13 Acute and Long-Term Surgical Management of the Spinal Cord Injury Patient

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Introduction

One quarter of the 2.5 million injured Americans who required hospitalization in 2013 required post-acute care rehabilitation services [1]. Many injured patients have ongoing medical needs that require prolonged hospital stays even when stable enough to progress to the recovery phase of care. Though this experienced functional decline is due primarily to traumatic injury, prolonged immobilization in the hospital, inadequate nutrition, and procedural and infectious complications increase patient debility and lengthen recovery time. The importance of early mobilization is being recognized and instituted not just in the acute care areas but in the intensive care units as well. Therefore, a better understanding and increased familiarity with early procedures and associated appliances are important for the safe treatment of the injured patient.

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Damage Control Surgery

Damage control surgery describes initial non-definitive treatment of traumatic injuries in unstable patients who may only tolerate an abbreviated operation [2]. This type of intervention has been shown to increase survival by decreasing initial stressors, avoiding worsening coagulopathy and allowing time to adequately resuscitate the patient before definitive treatment [3]. Damage control surgery generally applies to control of hemorrhage and contamination of intra-abdominal injuries, but the same principles can apply to intrathoracic and extremity injuries.

Some indications for damage control laparotomy include abdominal compartment syndrome, perforation, or intra-abdominal or pelvic vascular injuries. After the initial procedure, the abdominal cavity is left open with a negative-pressure vacuum dressing to prevent abdominal compartment syndrome during the resuscitation period. Definitive repair of injuries is performed once the patient is stabilized. The abdomen is either closed primarily within a week of the initial operation, or a delayed closure with split-thickness skin graft over exposed viscera can be performed in a few weeks with formal repair of the ventral hernia performed in 6 months to 1 year [3].

With the use of commercially available portable vacuum dressings, there is less concern for evisceration. This allows for earlier extubation and quicker mobilization with participation in physical therapy. It is important to make sure

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the vacuum dressing has little or no leak so that the dressing remains intact. These temporary abdominal closure methods are associated with long-term risks, such as enterocutaneous (EC) fistula, although this is more likely to occur with graft material than a vacuum dressing or silo bag alone [3].

Enterocutaneous and Enteroatmospheric Fistulas

A fistula is an abnormal connection between two epithelialized surfaces. In an enterocutaneous (EC) fistula, the bowel is connected to the epidermis, and stool contents drain from the skin surface (Fig. 13.1 – enteroatmospheric fistula (EAF)). The majority of EC fistulas occur postoperatively, while a small portion present after radiation therapy or from inflammatory changes [4]. In a patient with an EC fistula, some important considerations are control of ostomy output, maintenance of patient nutrition, and proper wound care.

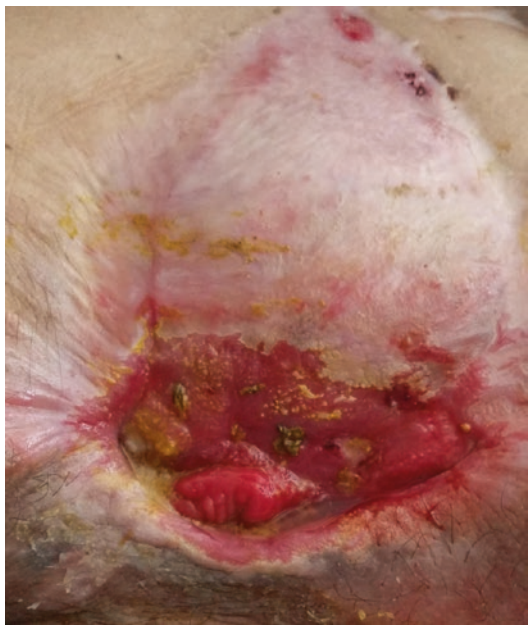

Fig. 13.1 Enteroatmospheric fistula – a section of small bowel is visible protruding through the lower pole of the abdominal wound

Once an EC fistula is diagnosed, usually within the first week postoperatively, drainage should be recorded to allow for proper resuscitation. A high-output fistula, draining >500 cc/day, puts the patient at greater risk of malnutrition and electrolyte imbalances, eventually requiring nutritional support [5]. Parenteral nutrition (PN) has been shown to result in increased rates of fistula closure compared to enteral nutrition (EN), although enteral nutrition (EN) is the preferred route as long as fistula output does not significantly increase once EN is begun [6]. Local wound care is important to protect the skin in preparation for surgical closure. The bowel effluent contains bacteria, digestive enzymes, and bile, which can cause skin breakdown around the fistula. Stoma barriers and creams are very helpful in protecting the skin around the fistula site, and the use of negative-pressure wound dressings has allowed for contained control of the drainage.

