

Surgical Procedures for Severe Typhoid Fever

Katherine Shafer, Brad-Lot Igiraneza, Yakoubou Sanoussi

Introduction:

Typhoid fever is a bacterial infection caused by *Salmonella typhi*. It is spread by ingesting contaminated food or water. If not treated with early antibiotics, it can lead to serious surgical complications most often presenting with typhoid intestinal perforations in the terminal ileum. It can also less frequently cause gangrenous or perforated acalculous cholecystitis, or can involve both ileal and gallbladder disease concurrently.



Single typhoid intestinal perforation (Black circle) on the antimesenteric border of the terminal ileum



Gangrenous acute cholecystitis and typhoid intestinal perforations in the same patient.



A patient with gangrenous acute acalculous cholecystitis (top specimen, opened) and multiple intestinal perforations



Gangrenous acalculous cholecystitis with necrosis of most of the gallbladder wall, consistent with severe typhoid infection.

The intestinal injury starts internally on the antimesenteric border and is thought to be related to the location of the infection in the lymphoid follicles of the terminal ileum (“Peyer’s patches”). The injury to the intestinal wall can worsen to violaceous or erythematous areas on the serosal surface that represent concern for underlying mucosal injury (pre-perforations). Sometimes the bowel can feel thinner in these places, but tactile sense alone can be inaccurate because of the edema in the bowel wall.

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External and internal images of the same terminal ileum segment. The internal mucosal damage (bottom image) is often much more extensive than external appearance (top image) may imply. This can contribute to the patient having additional perforations after repair of the initial full thickness perforation—these areas often do not look like they're “at risk” since there is no evidence of external tissue loss.

These pre-perforations can also develop into necrosis of the intestinal wall before they develop full thickness perforations, so the patient can have peritonitis without evidence of free fluid. These patients still need to have an operation and these areas resected and not just oversewn.



Both above pictures show pre-perforations that have developed necrosis and are close to full thickness perforations.

Patients with typhoid intestinal perforations often present with two weeks of fever and then develop severe abdominal pain as they develop pre-perforations and then full thickness perforations with spillage and peritonitis. They may also present with other symptoms such as obstipation, nausea, and vomiting. In areas without the ability to perform blood cultures or more advanced imaging, it is very important to obtain a clear history to rule out trauma, to perform a good clinical examination, and to obtain laboratory analyses looking especially for abnormalities such as hyponatremia, anemia, or renal failure. Patients might not have a leukocytosis, as would be expected in other infectious cases of peritonitis.

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Abdominal ultrasound helps to assess the presence of free fluid, though patients can be perforated and may have only a localized fluid collection, contained by omentum and not easily seen on ultrasound. An upright abdominal x-ray is not always useful, as pneumoperitoneum is not always seen if the infectious process has been sealed off by the omentum or adjacent loops of bowel. Therefore, do not wait for free fluid or pneumoperitoneum on imaging to operate on these patients.

When there is suspicion of intestinal perforation, these are the steps to follow to prepare the patient for surgery:

- Insert a nasogastric tube
- Insert a urinary catheter
- Start broad-spectrum intra-venous antibiotics:
 - Children: Ceftriaxone 100mg/kg daily (not to exceed 4 grams) and Metronidazole 30mg/kg/day every 8 hours (not to exceed 500 grams/dose)
 - Adults: Ceftriaxone 2 grams daily and Metronidazole 500mg every 8 hours
- Intravenous fluid resuscitation
- Consent for exploratory laparotomy: every patient needs to understand there will be a possible bowel resection and a possible ostomy.

Surgical procedures for typhoid perforations proceed according to the following general steps:

- Midline exploratory laparotomy
- Aspiration of purulent fluid or succus and initial washout and exploration, to identify perforations
- Visualization of the gallbladder to ensure no evidence of gangrene or perforation
- Careful, systematic examination of all the small bowel with identification of the full thickness perforations and pre-perforations
- Surgical procedure, chosen depending on the location of the perforations, the number of perforations, the degree of contamination, the extent of inflammation of the bowel wall, and the clinical state of the patient (hypotension, malnutrition, etc.)

