrounding skin (Fig. 5.23). When the stoma is surrounded by normal skin, we usually use benzoin to cover the skin that will be in contact with the appliance. The orifice in the stoma bag is tailored according to the size of the patient's stoma. All this is done by us in the operating room. We believe the surgeon should pay a lot of attention to the feedback provided by mothers, nurses, and stoma therapists, concerning the quality of stomas. It is our impression that surgeons do not pay enough attention to these details.

5.12 Colostomy Closure

As soon as the patient recovers from the main repair and the parents are passing a dilator of a size adequate for the patient's age, the presence of the colostomy is no longer necessary, and therefore, it can be closed. Leaving the colostomy open longer than necessary exposes the patient to the formation of a microcolon distal to the colostomy, as a consequence of the lack of use. That makes the colostomy closure technically more demanding. We have seen two extreme cases, in which the colostomy closure was delayed about 10 years. The distal microcolon never really grew after several attempts at closing the colostomy. Most of the times, however, the microcolon grows back to a normal size, after the colostomy is closed.

In cases of extremely severe, grotesque size discrepancy between both ends (proximal and distal) of the colostomy, we recommend a couple of good technical maneuvers that proved to be very useful:

A. End-to-side anastomosis
B. Lateral window diversion
   (a) *End-to-side anastomosis*

   In general, we recognize and recommend an end-to-end anastomosis as an ideal way to close a colostomy. However, in cases of severe size discrepancy, an end-to-side anastomosis has demonstrated to be equally useful and safer (Fig. 5.24).
   (b) *Lateral window diversion*

   In cases of extreme size discrepancy (Fig. 5.24), in which the surgeons feel

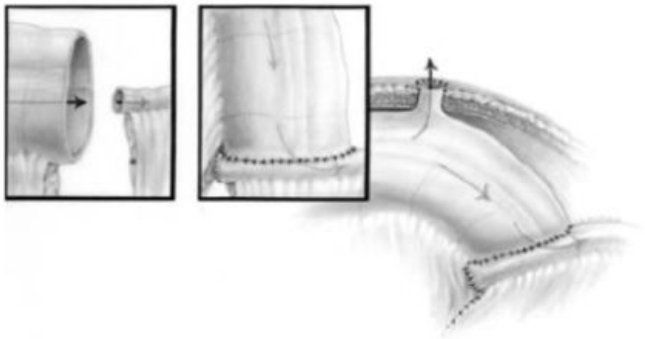

Fig. 5.24 End-to-side colocolic anastomosis in cases of severe size discrepancy. Lateral window diversion, located proximal to the anastomosis, useful in cases of extreme size discrepancy

insecure about the functional capacity of the anastomosis and the distal bowel, we have created a "lateral window" type of vent located on the very dilated proximal colon (proximal to the anastomosis) (Fig. 5.24). In the following days and weeks postoperatively, one can monitor the amount of stool coming out through the window and through the rectum. The window can also be used as a communication to inject contrast material and evaluate the function of the anastomosis and growth of the distal bowel.

The preoperative preparation for colostomy closure includes only irrigation of the proximal stoma with saline solution. The distal stoma does not have to be irrigated because that has been clean from the time of the main procedure. In cases of loop stomas, both ends need to be irrigated. Prior to the definitive colorectal reconstruction, only the distal stoma needs to be irrigated.

The patients are admitted to the hospital the day before surgery and receive a normal breakfast followed by clear fluids until midnight. The proximal stoma is irrigated as many times as necessary until the nurses believe that the fluid that comes back is clear. We do not give GoLYTELY®[1] to these patients because we do not need or expect them to have a completely clean colon.

[1] GoLYTELY® PEG 3350 236 g, sodium sulfate 22.74 g, sodium bicarbonate 6.74 g, sodium chloride 5.86 g, and potassium chloride 2.97 g (4,000 mL) [regular and pineapple flavor].

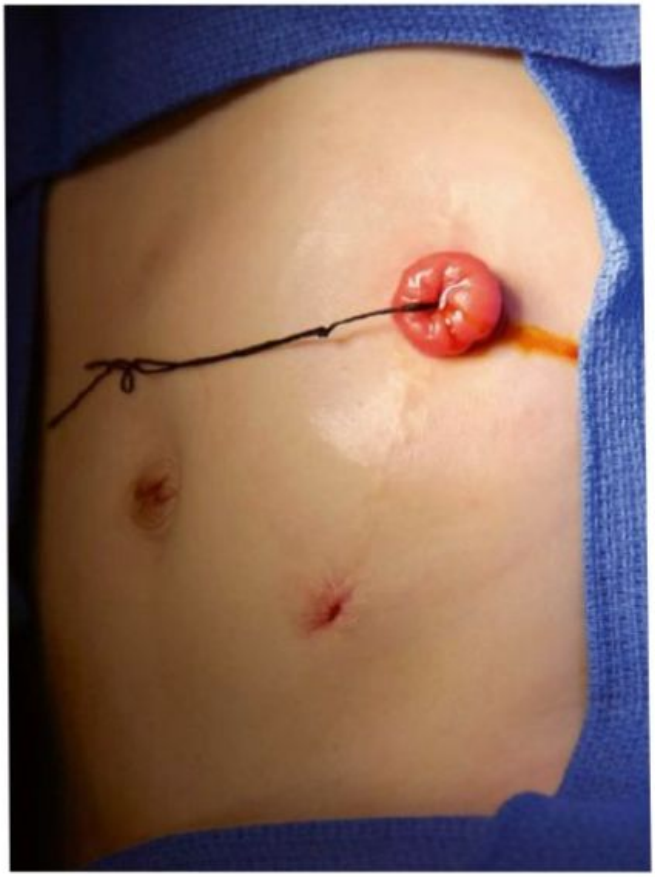

Fig. 5.25 Colostomy closure. Packing of the proximal stoma

5.13 Surgical Technique

The patient is taken to the operating room. Under general anesthesia, the abdominal wall is washed, prepped, and draped in the usual fashion. A packing gauze impregnated with Betadine is placed in the proximal stoma (Fig. 5.25). Multiple 5-0 silk sutures are placed at the mucocutaneous junction, including both stomas (Fig. 5.26). These multiple silk sutures are used to apply uniform traction to both stomas to facilitate the dissection. Usually, when the stomas are not too distant from one another, we use a wedge resection of both stomas with a piece of skin in between (Fig. 5.27). A needle-tip cautery is used to perform this elliptical incision. The incision is done while applying uniform traction to both stomas, and it goes through the skin, subcutaneous tissue, aponeurosis muscle, and peritoneum, staying in our dissection, as close as possible to the bowel wall, but without touching the bowel wall itself (Fig. 5.28).

Once both stomas have been completely separated from the abdominal wall, the packing gauze is removed from the proximal one. We use Baby Allen clamps to resect the part of the bowel that used to be attached to the abdominal wall (Fig. 5.29).

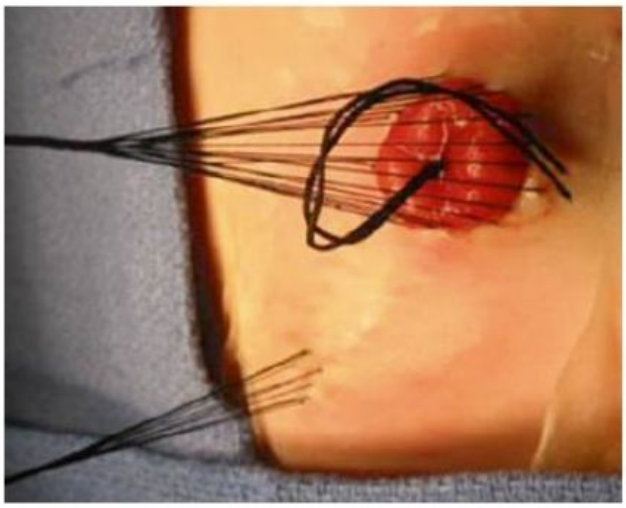

Fig. 5.26 Multiple silk sutures are placed at the mucocutaneous junction of both stomas. Traction is applied

By doing this, we use fresh portions of the proximal and distal colon to perform an end-to-end anastomosis with two layers of long-term absorbable 6-0 sutures (Figs. 5.30 and 5.31). The mesenteric defect is meticulously closed, also with 6-0 long-term absorbable sutures. The peritoneal cavity is irrigated with saline solution. The peritoneum and posterior fascia are closed together, with a running, locked 4-0 long-term absorbable suture. The anterior fascia of the abdominal wall is closed with interrupted 5-0 long-term absorbable sutures. The same suture material is used to close the subcutaneous tissue and Scarpa fascia. The skin is closed with a subcuticular 5-0 monofilament absorbable suture. The wound is finally covered with flexible collodion (Fig. 5.31).