Although spontaneous fistula closure may occur, a fistula arising from the proximal gut, with a short tract of < 2 cm or a large skin defect of > 1 cm, is less likely to close spontaneously and may require operative closure. Patients with abscesses, inflammatory bowel disease, foreign body, or malnutrition are also more likely to require operative closure. Generally, colonic EC fistulas will close within a month, and small bowel EC fistulas may take up to 2 months to close [5]. If closure does not occur within this time, the patient should be optimized for surgical closure of the fistula with a procedure similar to an ostomy reversal. Continued optimal nutrition is important to allow for healing of the new wounds and preventing fistula recurrence.

Ileostomy and Colostomy

Stomas of the colon (colostomy) or small bowel (ileostomy) are created for fecal diversion or as a permanent orifice for the passage of stool. In the setting of trauma, a stoma may be used for temporary diversion if the bowel is perforated with intra-abdominal fecal contamination. This is performed as an end colostomy, where the rectum is

stapled off and the segment of colon is brought to the skin surface (Hartmann's procedure), or as a loop ileostomy/colostomy, where a loop of bowel is brought up through the incision in the abdomen. An end ostomy has one lumen, whereas a loop ostomy has two lumens within the same stoma site (Fig. 13.2a, b). A red rubber catheter is initially placed between the lumens to maintain external positioning. With a loop ostomy, the afferent limb stoma is maintained for stool output, while the efferent limb stoma is connected to the distal bowel without expected output. After dissection of the abdominal wall is performed and the segment of bowel is everted, the enterocutaneous anastomosis is performed. The bowel should appear pink and viable extruding a few centimeters above the skin edge once the ostomy is completed [7].

The ostomy should begin to produce gas and stool within a few days after the operation. Early stoma-related complications include high output, obstruction, and ischemia. A high-output stoma, producing greater than two liters per day, is more common with an ileostomy than a colostomy [8]. Patients should be evaluated for signs of dehydration, and electrolytes should be regularly monitored during the first few weeks postoperatively. Patients may be started on antimotility agents such as loperamide or opiates such as a tincture of opium to slow gut transit. In addition, medications to reduce stomach acid production or bile acid-binding resins may be helpful in decreasing output [9]. Early obstruction can occur when the fascial incision for the stoma is too small, causing the rectus muscle to contract around the bowel. This is diagnosed clinically by inability to digitalize the ostomy and usually requires reoperation.

Other late complications include peristomal skin irritation due to a poor fitting appliance, peristomal hernia, prolapse, stenosis, and complications related to small bowel obstruction after surgery. Parastomal hernias may be managed conservatively with a belt appliance or repaired surgically with or without mesh, although recurrence rates are high. A prolapsed stoma will be evident by protruding mucosa beyond the usual stoma site and should be easily and gently reduced. If there is edema of the mucosa and a prolapsed stoma appears incarcerated, the use of