- Possible surgical procedures include: primary repair or resection (small bowel resection or ileocecectomy) with anastomosis vs. ostomy creation (end ileostomy and mucus fistula vs. diverting loop ileostomy). Both operations are discussed separately in detail below.
- Final irrigation of the abdominal cavity

PRIMARY REPAIR OF A PERFORATION

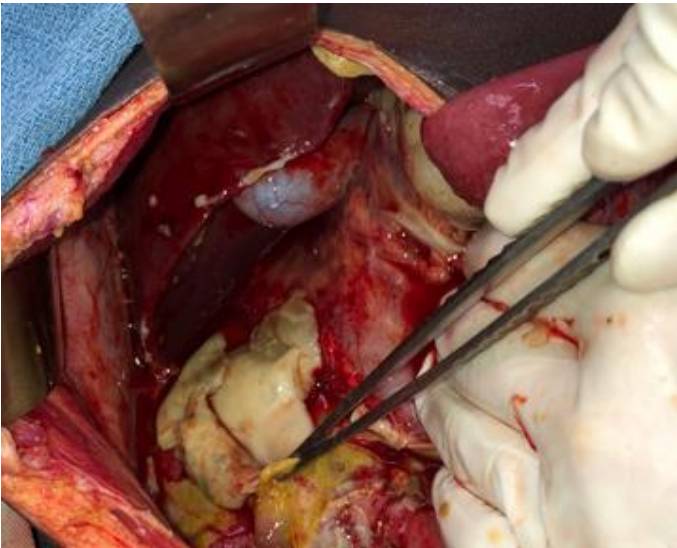
Steps:

1. Perform initial assessment, as described above. Assess also for malnutrition, abdominal compartment syndrome, signs of shock, electrolyte imbalance.
2. Perform abdominal ultrasound to assess the presence or absence of free fluid. Particulate free fluid is more concerning for thick purulence or succus.
3. Insert a nasogastric tube and a urinary catheter. Administer IV fluid for resuscitation, antibiotics, correct electrolyte abnormalities, and transfuse if needed (we prefer a hemoglobin >8g/dL / Hct>24%).
4. Obtain surgical consent by explaining to the patient the importance of the surgery needed, the risks and benefits, and the possibility of an ostomy.
5. General endotracheal anesthesia: the patient is at risk for circulatory collapse during induction if not sufficiently resuscitated. Surgical safety checklist with time out is performed before the start of the surgery.
6. A vertical midline incision is made, passing to the left of the umbilicus to leave room for a right lower quadrant ostomy if necessary.
7. Aspirate the purulence or succus and perform the initial washout
8. Survey the abdomen, looking especially for any gallbladder necrosis or terminal ileum perforations.



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The gallbladder must be examined for perforation or necrosis. In this photo, the thickened exudate has been peeled off to allow inspection of all of its intraperitoneal surface.

9. Gently remove any adherent exudate that is easy to remove, making sure to not cause serosal tears. Methodically examine all of the small intestine from the duodenojejunal junction (ligament of Treitz) to the ileocecal valve. Typhoid perforations and pre-perforations can be multiple, so this thorough inspection of all the small intestine is critical to not miss a pre-perforation or perforation under the exudate.



Inflammatory exudative “peel” on the small bowel. This should be removed so that the entire surface of the small bowel can be inspected, especially the region near the ileocecal valve.



A surgeon gently removes the exudative “peel” with a sponge while examining the bowel.

10. Identify the perforation and measure the location from the ileocecal valve for documentation and repair planning.



Decompress the small bowel by removing stool through the perforation. This facilitates pressure-free closure of the abdomen and removes traditional herbal remedies that have been administered previously, that might be harmful to the patient. The traditional medication usually causes hard and thick succus and can lead to delayed return of bowel function after surgery.

11. Perform full thickness debridement of any necrotic tissues at the edges of the perforation site and debride back to healthy bleeding mucosa.