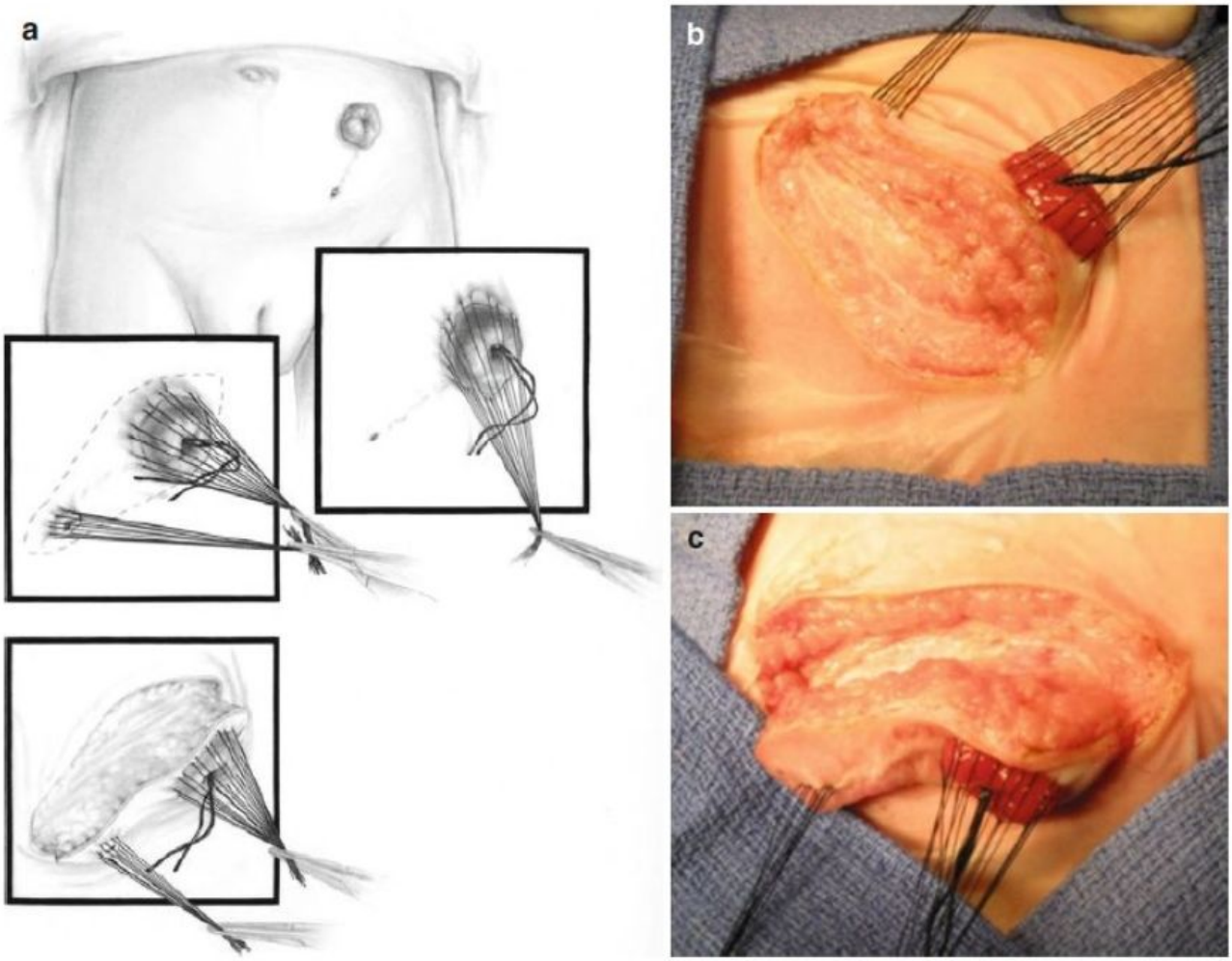

Fig. 5.27 Wedge incision. (**a**) Diagram. (**b**, **c**) Intraoperative pictures

At the beginning of the operation, the patient receives intravenous metronidazole and a broad-spectrum antibiotic. These medications will be administered for 48 h postoperatively. At the end of the operation, we do not insert a nasogastric tube in the majority of our patients, but we keep them fasting. The following day after surgery, if the patient had no nausea or vomiting and the abdomen is not distended, we start oral feedings. The patient usually stays in the hospital 3–4 days.

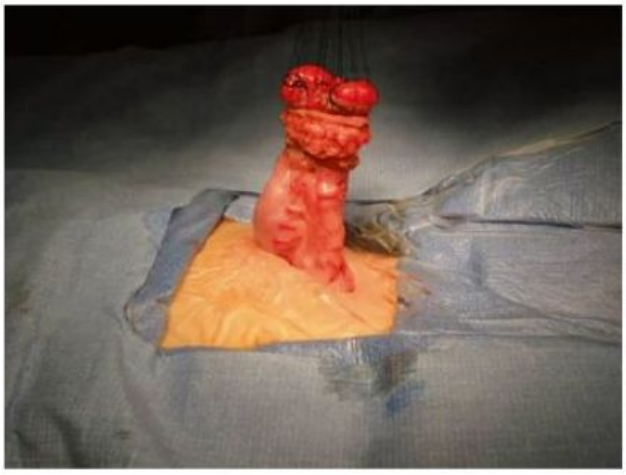

Fig. 5.28 Both stomas are meticulously dissected and separated from the abdominal wall

Occasionally, the patient has abdominal distention or vomits after the surgery; under those circumstances, we may insert a nasogastric tube and keep the patient fasting until the ileus resolves.

Colostomy closures must be done using a delicate and meticulous technique. This is an operation with serious potential complications [31, 32, 33–37].

We are very proud of our results in colostomy closures [38]. We believe that a meticulous, delicate technique explains our good results. We have closed over 1,000 colostomies, and we have only had one case of a dehiscence of the anastomosis. That particular patient had a colostomy closed with a single-layer anastomosis. The colostomy had to be reopened on an emergency basis and closed a month later with no problems. Another patient came back to the hospital a week later, with a colonic perforation located about 1 cm proximal to the anastomosis. We do not have an explanation for this complication; we are not sure if it may have been a cautery burn done inadvertently. All of these patients have been operated on without any drains from the peritoneum or the subcutaneous tissue. We put special emphasis in a meticulous hemosta-