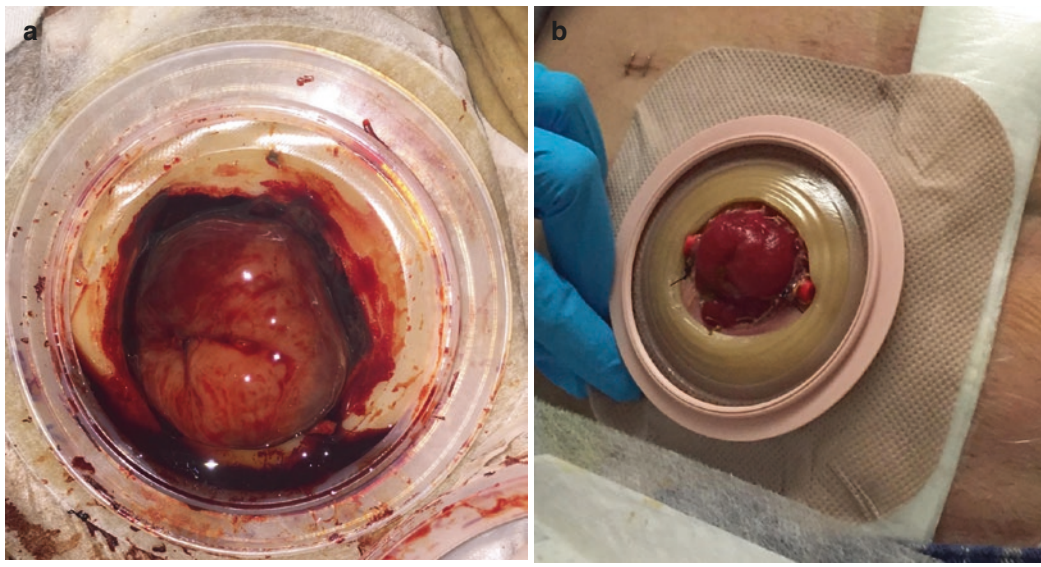

Fig. 13.2 (**a**) Colostomy – sigmoid colon anchored to the abdominal wall, pictured postoperative day one with mild edema and a small hematoma. (**b**) Loop ileostomy – a loop of small bowel has been brought out through an abdominal incision with a red rubber catheter in place; the catheter helps keep the ostomy elevated in the early postoperative course. The larger afferent limb and smaller efferent limb are in the superior and inferior positions, respectively

sugar on the mucosa to draw out excess fluids and allow for reduction has been shown to be effective [10, 11]. Bleeding from the stoma site may occur with minor trauma to the tissue, but bleeding may also be related to parastomal varices. Minor bleeding may be managed with light pressure, although significant bleeding may indicate erosion into a larger vessel and a surgical emergency. Bleeding or mucous discharge from the rectum associated with abdominal or perianal pain after a colostomy may be a sign of diversion colitis. This is treated with short-chain fatty acid enemas and earlier reversal if possible. Bowel obstruction should be suspected if a patient stops producing gas and stool from the ostomy and begins to complain of abdominal pain and bloating. In this case, a CT scan with oral and intravenous contrast should be obtained, and the patient should be prepared for inpatient admission if obstruction is evident. In general, ostomies are reversed no earlier than 3 months after creation or last intra-abdominal surgery.

Nutrition

Because the body is in a hypercatabolic state after trauma, it is important to maintain optimal nutritional support for wound healing and immune function. Non-oral nutrition is recommended if the patient is in a malnourished state at baseline or is expected to be without nutrition for longer than 1 week. Nutritional needs will be determined based on pre-injury nutritional state and stress level. When the gastrointestinal tract is functional and safe to use, enteral nutrition (EN) is preferred over parenteral nutrition (PN). EN is more efficiently utilized by the body due to first-pass metabolism in the liver and helps support the functional integrity of the gut. However, parenteral nutrition may be used when enteral feeding is not tolerated, as with a mechanical bowel obstruction, severe gastrointestinal bleeding, short gut syndrome, or a proximal enterocutaneous or enteroatmospheric fistula [12].

When the patient is unable to tolerate oral feeding, enteral nutrition may be administered through a nasogastric, nasojejunal, gastrostomy, or jejunostomy tube. Generally, nasogastric or nasojejunal tubes are used as a temporary measure until the patient is able to take in oral nutrition, e.g., patients with altered mental status or dysphagia. For patients who are expected to take no oral nutrition for 4 weeks or more, placement of a gastrostomy or jejunostomy tube is recommended [13]. This may include patients with neurological disorders such as stroke or traumatic brain injury, patients presenting after significant trauma, with cancer or recent surgery of the upper gastrointestinal tract [7]. A gastrostomy tube is sufficient for most patients, but a jejunostomy tube is preferred in patients requiring post-pyloric feeding due to injury or gastroparesis (Fig.13.6, Fig 13.7).

Enteral access procedures can be performed in a variety of settings, including at the bedside, in the endoscopy or interventional radiology suite, or in the operating room. The options for long-term feeding tube placement include laparoscopic or open gastrostomy or jejunostomy tube placement, percutaneous endoscopic gastrostomy (PEG) tube placement, and laparoscopic-assisted PEG tube placement (Fig. 13.3a, b). Open or laparoscopic gastrostomy and jejunostomy feeding tubes allow for fixation of the bowel wall to the anterior abdominal wall (see Box for procedure details). While a PEG tube is the preferred method, anatomic considerations may require open or laparoscopic techniques. After the procedure, the tubing is left to drain, and feedings are gradually begun the next day. The tubing should not be changed for 4–8 weeks to allow time for an epithelialized tract to form. When the patient recovers and feeding assistance is no longer needed, the tube can be removed, leaving the tract to granulate and heal.

Nutrition and electrolytes should be assessed while the patient is receiving enteral or parenteral nutrition. Early complications include surgical site bleeding and tube dislodgement, both of which require urgent surgical consultation. If tube dislodgement occurs after the 4 weeks, it can be carefully replaced with a Foley or red rubber catheter and intraluminal placement confirmed with radiologic contrast study.