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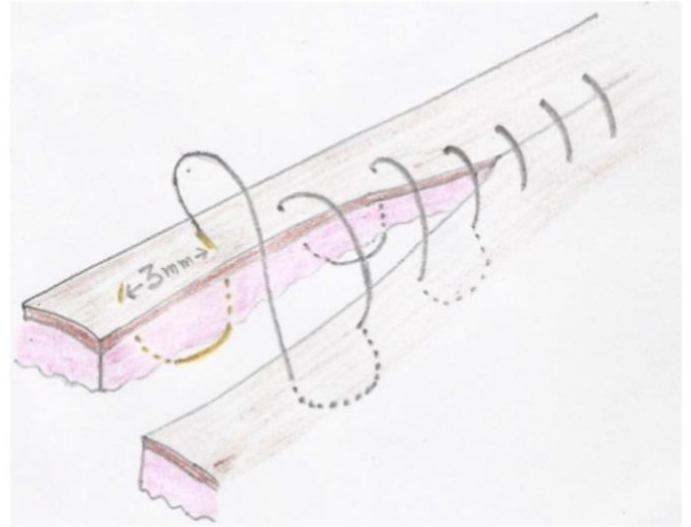
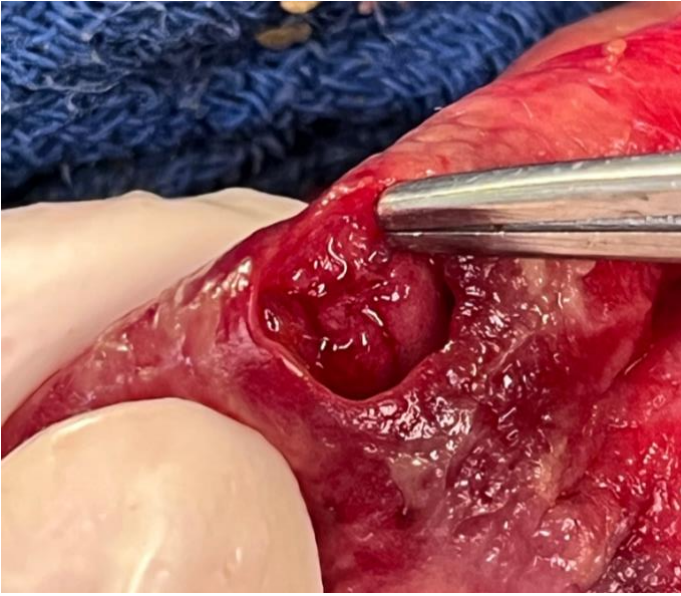
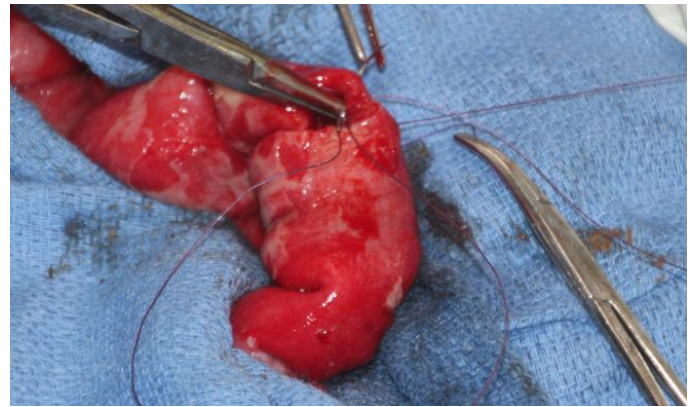


Diagram of a Connell stitch. Source: Pal M and Bandyopadhyay S, DOI: 10.4172/2329-9126.1000125



Closure of the perforation site in two layers, starting with a Connell running stitch

Dusky or necrotic tissue should be sharply debrided prior to closure.

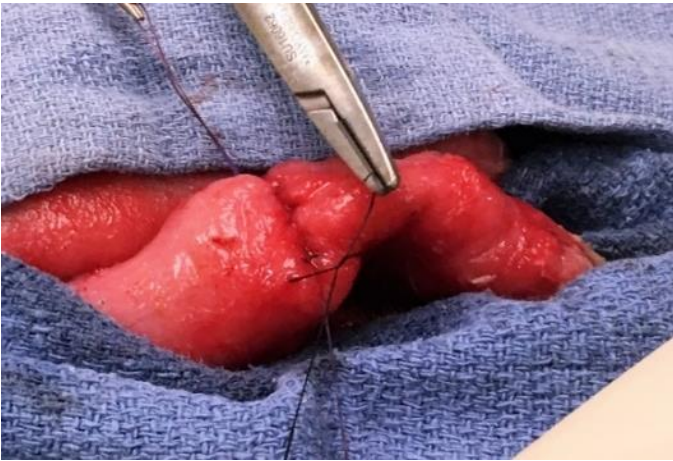
12. Repair the perforation in two layers. The first layer is repaired with a running absorbable 3-0 suture (such as Vicryl). We prefer the Connell stitch for this layer, as shown below. The repair is performed in a transverse orientation, not longitudinally, to avoid a stricture during healing.