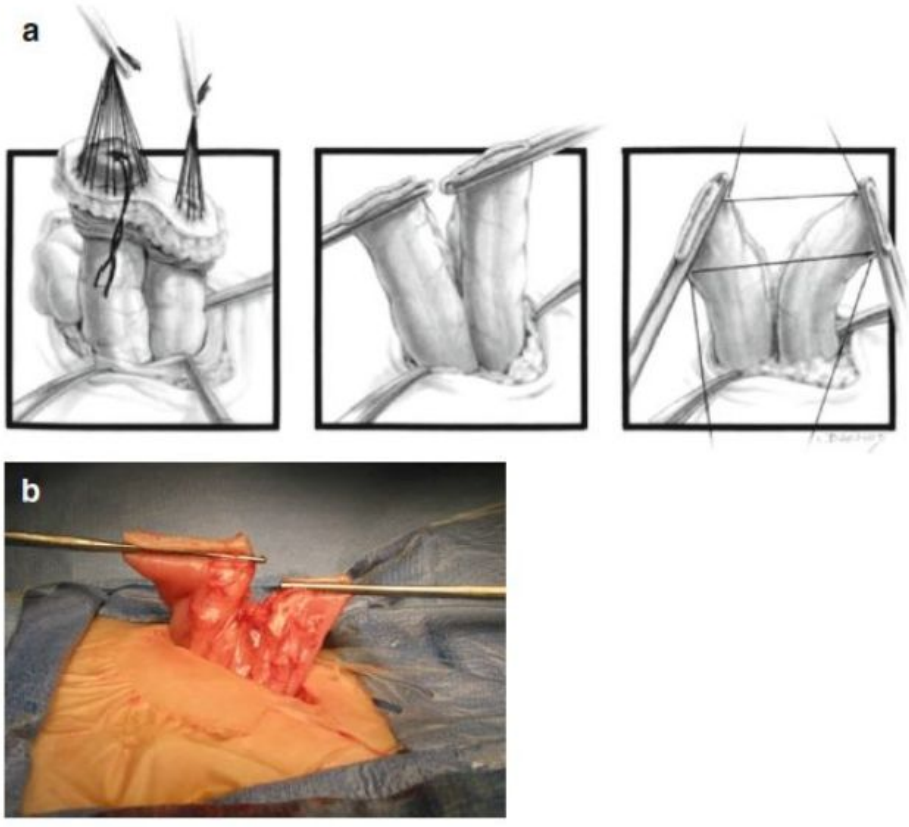

Fig. 5.29 Stomas are resected to use a fresh portion of the bowel on each side to perform an anastomosis. (**a**) Diagram. (**b**) Picture

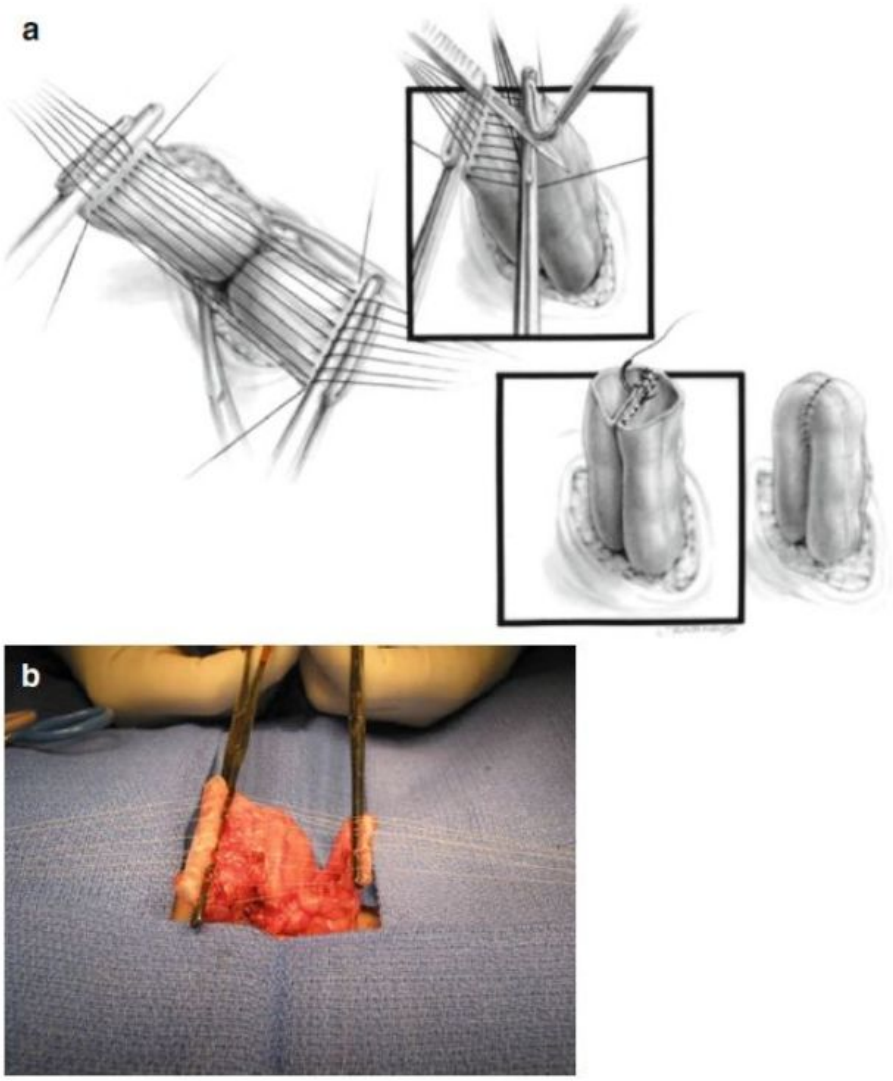

Fig. 5.30 A two-layer anastomosis with separated stitches is performed, using very fine (6-0) long-term absorbable sutures. The mesenteric defect is closed. (**a**) Diagram. (**b**) Operative picture

sis, closing each one of the layers of the abdominal wall, leaving no dead spaces and irrigating each plane. We never had a case of a wound infection, despite all wounds being closed primarily.

5.14 Errors and Complications in Colostomies

Over 1,500 patients came to us with a colostomy created at another institution. As can be imagined, we have seen literally all kinds of colostomies. From that experience, we learned about the potential advantages and disadvantages, as well as complications of each type [30]. The most common error seen by us in patients with anorectal malformations, who underwent a colostomy opening at another institution, consists in having the stoma created too distal into the sigmoid colon (Fig. 5.32) leaving a very short piece of bowel between the distal stoma (mucous fistula) and the end of the rectum (blind end or fistula site). This is a serious mistake because it interferes with the mobilization and pull-through of the rectum to create a new anus. This is another reason why the distal colostogram is so important. The first piece of information that the surgeon must obtain from this study is related to the length of bowel available for pull-through, distal to the mucous fistula (Fig. 5.33). A colostomy located too distal must be ruled out before embarking in a misadventurous, failed attempted repair. The surgical alternatives when confronted with that problem are:

A. Colostomy revision

Closing the colostomy and reopening a more proximal one, exteriorized through the same abdominal orifice, and doing the main repair at least 3 months later (Fig. 5.34).