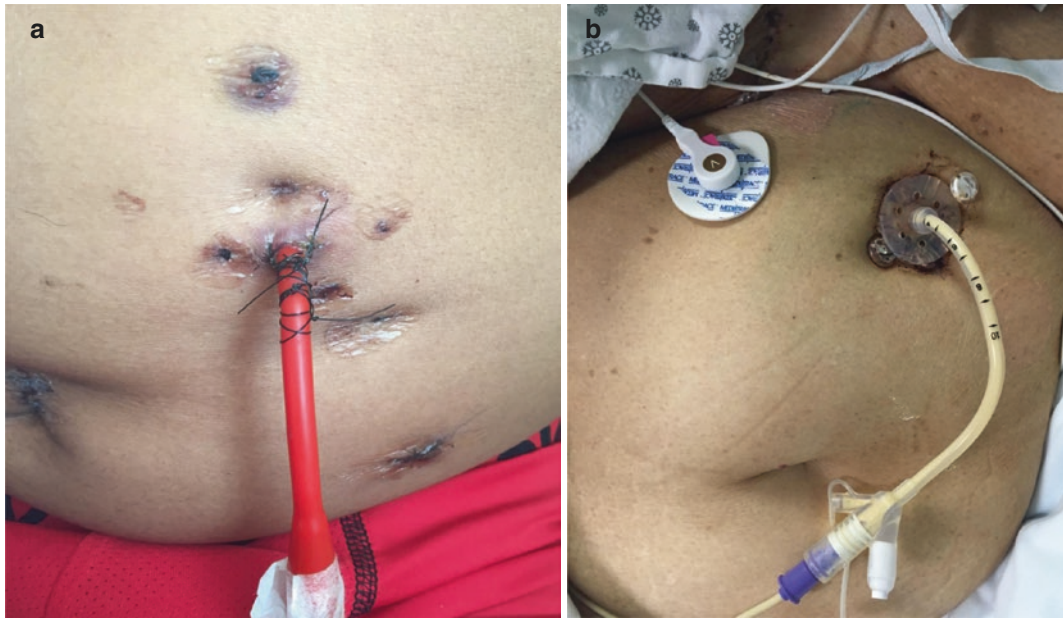

Fig. 13.3 (**a**) Jejunostomy tube – external tubing after a laparoscopic jejunostomy tube placement. (**b**) PEG tube – external tubing from a percutaneous endoscopic gastrostomy tube

Procedure in Details

1. Gastrostomy tube placement – Two concentric purse-string sutures are placed near the greater curvature of the stomach, and a gastrostomy is made in the center. The gastrostomy tubing is advanced through a small skin incision into the gastrostomy site, and the balloon is inflated. The purse-string sutures are tightened, cinching gastric mucosa around the tubing. The stomach is then anchored to the anterior abdominal wall at four points. The gastrostomy tubing is then secured to the skin.
2. Jejunostomy tube placement – The purse-string sutures are placed in an area 30–45 cm distal to the ligament of Treitz. The enterotomy is made on the antimesenteric side of jejunum, and a red rubber tubing is inserted through a small skin incision into the enterotomy. The purse strings are tightened, and a serosal tunnel of a few centimeters is created around the tube to secure it in place, and the site is then sutured to the abdominal wall with nonabsorbable sutures.
3. PEG tube placement – Endoscopic gastrostomy is performed, and the stomach is insufflated to appose the anterior abdominal wall. A small skin incision is made, and the Seldinger technique is used to percutaneously introduce a needle and wire into the gastric lumen. The wire is grasped with the endoscope and extracted through the patient's oral cavity as the endoscope is removed. The gastrostomy tubing is tied to the wire, which is pulled through the skin incision until the bumper sits just abutting the gastric mucosa. An anchor is placed around the gastric tubing and secured to the skin [3].

Other complications after gastrostomy tube placement include infection or bleeding around the tubing site, "buried bumper" syndrome, ulceration or peristomal leakage, and gastric outlet obstruction [14]. A relatively common feeding tube problem is blockage of the tubing, which occurs more often with jejunostomy tubes. The first step in management is flushing the tube with warm water, carbonated beverages, juices, or an enzymatic solution. If this fails to unclog the tube, mechanical unclogging may be performed at the bedside with an approved device. To prevent blockage, the tubing should be flushed with 15–30 cc of water prior to and after each use, and all medications should be given as liquids or crushed thoroughly prior to administration.

Gastric outlet obstruction may be suspected when a patient complains of abdominal pain and nausea with emesis. In this case, the gastrostomy tube should be placed to gravity to allow stomach contents to drain. There are commercially available gastrostomy–jejunostomy (G–J) tubes so that the jejunostomy tube can be used for feeding, while the gastrostomy tube is used for gastric decompression. "Buried bumper" syndrome occurs when the inner bumper becomes impacted between the gastric wall mucosa and the skin. This may lead to infection or necrosis and can be managed endoscopically or surgically. To help prevent buried bumper syndrome, ulceration, or peristomal leakage, the distance markers along the tubing should be used to ensure that there is not undue tension or too much slack in the appliance. In general, these markings are at 2–3 cm at the skin, but this length can vary depending on the depth of a patient's abdominal wall thickness. Marker placement should be confirmed with the physician performing the tube placement.