Completed first layer of the closure

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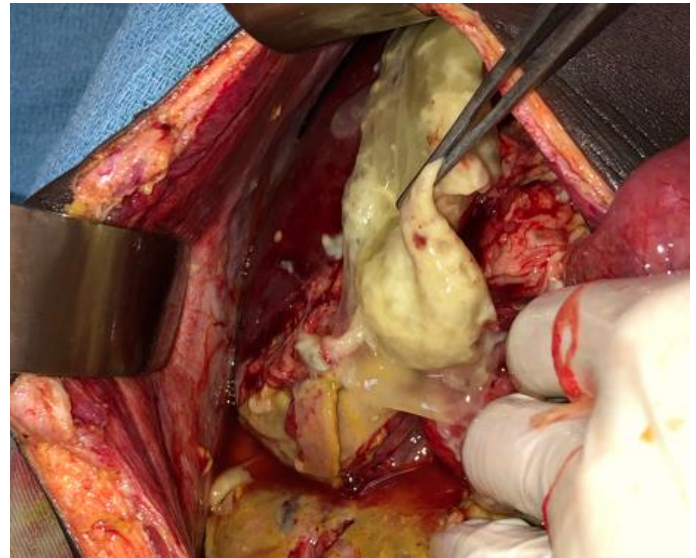


Adding a second layer using interrupted seromuscular (Lembert) stitches making sure not to enter into the mucosa.



Completed second layer

13. Irrigate the abdominal cavity quadrant by quadrant. We usually use multiple liters of warm normal saline. Make sure to clean well in the bilateral subdiaphragmatic spaces and remove exudative “peel” over the right and left lobes of the liver, to avoid reoperation for a subdiaphragmatic abscess. Make sure to extend your incision as necessary if you cannot visualize these spaces well for adequate source control.



Washing and removing exudative “peel” found superior and lateral to the liver



Irrigating the pelvis after primary repair and removing the exudative peel to prevent postoperative abscess formation.



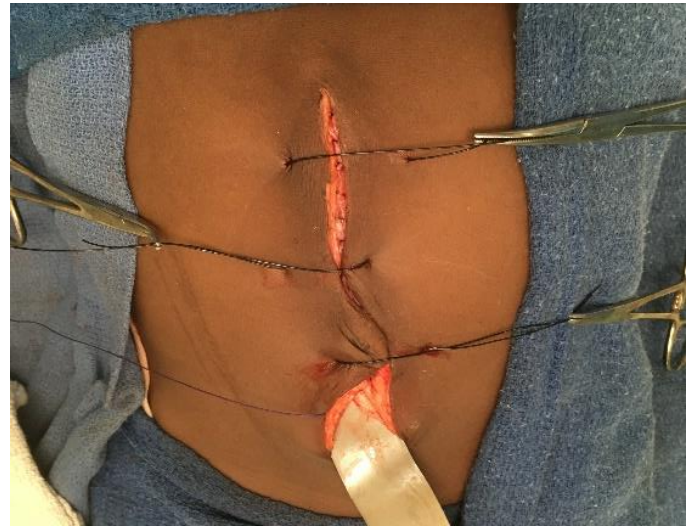
Irrigating the left upper quadrant. Be gentle when cleaning superior and lateral to the spleen to avoid bleeding.