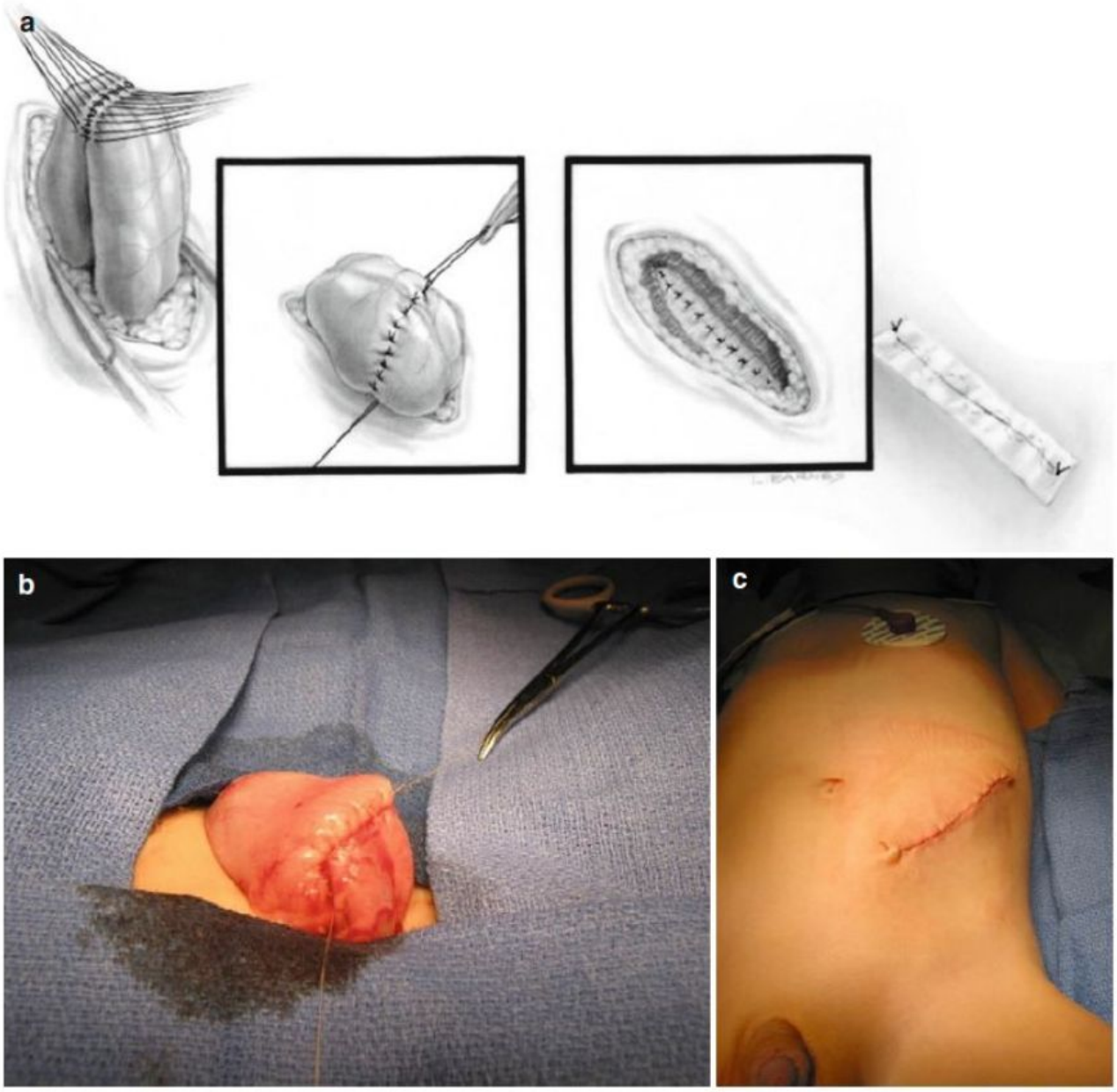

Fig. 5.31 The bowel anastomosis finished and the wound is closed. (**a**) Diagram. (**b**) Operative field. (**c**) Closed wound

B. Repair the malformation, detaching the bowel (mucous fistula) from the abdominal wall, to allow its mobilization and leaving the distal bowel closed as a Hartmann pouch (Fig. 5.35).
C. Close the colostomy and perform the pull-through at the same time.
   - Leaving the patient without a protective colostomy or
   - Opening a new more proximal stoma
D. Resect the short piece of bowel located between the mucous fistula and blind end of the fistula, pulling through the colostomy site bowel, leaving the patient without a colostomy or opening a new one more proximal.

Alternative A: Colostomy revision is probably the safest one, although it represents an extra operation for the patient.

Alternative B: Repair the malformation, leaving the patient with a Hartmann pouch (Fig. 5.35), may represent a future technical challenge, depending on how low the pouch is located. It is a technically demanding operation to close a colostomy performing a bowel anastomosis behind the bladder. In fact, if the upper end of

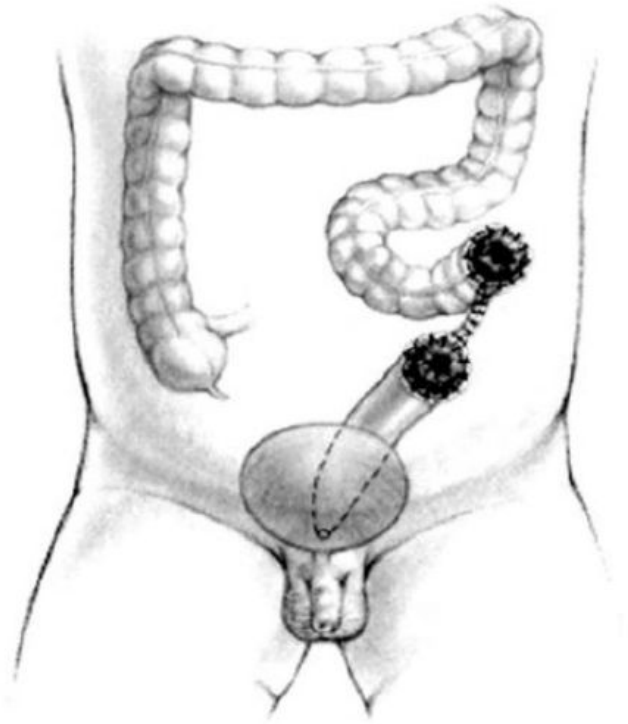

Fig. 5.32 Colostomy created too distal

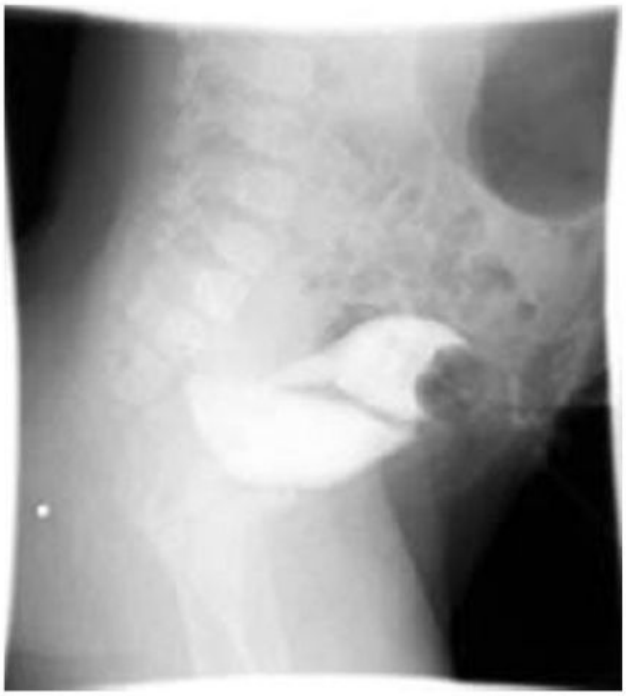

Fig. 5.33 Distal colostogram showing a very short piece of bowel distal to the stoma

the Hartmann pouch is located behind the posterior urethra, the operation may be almost impossible to perform, not to mention the risk involved.

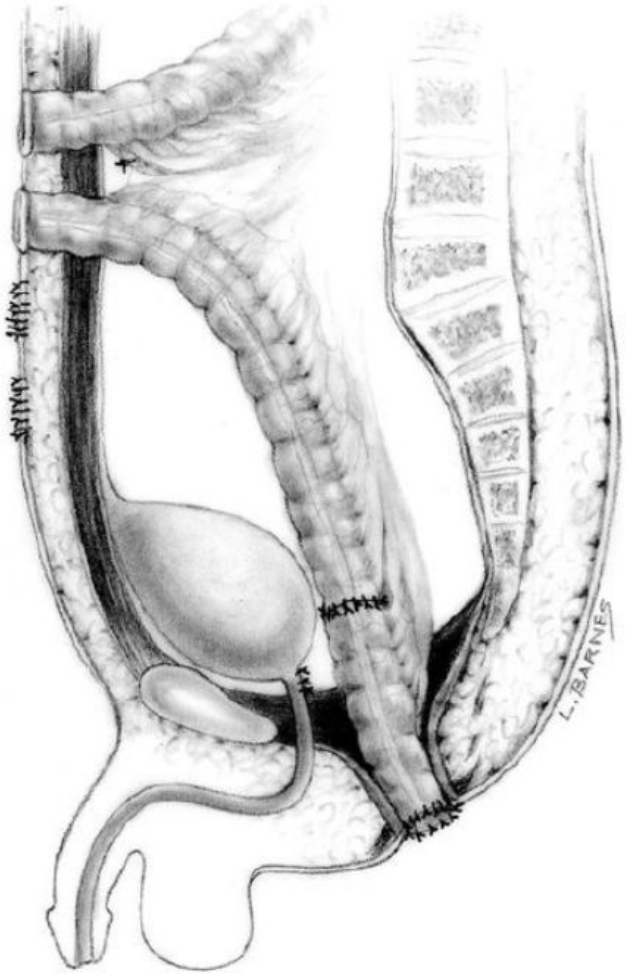

Fig. 5.34 Closure of a colostomy and opening of a more proximal one, prior to the main repair, in a patient who previously underwent a defective (too distal) colostomy