Wound Complications

Wound complications after surgery range from a benign seroma to a life-threatening necrotizing fasciitis. A seroma is a clear, yellow fluid composed of liquefied fat, lymphatic drainage, or serous fluid. Procedures with large skin flaps and deep soft tissue pockets, such as axillary or groin dissection, mastectomy, or mesh repair, may be prone to developing seromas. Clinically, this appears as a small, localized swelling near the incision site. A seroma may be left alone, and the body will resorb the fluid, or the collection may be sterilely drained. A pressure dressing and the use of drains can prevent a seroma from recurring [6].

A hematoma is a collection composed of blood rather than serous fluid. Hematomas are more prone to infection and may be caused by inadequate hemostasis, coagulopathy, or trauma to the wound. After a trauma, wounds may be more prone to developing hematomas due to coagulopathy from cellular dysfunction, inflammation, or factor consumption. Unlike seromas, hematomas can expand rapidly in a small compartment leading serious complications, such as airway compromise or abdominal compartment syndrome. In patients with suspected hematomas, a complete blood count, prothrombin time/international normalized ratio, partial thromboplastin time, and type and screen should be assessed. Patients may need to go back to the operating room for exploration and washout of the wound and control of hemostasis [6].

Wound dehiscence is a serious complication following large abdominal procedures with fascial repairs. Abdominal musculoaponeurotic layers separate with concern for impending evisceration of abdominal contents. A patient is most prone to develop wound dehiscence 7–10 days after an operation, and dehiscence may be more likely to occur after an emergent operation in the setting of trauma (Fig. 13.4). Other risk factors include hematoma, infection, technical error, steroid use, obesity, and malnutrition. The classic sign of dehiscence is drainage of clear, salmon-colored fluid from the wound. If wound dehiscence is suspected, the wound should be covered with gauze and the operating team called to the bedside. It is possible to treat a small area of dehiscence with local wound packing. However, if eviscerated intestines are noted, a sterile saline-moistened gauze should be placed over the contents, and the patient should be taken immediately to the operating room for further management [6].

Fig. 13.4 Wound dehiscence – fascial separation with exposed bowel is seen in this midline incision after an open colon resection

Fig. 13.5 Vacuum-assisted dressing – midline abdominal wound with vacuum dressing to suction

Despite efforts by operating room staff and surgeons to reduce the incidence of surgical site infection (SSI), there is a risk for infection after any procedure. In trauma operations, this risk may be higher due to emergent procedures performed in a non-sterile setting. In addition, operations in a trauma setting may already be classified as dirty and more prone to developing SSI. With a scheduled operation, smoking cessation, corticosteroid weaning, proper blood glucose control, and adequate nutrition can help with wound healing, immunity, and prevention of SSI.

Surgical site infections usually present within a week of the operation with erythema, edema, pain, or purulent drainage from the wound. If an SSI is suspected, skin staples or sutures may be removed at the bedside with careful probing of the wound. If cellulitis or systemic signs of infection are present, empiric antibiotics are started. Crepitus, gray dishwater-looking fluid, or rapidly expanding necrosis of the fascial layer indicates necrotizing fasciitis, and emergent surgical debridement should be performed. Any infected wound should be left to heal by secondary intention or delayed primary closure.

Treatment of SSIs requires local wound care after removal of skin staples/sutures. With a small wound, wet-to-dry dressings are applied to assist in debridement of the wound with each dressing change. Gauze dressing is lightly moistened with saline and packed loosely into the wound. Dry gauze dressing is then placed over this to help absorb any excess drainage and prevent the skin from breakdown. When the wound is larger or deeper without signs of active infection, a vacuum-assisted dressing may be beneficial, e.g., KCI V.A.C.® dressing. With this dressing, a sponge is cut to fit the wound cavity and covered by a watertight dressing, allowing continuous negative pressure on the wound (Fig. 13.5). This keeps the outer skin dry with constant evacuation of drainage while promoting angiogenesis and granulation of the wound. Dressing changes occur every 3–5 days, and devices are portable allowing for mobilization and active participation in rehabilitation therapy. In a superficial wound with little drainage, nonstick dressings, like Adaptic® or

Xeroform, may be used to prevent debridement and painful dressing changes while also having antibacterial properties.