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14. Make sure that the nasogastric tube is in a good position and that the stomach is decompressed before closing the abdomen, to decrease the risk of immediate postoperative aspiration.
15. Determine whether to return for further washouts of the abdomen if extensive purulent or succus contamination was seen at this first surgery. If further washouts are needed, close the skin only (not fascia) with a running nonabsorbable stitch (Nylon 3-0) and return within 48 hours. See the chapter on [Temporary Abdominal Closure](#).
16. If no additional operations are needed, close the fascia with slowly absorbing suture (such as PDS or in our center #1 Vicryl) and strongly consider placing retention sutures (1-0 Nylon) for those who have malnutrition or who have had multiple repeat washouts- both of these groups of patients are at risk of fascial dehiscence. See the chapter on [Closure of Laparotomy Dehiscence](#) for more details on full thickness retention sutures.

Sometimes a closed suction drain is placed if there is concern about a large amount of contamination in one particular quadrant. We do NOT routinely recommend a drain placed in each patient, as we cannot drain all the abdominal cavity, if all the abdominal cavity had purulence or succus. The key is large volume saline irrigation and meticulous attention to ensuring no major exudate and purulence is still present before fascial closure. If you do decide to place an abdominal drain, place it through the left abdominal wall as far lateral as possible, to allow future right lower quadrant ostomy placement if needed during a subsequent operation.



Simple horizontal external retention sutures placed, but not tied, while closing the fascia with a running stitch.



Final appearance of the skin after abdominal closure with running fascial suture supplemented with simple horizontal external retention sutures. We have found that latex urinary (Foley) catheter pieces often cause less skin damage than intravenous catheter tubing.

17. If need for a repeat washout was determined at the first surgery, the patient returns in 48 hours and there is close assessment of the repair site to ensure it is still intact without leak and that there are no new perforations or new areas of pre-perforation.
18. The patient will need to continue IV antibiotics for 7 days (ceftriaxone and metronidazole) and transition to oral antibiotics such as ciprofloxacin and metronidazole when tolerating an oral liquid diet. In areas where resistance to ciprofloxacin is high, consider substituting azithromycin.

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ILEOCECTOMY, END ILEOSTOMY, AND MUCUS FISTULA

Indications:

This procedure is recommended for those patients with multiple perforations (usually more than 3) or especially one close to the ileocecal valve with concern for viability of this tissue (usually within 3 to 5 cm of the ileocecal valve). Even one perforation close to the valve with high contamination and friable bowel would lead to consideration of an ostomy or a resection with anastomosis.

An anastomosis is not recommended in patients with any of the following: hemodynamic instability during the case, malnutrition (especially with a Z score ≥ -3 : See [Nutrition in the Surgical Patient](#)), high contamination, and/or friable tissue with multiple other pre-perforations.



Multiple small bowel perforations (arrows) with the most distal (Black arrow) too close to the ileocecal valve to undergo primary repair.

Steps:

1. The procedure is started the same as a primary repair (as described above).
2. Identify the extent of your resection of the small bowel making sure to look for not only full thickness perforations, but also pre-perforations that could later perforate.
3. Start with resection of the proximal small bowel working distally to the ileocecal valve.



Creating a "window" with a clamp in the mesentery adjacent to the planned proximal division of the small bowel



Dividing the proximal bowel between a non-crushing bowel clamp proximally (bottom clamp) and a heavy clamp (Kocher, top clamp) distally.

4. Divide the mesentery of the small bowel to be resected, starting at the divided bowel and proceeding to the ileocecal valve. Be sure to not go too close to the root of the mesentery, as there are often enlarged lymph nodes here and it can be difficult to have good tissue to ligate.