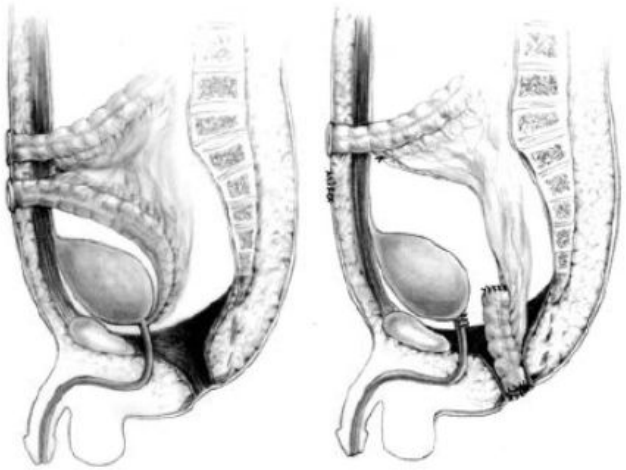

Fig. 5.35 Diagram showing a pull-through of a short distal colon. The mucous fistula had to be separated from the abdominal wall. The distal stoma is closed (Hartmann pouch). Alternatively, sometimes the distal stoma can be created in a lower part of the abdomen

Alternative C: Closing the colostomy and doing the pull-through, leaving the patient without a colostomy, is feasible but involves a certain degree of risk. We advise in such a case to leave the patient fasting for 10 days, receiving parenteral nutrition. In addition, to do this kind of operation requires a total bowel preoperative preparation.

Opening a new, more proximal colostomy is of course safer but requires one more major operation (colostomy closure).

Alternative D: (Resect the little, distal piece of bowel) We consider this alternative formally contraindicated. The most distal piece of bowel represents the future rectum for the patient. We have learned that the preservation of this part of the intestine is extremely important. Our observations in multiple patients lead us to believe that the colon's motility is slower in its most distal part. In fact, the normal rectosigmoid acts mainly as a reservoir of stool, except at the time of defecation, when the rectosigmoid has a very active, massive peristaltic wave that allows the emptying of its entire contents that usually represents the stool formed over a period of 12–48 h. In between episodes of defecation, the rectum remains virtually paralyzed (acting as a reservoir), receiving and storing stool. This is an extremely important function that allows us, human beings, to function socially, without using the toilet constantly. The observation of the way the different types of colostomies pass stool represents a clear demonstration of this. The more distal the colostomy, the longer the periods without passing stool.

Elimination of the rectum from the fecal stream results in an almost constant passing of stool. This may be managed relatively well by an otherwise normal individual in whom the anal canal and sphincter mechanism are intact. Yet, in patients with anorectal malformations, this is not tolerated at all and may well represent the difference between bowel control and fecal incontinence. In other words, it is necessary to have an intact anal canal (sensation and sphincter mechanism) in order to maintain bowel control with an absent rectosigmoid.

In patients with typical Hirschsprung's disease, we resect the aganglionic rectosigmoid and anastomose the descending normoganglionic colon to the anal canal, and patients have bowel control, provided the anal canal is preserved intact. Patients with anorectal malformations are born without an anal canal, and their sphincter mechanism is represented by a spectrum that includes cases with almost normal sphincter (in one extreme of the spectrum) to patients with absent sphincter (in the other extreme of the spectrum). Many patients operated from an anorectal malformation behave as if they were fecally continent; yet, they cannot tolerate sudden changes in the consistency of the stool or sudden peristaltic waves. For this reason, we insist that it is extremely important to try to preserve to the best of our capacity as much bowel as possible.

We know that the rectosigmoid in patients with anorectal malformations suffers from hypomotility, which is reflected in a marked tendency to constipation. Resection of the rectum may decrease the severity of the constipation problem, but may also provoke tendency to diarrhea, which, as we mentioned, will turn into incontinent a patient with borderline bowel control.

We have a large experience with patients that have come to our clinic to receive bowel management for the treatment of fecal incontinence. In some of them, the surgeons found it easier to simply remove the distal short rectum and pull the colostomy down. Those patients always become incontinent even in cases born with a good functional prognosis type of defect.

In addition, as mentioned in the chapter of bowel management, that group of patients (hypermotility, tendency to diarrhea) is much more difficult to manage.

5.15 The Case of Upper Sigmoidostomy

An interesting error occurs when the surgeon tries to open a transverse colostomy (either right or left sided) and actually creates what we have called an "upper sigmoidostomy" (Fig. 5.36). This occurs because the surgeon (frequently in a

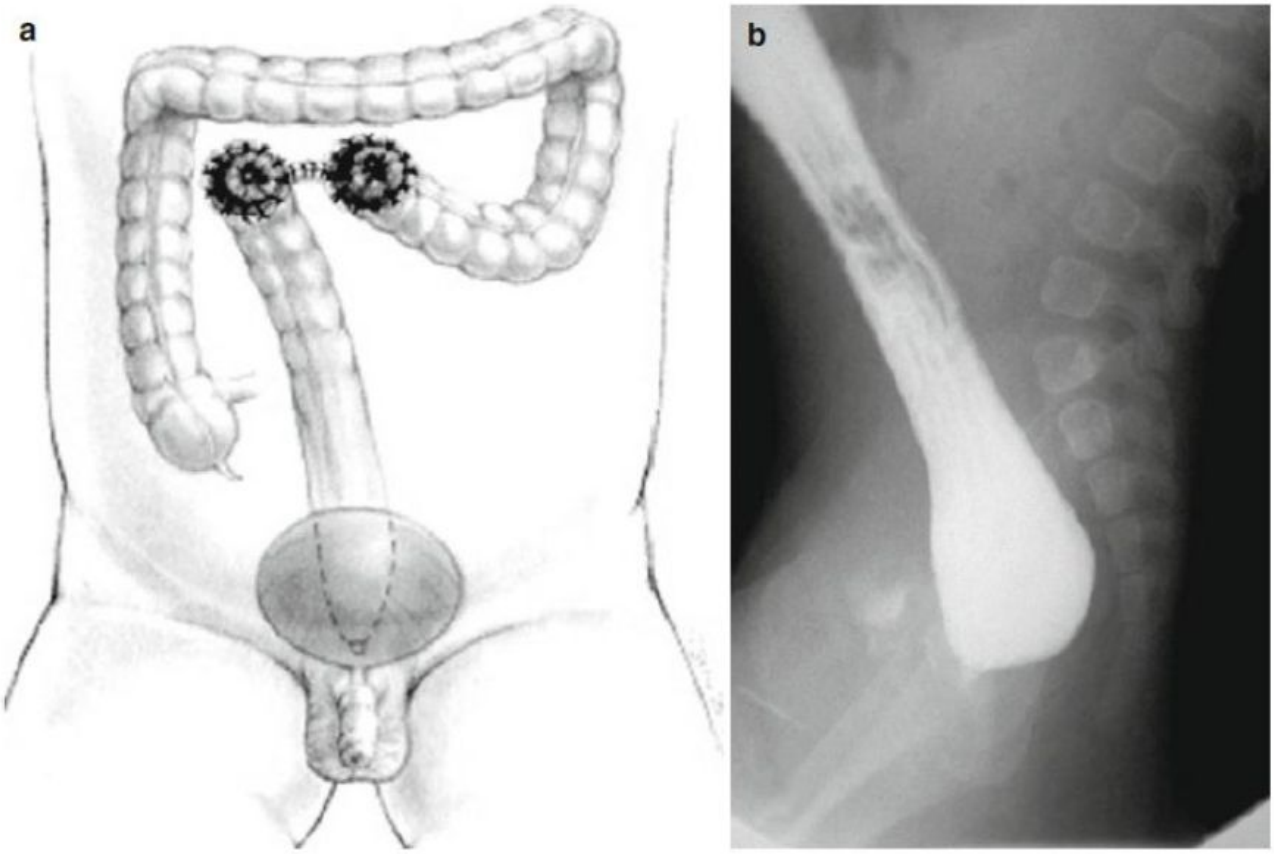

Fig. 5.36 Upper sigmoidostomy. The surgeon thought that he was doing a transverse colostomy, but actually he created a sigmoidostomy in the upper abdomen, which will interfere with the pull-through. (**a**) Diagram. (**b**) Colostogram