Surgical Drains

Surgical drains are used to remove or prevent fluid collections after surgery. Most drains used in surgery are closed drains with tubing connected to a suction device or bag. Active drains are connected to self-suction or wall suction. Passive drains work by means of gravity or pressure differentials. Either type of drain should be stitched in place and the output closely monitored. Drains are very effective but may also be linked to postoperative issues such as infection or inefficient drainage. A sudden increase in amount or character of drainage could be concerning for infection, and a sudden decrease in output could indicate the tubing is clogged. Dressings around drains should be changed daily to prevent surrounding infection.

There are many types of surgical drains. The most commonly used systems are Jackson-Pratt (JP), Blake®, Penrose, and pigtail drains. JP drains are under continuous self-suction with a low-negative-pressure system. They are most commonly used because they contain small fenestrations, preventing intra-abdominal contents from being sucked into the tubing. Uncapping the plug, squeezing the air out of the bulb, and recapping it create suction. When output is sufficiently decreased, removal of the drain requires uncapping the plug to release suction, cutting the suture at the skin level, and slowly withdrawing the tubing.

Blake® drains are connected to a similar suction bulb, but they have a large-diameter single-hole suction at the end of the drain. Penrose drains are a soft rubber tubing which is sutured in a wound to allow passive drainage [15]. These can be slowly withdrawn over time or pulled when the drainage is significantly decreased. Pigtail drains are long thin catheters with locking fenestrated tips, which curl once inserted. Pigtail drains are always placed, usually by interventional radiologists, in order to reach small cavities or lumens. In order to remove the pigtail catheter, the string on the outside must be cut to release the curl of the inner catheter and allow for a smooth withdrawal. If at any time a drain is unintentionally removed, the managing surgeon should be notified.

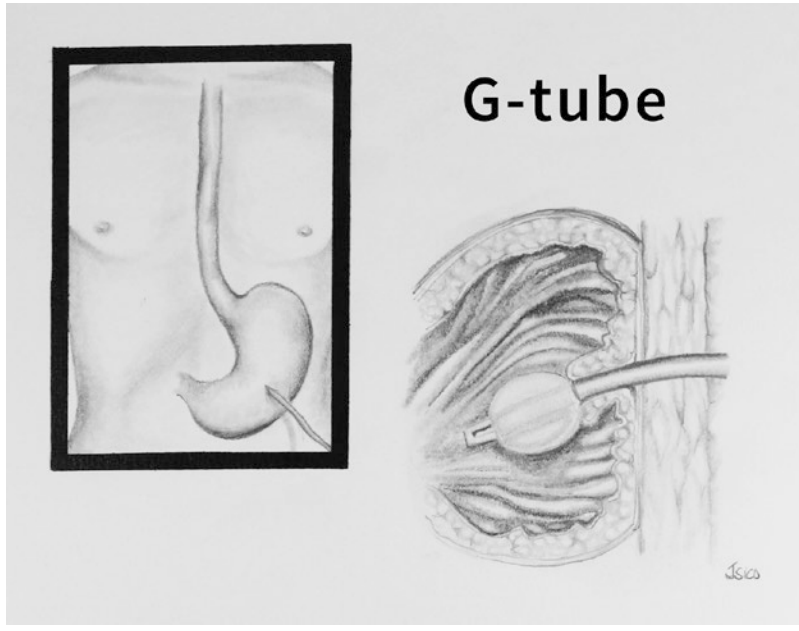

Fig. 13.6 Gastrostomy feeding tube

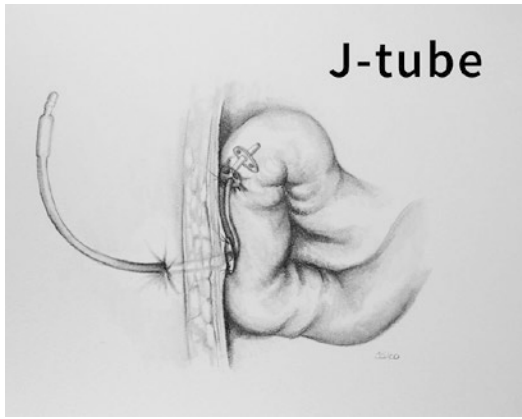

Fig. 13.7 Jejunostomy feeding tube

Compartment Syndrome

Compartment syndrome is a consequence of increased pressure in a confined space, limiting blood flow and leading to ischemia of vital tissue. The sequelae can be devastating if not diagnosed in a timely manner. Compartment syndrome most commonly presents after fracture of an extremity, but it may present after blunt trauma, arterial injury, reperfusion injury, prolonged malpositioning, and crush or burn injury. It can also present very late after a patient's injury if a cast is ill-fitting.