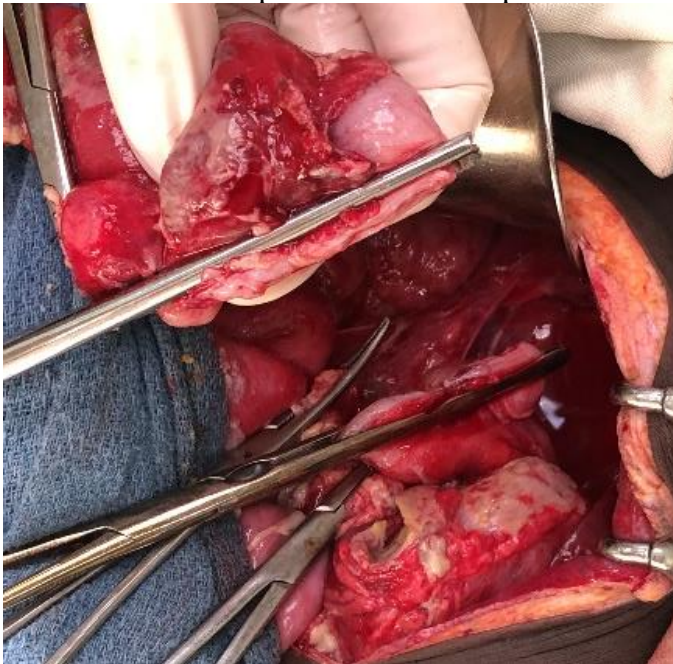
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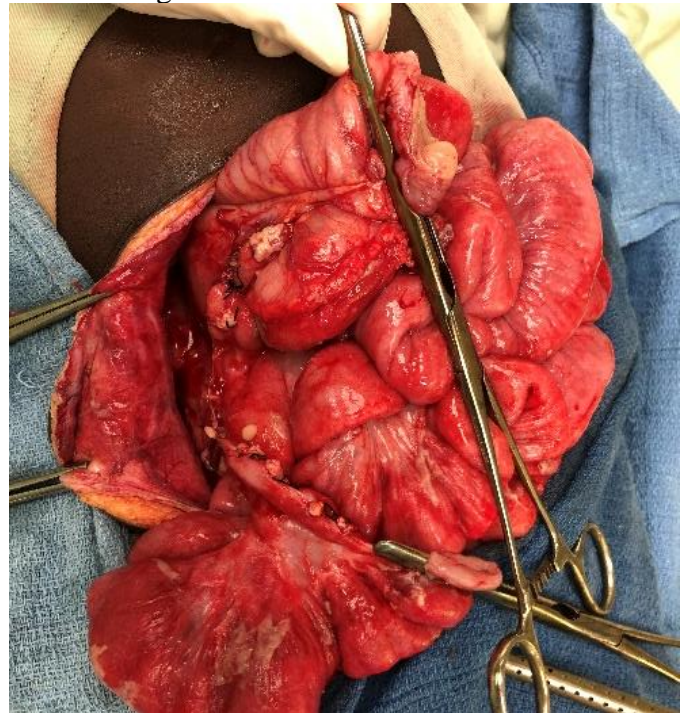
Dividing the small bowel mesentery down to the level of the ileocecal valve between clamps, then using ties to ligate the mesentery. Note that the division is close to the bowel, where the mesentery is less thickened with inflammatory lymph tissue.

5. Divide the ascending colon adjacent to the cecum, clamping and tying any remaining mesentery, and remove the specimen from the operative field.



The diseased ileum and cecum now removed. Non-crushing bowel clamps are on the distal ileum and the ascending colon, with hemostats on the small bowel mesentery.

6. Mobilize the end ileostomy and mucus fistula to be able to bring them through the abdominal wall without tension.
7. Create an opening in the abdominal wall to the right of the umbilicus for the end ileostomy and mucus fistula. We often do our ostomies at the lateral edge of the rectus or even lateral to the entire rectus just so that we have enough distance between the midline closure and the ostomy (especially in malnourished children, so there is enough room for retention sutures and packing of the skin if needed.) Creating the ostomy too close to the midline wound leads to difficulty in fitting the ostomy appliance and painful excoriation of the skin underneath it due to leakage.



Mobilization of the two divided ends of bowel. The ileum will usually reach the anterior abdominal wall without much dissection, but the ascending colon (in the upper non-crushing bowel clamp) usually needs to be mobilized further along its right retroperitoneal attachments.

8. Copiously irrigate the abdominal cavity, as it can be harder to irrigate after the ostomy is created.
9. Create an opening in the abdominal wall to the right of the umbilicus for the end ileostomy and mucus fistula. Sharply divide fascia and bluntly divide muscle to make a hole through the

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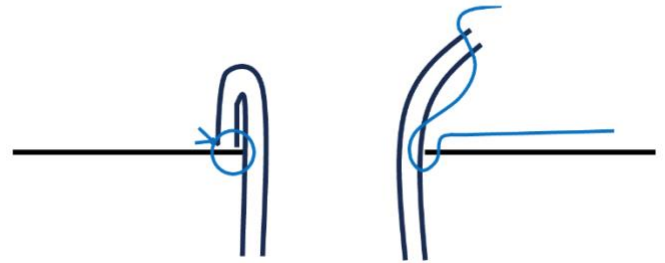
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abdominal wall. In an adult, this hole should easily admit two fingers.