hurry) creates a right or left upper quadrant incision and grabs the first visible segment of the colon, erroneously assuming that it is either a right or left transverse colon. One must always keep in mind that in cases of anorectal malformations, the sigmoid colon is very dilated and redundant, reaching the upper abdomen. The surgeon must take the time to observe carefully the characteristics of the piece of colon that he selected, to be sure that that is the correct portion of the colon.

The negative implications and inconveniences of this type of colostomy (upper sigmoidostomy) are obvious. The attached (tethered) sigmoid to the abdominal wall will interfere with the pull-through.

Again, we cannot overemphasize the importance of the distal colostogram in the planning of the main repair of an anorectal malformation. The location of the stoma in the abdominal wall does not necessarily correspond to the portion of the colon employed. In other words, a right upper quadrant stoma does not necessarily mean that the portion of the colon employed is the right transverse. Only with a distal colostogram one can objectively determine the characteristics of the colostomy.

Complications in colostomies are divided into immediate and late. Immediate complications include dehiscence of the stoma, retraction, and infection. These three complications usually occur together. This represents a catastrophe usually related to a poor technique, a colostomy opened in a very sick patient, or both. A tense anastomosis between the bowel and the abdominal wall, plus a devascularization of the bowel, may explain the retraction and dehiscence. A poor surgical technique with severe contamination may explain the infection [30].

Late complications include

Parastomal hernia: This is also a technical problem that is avoidable by using a meticulous surgical technique.

5.16 Prolapse

Prolapse is one of the most common complications that we have seen in colostomies done at other institutions [30]. There are some publications with recommendations to prevent prolapse from happening [39–41]. There is a merit on those recommendations. However, we think that we found the most important factor that contributes to the occurrence of prolapse. It took us several years to understand the mechanism of prolapse. By observing all of the patients that had prolapse, we finally concluded that prolapse occurs every time the colostomy is opened in a mobile portion of the colon. In retrospect, this sounds like an extremely simplistic, yet very valuable conclusion. In a case of a two stoma type of colostomy opened into a mobile portion of the colon, we would expect both stomas to prolapse. Otherwise, if the proximal stoma was opened in a fixed portion of the colon, like in the right transverse colostomy, we would expect the prolapse to occur in the distal stoma (Fig. 5.37). The proximal will not prolapse because it is opened into a fixed portion of the colon (hepatic flexure). In a case with a left transverse colostomy, the proximal one is expected to prolapse and not the distal (Fig. 5.38). A sigmoid colostomy will have a high tendency to prolapse, unless it is done in the way that we recommend, in which the proximal stoma is opened in the descending fixed portion of the colon and the mucous fistula is tapered to create a very small stoma (Fig. 5.39).