The symptoms of compartment syndrome are pain, pallor, paresthesias, pulselessness, paralysis, and poikilothermia (coolness on palpation). If the extremity or compartment feels tense or the patient complains of tenderness upon palpation or with passive movement, there should be concern for impending compartment syndrome. Sensory deficits may be present early on, while pulselessness and pallor are very late findings. Generally, compartment pressures greater than 30 mmHg are considered concerning for compartment syndrome and require fasciotomy to prevent permanent muscle and nerve damage. There are many needle and catheter devices to measure compartment pressures, but these may not be necessary once a clinical diagnosis is made.

The treatment for compartment syndrome is fasciotomy, and the techniques vary based on the extremity involved. The goal of fasciotomy is to open up the fascial layer in all compartments to relieve the underlying built-up pressure. In the lower extremity, a four-compartment fasciotomy usually involves a single- or double-incision technique to release the anterior, lateral, deep posterior, and superficial posterior compartments [16]. The incisions are left open, and viability of the muscles and tissues are determined in the coming days. Wet-to-dry dressings are applied during this time, and the patient is brought back to the operating room for debridement after a couple of days. Delayed primary closure, split-thickness skin grafting, and healing by secondary intension are all options for closure of the fasciotomy wounds. Rotational flaps may also be necessary to cover vital structures prior to skin closure. When the wound is left to heal by secondary intention, wound vacuum devices may be used to assist in wound healing. If compartment syndrome is diagnosed and treated in a timely manner, usually within the first six hours, the extremity should heal and regain full function.

Tracheostomy

Many studies have looked at benefits of early tracheostomy within 4 days of admission compared to late tracheostomy in critically ill patients. Data has not shown a significant difference in 30-day mortality or secondary outcomes, including length of sedation, antibiotic use, or time in the intensive care unit [17]. However, many practitioners believe early tracheostomy in patients requiring long-term mechanical ventilation does have clinical benefits.

Indications for tracheostomy placement include ventilator dependence, airway obstruction from angioedema, burns, traumatic obstruction, neoplasm, laryngeal dysfunction, neck irradiation, or neurologic injury inhibiting a patient from protecting his/her airway [18]. The expected length of time a patient will require intubation is often the determining factor for performing tracheostomy. Frequently, a tracheostomy is performed within 7 days of intubation if the expected time of intubation is greater than 2

weeks. Some advantages to a tracheostomy are increased patient comfort, decreased need for ventilator dependence, and decreased risk of subglottic or laryngeal stenosis compared to intubation. There are few contraindications to performing a tracheostomy, but surrounding infection or distorted anatomy may increase the risk of the procedure [19].

A tracheostomy can be performed via open or percutaneous technique. A 2–3-cm incision is made about 2 cm above the sternal notch while the patient's neck is extended. When performed percutaneously, the Seldinger technique is applied. In this technique, a needle is used to access the trachea, a guidewire is then passed through the needle, and serial dilations are performed until a tracheostomy tube can be advanced over the wire. In an open technique, the platysma and strap muscles are dissected and divided to directly visualize the trachea, an incision is made between the second and fourth tracheal rings, and a tracheostomy appliance is inserted [19].

One of the most concerning complications after tracheostomy is accidental decannulation of the tracheostomy tube within the first week, before the tract has epithelialized. If this occurs, the patient should be placed in a recumbent position with a bump under the neck to keep the airway open, while supplies for re-cannulation are obtained. For this reason, spare supplies should always be kept at the patient's bedside. Other early complications include surgical site bleeding and obstruction of the inner cannula. For surgical site bleeding, the primary surgical team should be notified, while suctioning is performed and pressure applied. If the inner cannula is obstructed, it should be removed, while the patient is oxygenated and ventilated through the tracheostomy.

Other complications of tracheostomy include stoma site infection or stricture from ischemic necrosis at the cuff site, due to high cuff pressures or an oversized tube. Stridor, wheezing, or signs of airway obstruction may indicate tracheomalacia, where the airway collapses on expiration leading to air trapping, retained secretions, recurrent infection, or respiratory failure. Tracheoesophageal fistula is a rare complication of tracheostomy associated with high cuff pressures or simultaneous nasogastric tube placement, which can be diagnosed by CT scan or barium swallow. An even rarer complication, tracheo-innominate fistula, may occur within the first few weeks of placement after a low tracheostomy incision. It should be suspected if a pulsating tube or small bleed is evident, and the cuff should be inflated or a finger placed into the stoma to occlude the bleeding site against the sternum [20, 21].