Create an ostomy directly to the right of the umbilicus by grasping skin here and cutting horizontally just below the clamp. Note that we prefer the right mid-abdomen rather than the right lower quadrant, to allow the ascending colon mucus fistula to reach the site easily.

10. Pass both the terminal ileum and the ascending colon through the ostomy site. Both should sit easily in their location and not be under excess tension.
11. Close the fascia and skin of the midline incision, or the skin alone if performing a temporary abdominal closure.
12. Secure the stoma to the fascia of the abdominal wall with absorbable suture (3-0 Vicryl). Then “mature” both limbs of the stoma by suturing the mucosa circumferentially to the skin with interrupted absorbable sutures. The first four circumferential sutures evert the bowel and are placed as below:



For ileostomy maturation, the cut end of the small bowel is intentionally brought out 3-4cm above the level of the skin. Then, four sutures are placed at four corners of the ostomy. These are through the skin, then the serosa, then the mucosal edge, as shown above. The effect is to evert the ostomy so that it sticks 2cm above the skin level. This is especially important for an ileostomy, as the ostomy appliance can more easily be crafted to avoid contact between the enteric succus and the skin.



“Mature” the ostomy by suturing the edges of both limbs to the skin circumferentially, starting with four sutures as shown above.

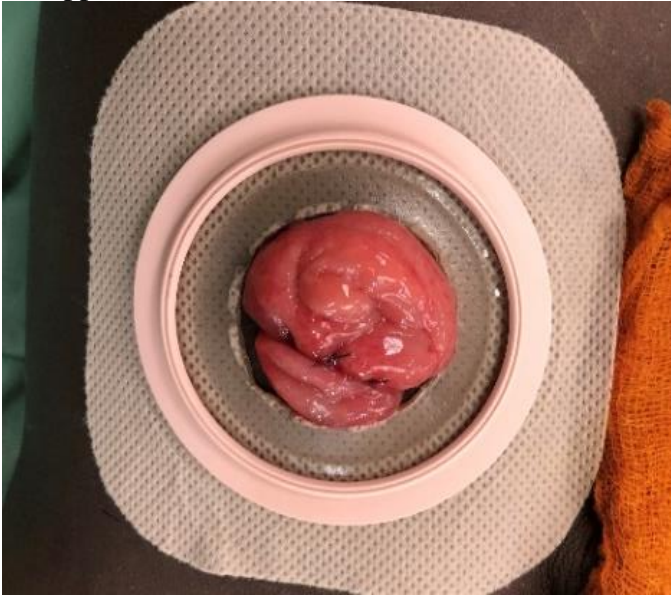
13. Cut and shape the ostomy appliance to fit the ostomy. Clean the skin thoroughly and make sure it is dry, then clean it again with alcohol and allow that to dry. If any moisture wants to leak out of the ostomy onto the skin, prevent it from doing so; these measures help the appliance to stick to the skin as much as possible.

If you are using a “wafer” and detachable bag, cut the wafer so that there is a small amount of space between it and the ostomy, so it does not “strangulate” the ostomy. Do not cut this hole too big, or else succus from the small bowel will come in contact with the skin and cause

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excoriation, making future placement of ostomy appliances more difficult.



Correctly sized ostomy wafer, with minimal space between the cut edges and the ostomy itself.

Ostomy creation and management of output can be very challenging, especially for patients with limited resources. Use loperamide to thicken the ileostomy output and oral rehydration solutions to replace fluid losses from an ileostomy.

Pitfalls:

- **Anastomotic Leak:** At the initial operation, do not attempt a primary repair or an anastomosis in a patient with malnutrition, high levels of contamination, or inflamed and friable bowel. If any of these are present, an anastomotic leak is likely to develop even with excellent surgical technique. This is not the same scenario as operating on a young healthy patient with a traumatic small bowel perforation.