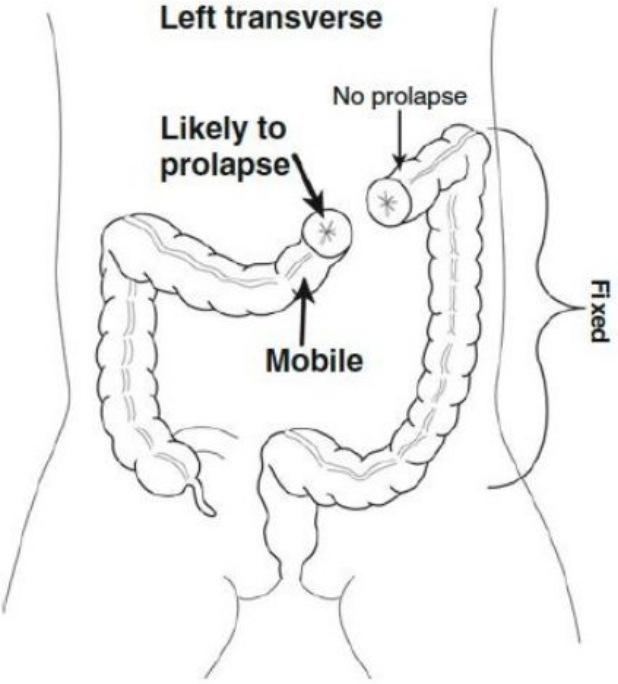

Fig. 5.38 Left transverse colostomy

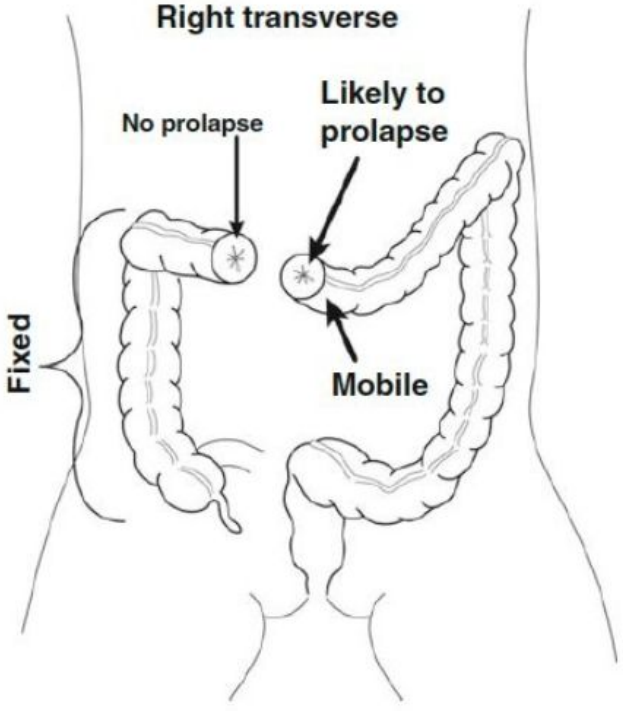

Fig. 5.37 Understanding the etiology of prolapse. Right transverse colostomy

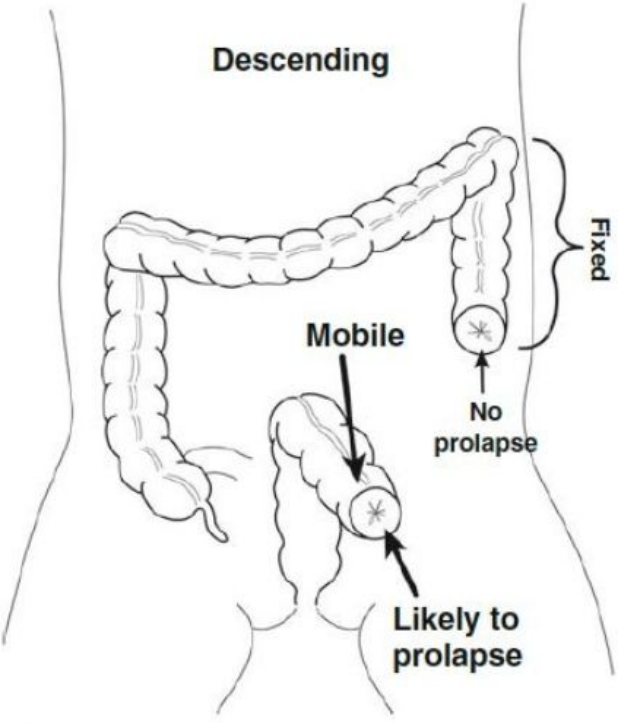

Fig. 5.39 Descending colostomy

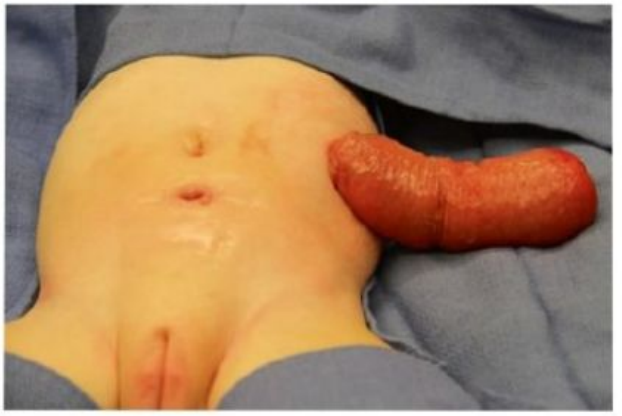

Fig. 5.40 Severe stoma prolapse

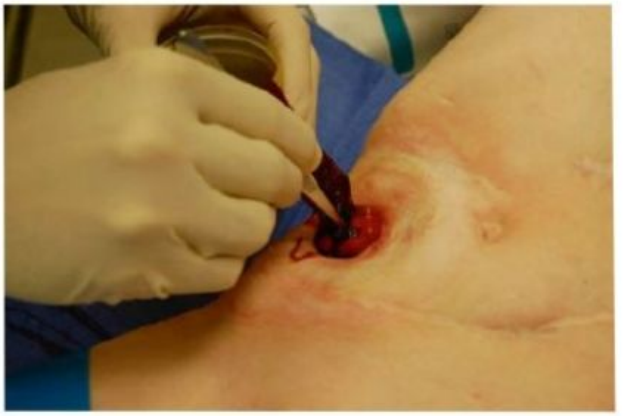

Fig. 5.41 Packing gauze inserted in the prolapsing stoma, reducing the prolapse

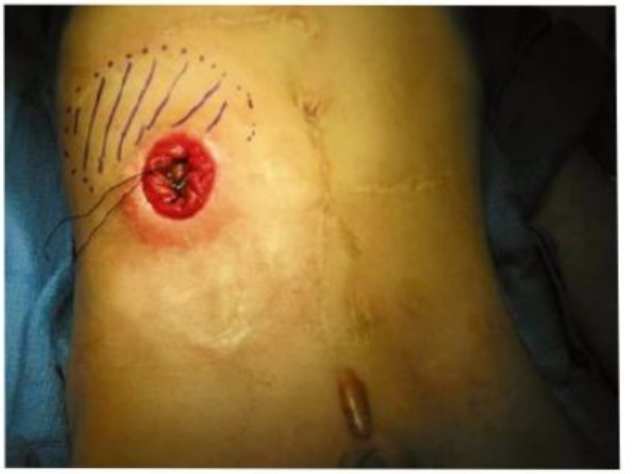

Fig. 5.42 The prolapse is reduced, taking its natural position in the abdomen

In general, if a surgeon has to open a colostomy and has no choice but to open it in a mobile portion of the colon, we recommend affixing that piece of bowel to the anterior abdominal wall for approximately 8 cm, proximal to the stoma with nonabsorbable sutures. Some patients that came to us with a severe prolapse were supposed to have a repair of the anorectal malformation, but rather than doing that, we decided to take care of the prolapse. Severe prolapse (Fig. 5.40) frequently produces ischemia of the most distal part of the prolapsed bowel with serious consequences and must be avoided. We have seen patients that suffered from prolapse, the parents took the baby to a hospital, and the surgeons decided simply to amputate the prolapsed part of the colon. This has very serious consequences for the patient, because the absence of the colon or the presence of a short colon, in a patient with an anorectal malformation, may result in incapacity to form solid stool which will produce fecal incontinence, even in cases of patients born with a good functional prognosis type of anorectal malformation. In addition, as previously mentioned, the management of fecally incontinent patients with tendency to diarrhea is more difficult, and the results of the implementation of our bowel management program are not as good as the ones in constipated patients.

5.17 Surgical Treatment for Prolapse

Several authors published ingenious procedures to treat colostomy prolapse [42–45]. We do not have experience with those methods. The treatment that we propose for the management of prolapse is illustrated in diagrams 41–44. Under general anesthesia, the prolapsed stoma is packed with packing gauze impregnated with Betadine (Fig. 5.41). By doing this, we reduce the prolapsed bowel and let the bowel take its natural, comfortable position inside the abdomen (Fig. 5.42). Once we finish packing the stoma, we palpate the abdomen around the stoma. It is very easy to feel a sausage-like mass, situated somewhere around the stoma (Fig. 5.43). We then make a 4–5-cm incision, away from the stoma, in the area where the "sausage" is palpated. The incision must be located far enough from the stoma, as to be sure that after the operation the stoma bag can be placed on a smooth piece of skin and not on top of the incision (Fig. 5.44). Once we open the abdominal wall, we can easily

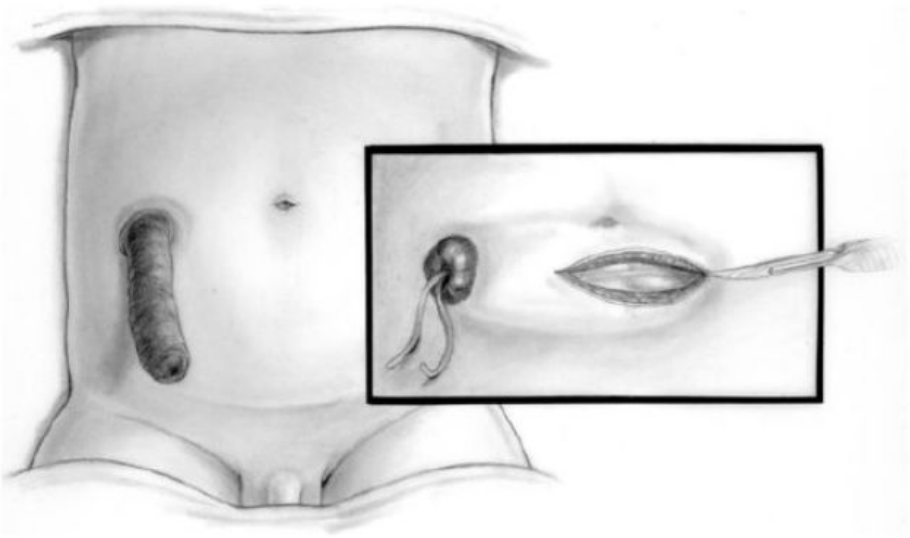

Fig. 5.43 A "sausage-like" mass is easily palpable, which represents the reduced prolapse

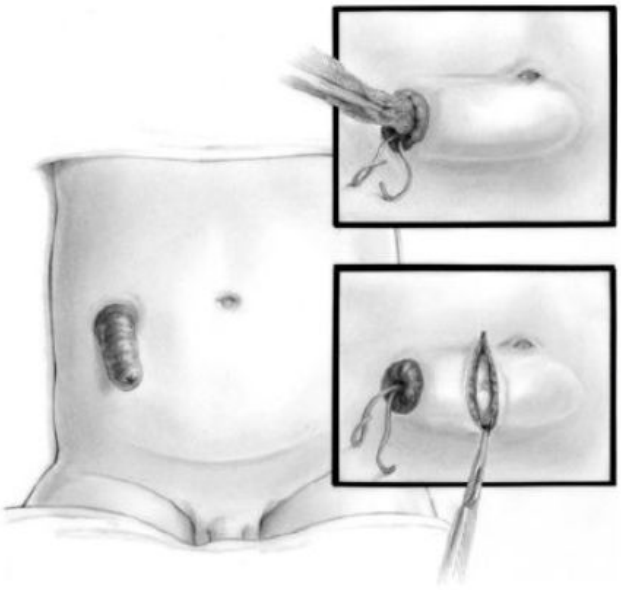

Fig. 5.44 Incision made on the area of the palpable "sausage-like" mass and away from the stoma. The abdomen is entered and the prolapsed bowel is easily identified. While closing the peritoneum and fascia, the stitches take the bowel wall

see the dilated colon that used to be prolapsed and now is full of the packing gauze (sausage) (Fig. 5.44). We start by closing the peritoneum and posterior fascia, including in our stitches a bite of the colonic wall ("sausage") that used to be prolapsed. We finish by closing that incision and removing the packing gauze. The bowel will not prolapse again. We have seen one case of recurrence, but we have done at least 25 of these cases this way, with no recurrence. We have seen no case of a cutaneous fistula related to this suturing.