When a patient without upper airway obstruction no longer requires mechanical ventilation or frequent pulmonary toilet, the patient is likely ready for decannulation. A capping trial may be performed for 24 h prior to decannulation, while oxygen saturation and breathing are monitored. After decannulation, the patient should be monitored for another 24 h, while the stoma site is covered with an occlusive dressing and left to heal.

Acute Abdomen in Spinal Cord Injury Patients

Diagnosis of an acute surgical abdomen relies on clinical exam, which is difficult in patients with spinal cord injury (SCI), especially those with high-level injury or complete transection. Severe pain, tenderness, rebound, and fever may all be absent in these patients, delaying diagnosis and management. Some signs of an acute abdominal injury in SCI patients include autonomic dysreflexia and referred shoulder pain due to irritation of the diaphragm. Abdominal distention is still very important to monitor, and increased distension with or without rigidity, nausea, or vomiting may be the only sign of a concerning intra-abdominal process in these patients. While autonomic dysreflexia is a common response to noxious stimuli in SCI patients, it should be a warning sign in those patients with concern for abdominal injury after trauma or bowel perforation from chronic constipation or stress ulcers after a long, immobile hospitalization [22].

In a study looking at paraplegic or quadriplegic patients, it was determined that the correct diagnosis was made 77 % of the time by radio-

logic studies rather than history and physical exam. The most common presenting signs or symptoms were abdominal pain in the low-cord lesion patients, abdominal distension, shoulder pain, fever, and less commonly autonomic dysreflexia with hypertension, headaches, diaphoresis, and arrhythmias. The most common diagnoses were biliary-associated infections (e.g., acute cholecystitis), perforated ulcers, renal diseases, and other gastrointestinal pathology. It is recommended that an abdominal plain film is obtained as an initial diagnostic test, followed by an ultrasound to evaluate the hepatobiliary system or any obvious abscesses, and a CT scan if necessary thereafter. A low threshold to obtain imaging or take the patient for a diagnostic laparoscopy should be maintained in SCI patients [23].

Although spinal cord injury patients may suffer from constipation, impaction was noted to be a less common cause of acute abdomen in these patients. In any patient with a history of constipation presenting with an acute abdomen, the diagnosis of stercoral colitis should not be overlooked. In general, these patients present with severe constipation and an inflammatory process, often progressing to septic shock. The diagnosis is made on CT scan with evidence of a large fecaloma and proximal colonic dilatation. Wall thickening and fat stranding are often present with this diagnosis, and mortality rates are high even with prompt diagnosis. A low threshold to obtain a CT scan should be maintained if stercoral colitis is suspected [24].

Summary

After traumatic injury or surgery, patients may require continued care and rehabilitation despite completion of acute medical care. Postoperative nutrition, wound care, and prevention of infection and procedural complications need to be monitored during this transition of care where patients are working to regain function and mobility. It is important for practitioners to have an understanding of the needs of these patients and potential complications that may arise under their care.

- In an unstable patient, initial damage control laparotomy may be necessary, where the abdomen is left open with a vacuum dressing and closed at the next operation or weeks later with the use of split-thickness skin grafts. Despite having a large ventral hernia, patients can maintain a functional lifestyle.
- Enterocutaneous or enteroatmospheric fistulas may arise after surgery or from an inflammatory process. It is important to maintain adequate nutrition and decrease fistula output while awaiting spontaneous or operative closure.
- Patients with ostomies should be monitored for adequate fluid intake and nutrition, in addition to signs of possible complications including obstruction, hernia, high output, or prolapse.
- Maintaining adequate nutrition is very important in any injured or postoperative patient. Enteral nutrition is generally preferred and can be given through nasogastric, gastrostomy, or jejunostomy tubes, when oral intake is inadequate.
- Wound infection, dehiscence, or evisceration can be a devastating complication after surgery. Other wound complications such as a hematoma or seroma may require operative drainage if infection or compression of surrounding structures occurs.
- Surgical drains are used to prevent fluid collections, which may be prone to infection. Jackson-Pratt and Blake drains are most commonly used to allow for continuous suction, although Penrose drains may be placed for passive drainage from superficial spaces.
- Compartment syndrome most commonly occurs in the extremities after trauma or ischemia or in the abdomen with significant edema. A high index of suspicion is key to diagnosis, and prompt operative treatment is required.
- In patients requiring prolonged respiratory support, there are many advantages to a tracheostomy. Patients with a tracheostomy should be monitored for accidental decannula-

tion and respiratory compromise, bleeding, obstruction, or airway stenosis.

- In the patient with spinal cord injury, an acute abdomen may present with findings other than abdominal pain, such as shoulder pain or autonomic dysreflexia. A low threshold for imaging and diagnostic laparoscopy should be maintained in these patients.

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