Anastomotic leak after ill-considered primary bowel anastomosis for typhoid perforation.

These patients will present with their leak either acutely with postoperative peritonitis (often with a fascial dehiscence) or with a more delayed enterocutaneous or entero-atmospheric fistula. **Absolutely do not** attempt another primary repair or resection with another anastomosis, or just adding additional sutures over the leak. Proceed with an ostomy. See [Recognizing Postoperative Intra-Abdominal Sepsis](#) and [Management of the Open Abdomen and Enteric Fistula](#) for more on decision-making and management in these difficult situations.



Malnourished patient with an entero-atmospheric fistula who presented to our hospital after attempt at anastomosis at another hospital. Note also that the original abdominal incision was likely not large enough to adequately perform the steps

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outlined in this chapter, including complete assessment and mobilization of the bowel and thorough inspection, irrigation and debridement.

- Intraabdominal Abscess: Make sure to irrigate the abdominal cavity well, especially in the subdiaphragmatic area. If inflammatory exudate and succus are left behind, these may act as a nidus for an abscess to develop in the future.



Left upper quadrant postoperative abscess with purulent drainage superior and lateral to the spleen.

- Fascial Dehiscence: Make sure to consider reoperating on a patient who develops a fascial dehiscence within the first two weeks of surgery. Often there is an underlying abscess or leak in these patients. The dehiscence can lead to an increased risk for an enterocutaneous fistula if treated non operatively. In malnourished patients, place retention sutures pre-emptively during fascial closure, as described above.



Fascial dehiscence (despite placement of a few retention sutures) with loops of exposed bowel in the wound. Note also the closeness of the ileostomy to the midline wound: as described in the text, this would make the ostomy appliance more difficult to fit and potentially expose the skin or wound to enteric succus.

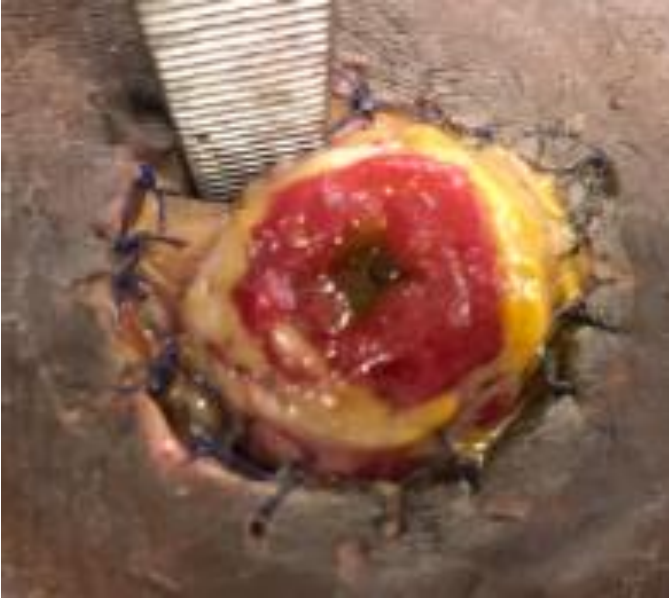
- Ostomy complications: Make sure to leave enough length on the end ileostomy or mucus fistula to ensure healthy perfused ostomies. The mucus fistula may be either small bowel or colon, depending on what part of the bowel was resected, but under all circumstances it must pass through the abdominal wall without being strangulated and reach the skin without tension. Make sure to examine the ostomy every day to ensure that it is pink and viable, and that there is no dehiscence of the skin around the ostomy.



Ischemia of the mucus fistula. Make sure to consider causes such as: excess tension, devascularization during mobilization, ischemia related to pressors for severe sepsis, or a defect in the muscle that is too tight.

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Dehiscence of the ostomy, with the potential for succus to enter into the subcutaneous space (causing cellulitis or subcutaneous abscess) or into the abdominal space (causing intra-abdominal abscess).

Photo credits: Dr. Brad-lot Igiraneza, Issiakou Boube, Dr. Katherine Shafer, Dr. Andrew Avery, Dr. Gracious Sankhulani

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