5.18 Malposition of the Stomas

We have seen stomas incorrectly located in places near the umbilicus, near the ribs, near the iliac bone, or near the pubis. Every time the patient moves, the stoma bag detaches, and there is stool leakage that is embarrassing and causes a lot of skin problem. This is why we emphasize that the functional stoma should be opened in a location surrounded by normal skin, and that is why we also emphasize the use of midline incisions in patients with potential colorectal problems.

The stomas located too close, one to another (Fig. 5.2a), represent a problem because the nurses and mothers cannot use a stoma bag to include only the proximal stoma. They have to include both stomas into the same bag, which means potential passage of stool into the distal bowel that may provoke urinary tract infections and/or fecal impaction distally. Stomas that are located too far one from the other (Fig. 5.45) represent a problem because at the time of colostomy closure, the patient will need a very long incision in order to bring both stomas together.

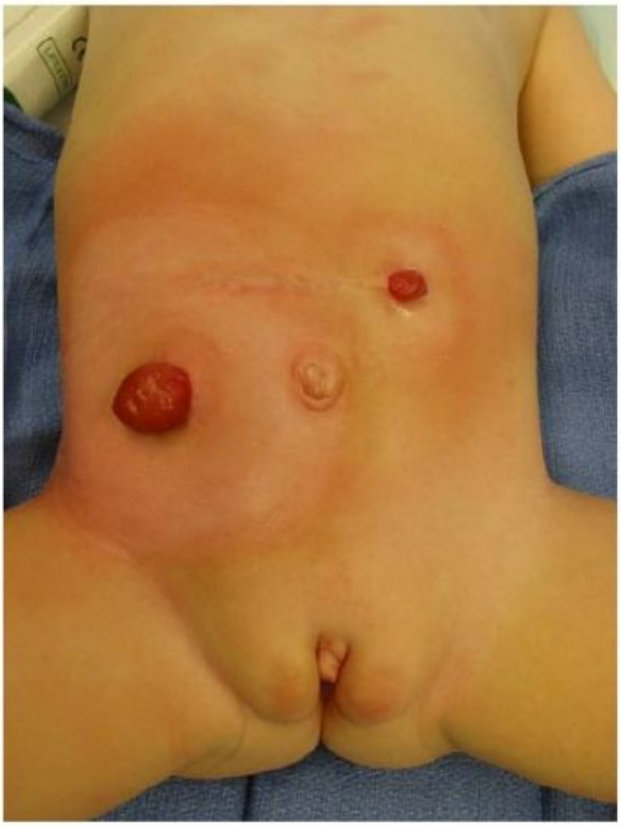

Fig. 5.45 Stomas located too far apart

Inverted stomas represent a lack of care and attention from the surgeon at the time of the operation. He or she thought that he or she was dealing with a proximal stoma that actually was distal and vice versa, and the bowel was twisted (Fig. 5.46).

Stricture usually occurs secondary to ischemia. That means that the bowel was perhaps squeezed when the surgeon closed the abdominal wall. Sometimes, the bowel was not properly mobilized, or the surgeon damaged the blood supply, provoking a stricture that requires a revision, or the fascial opening was made too small. A stricture may happen in the proximal stoma or may also happen in the mucous fistula. Closure of a mucous fistula (Hartmann pouch) represents a risk of mucocele and has to be reopened. In addition, we cannot do a high-pressure distal colostogram, and that is another reason why it should be reopened.

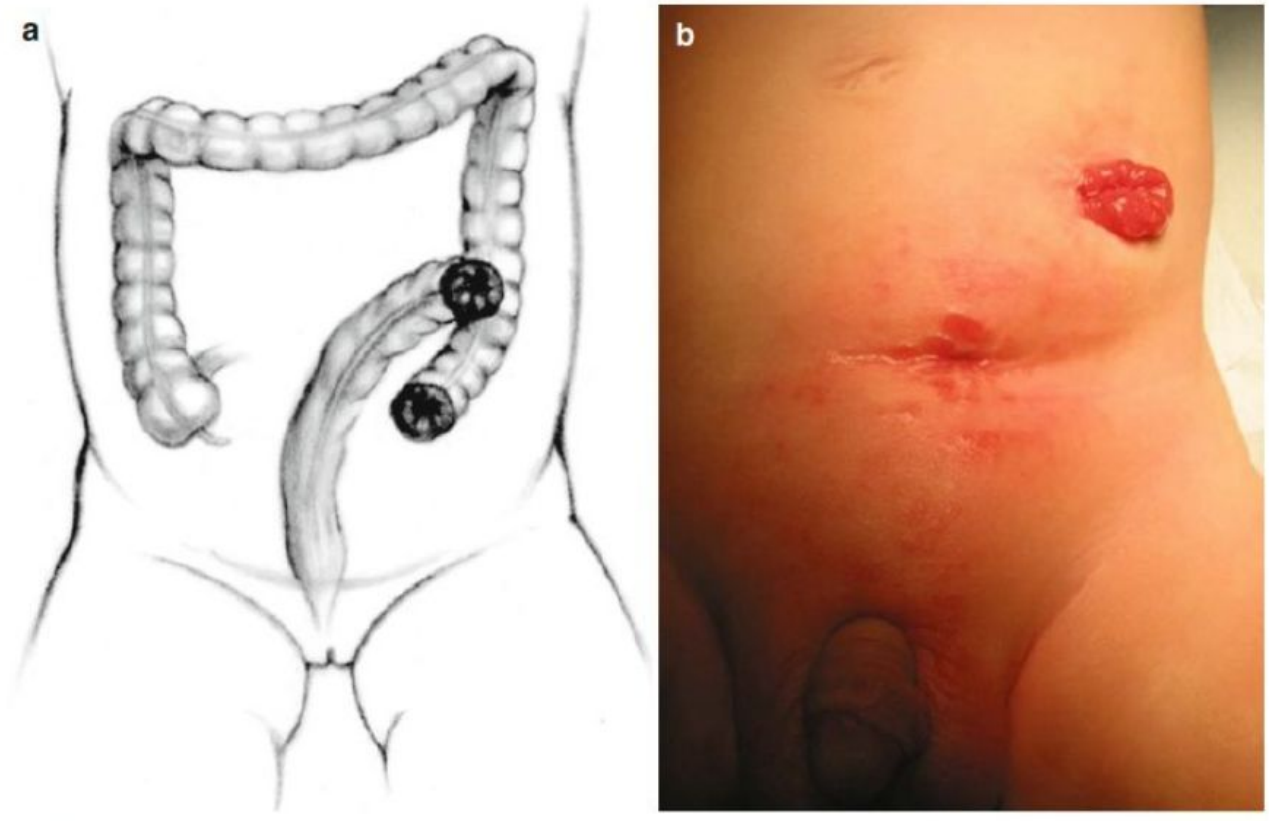

Fig. 5.46 Inverted stomas. (a) Diagram. (b) Picture

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