Clinical Scenarios in Surgery

Decision Making and Operative Technique

SECOND EDITION

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Decision Making and Operative Technique

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To my wife, Anastasia, and our children, Mary and Paul, for their love and support. To the dedicated general surgery residents, who will use the contents of this book to heal and comfort our patients.

—Justin B. Dimick

To the faculty and residents at the University of Florida for accepting me as a Gator.

—Gilbert R. Upchurch Jr.

To the general surgery residents of the University of Michigan, for their constant inspiration and dedication to patient care.

—Christopher J. Sonnenday

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—Lillian S. Kao

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FOREWORD

In preparing a generation of surgical residents to enter practice, there are some thoughts on reading that I may offer. There are also some rules that I have found useful while writing and editing chapters for surgical textbooks. Most of us are not born surgeons; we become surgeons through dedicated effort. If you are the exception—accomplished, articulate, and confident; if surgical principles come effortlessly, you may stop reading now. Still, you might want to take a look. Here are three thoughts:

1. Start reading right away
For most surgeons, the most difficult reading assignment is the first assignment. The problem lies not in realizing the high stakes of a board exam; the trouble comes with the commitment that board preparation requires. The form of most contemporary texts is part of the problem. A glance shows the chapters to be long, devoid of illustrations, a daunting proposition. *Clinical Scenarios in Surgery* is so inviting with its crisp writing, generous illustrations, and telegenic presentation that it begs to be read. Get started.

2. Look to the future
Modern surgery is forward looking, seeking to improve the care of current patients and to prevent disease in potential future patients. Given the pace of modern biomedical research, no individual can be expected to find, read, synthesize, and apply all new knowledge relevant to any clinical problem. All surgeons need an occasional guide through the surgical literature. In the midst of this information overload, the experienced, energetic editors of *Clinical Scenarios in Surgery* strike just the right balance. Keep going.

3. Keep reading, even just a little bit, every day
Reading is a skill, sharpened with practice, perfected by *continuous* practice. Operative surgery reinforces this notion. The physical skills, sense of prioritized organization, personal confidence, and intuition of the accomplished surgeon result from attention to the craft. That is the reason it is called the practice of surgery. A book becomes much friendlier with frequent use. Enjoy the journey.

Michael W. Mulholland, MD, PhD

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PREFACE

Despite remarkable technical advances and rapid scientific progress, it has never been more challenging to become a safe and proficient surgeon.

Young surgeons are challenged both by the pace of change and the subspecialization of surgery. Traditional surgical textbooks, which have grown to keep pace with these changes, are becoming encyclopedic reference books, which we turn to only when we need a comprehensive overview. With the vast amount of information available, it is often difficult to sort out the basic principles of safe surgery for a given clinical scenario. The mismatch between existing education materials and the need for a solid understanding of general surgical principles becomes most apparent when young surgeons sit down to prepare to take their written and oral board exams.

Young surgeons also learn differently than those in the past. Modern surgical trainees do not sit down and read for hours at a time. They are multitaskers who demand efficiency and immediate relevance in their learning materials. Most medical schools have responded to these changes by transitioning to curricula based on case-based learning. Clinical narratives are extremely effective learning tools because they use patient stories to teach essential surgical principles. Most existing surgical textbooks have not kept pace with these broader changes in medical education.

We wrote this book to fill these gaps. We have created a case-based text that communicates core principles of general surgery and its specialties. We believe the patient stories in these clinical scenarios will provide context to facilitate learning the principles of safe surgical care. Students, residents, and other young surgeons should find the chapters short enough to read between cases or after a long day in the hospital. We hope this book will be particularly useful for senior surgical residents and recent graduates as they prepare for the American Board of Surgery oral examination.

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SECTION 1

Abdominal Wall

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Symptomatic Primary Inguinal Hernia

1

REBECCA L. GUNTER AND JACOB A. GREENBERG

Based on the previous edition chapter "Symptomatic Primary Inguinal Hernia" by Evangelos Messaris

Presentation

A 47-year-old man with a history of hypertension and no previous abdominal surgeries presents to clinic with a bulge in his left groin. The bulge has been present for 6 months and gives him occasional discomfort but does not interfere with his daily activities. He denies fevers, chills, nausea, vomiting, and changes in bowel or bladder habits. On physical exam, the bulge is easily reducible without tenderness to palpation but easily recurs after reduction.

DIFFERENTIAL DIAGNOSIS

It is important to differentiate hernias from other pathologies that may lead to pain in the affected groin. While groin discomfort is a common complaint among patients with inguinal hernias, not all hernias are symptomatic. Inguinal lymphadenopathy, which may represent metastatic disease, primary lymphoma, or an inflammatory reaction, can present with a palpable mass and groin discomfort. Testicular and scrotal pathologies, such as varicocele, spermatocele, hydrocele, testicular torsion, testicular tumors, epididymitis, and epididymal cysts should be ruled out, as these can cause scrotal swelling and may even extend into the inguinal canal. Groin discomfort in the absence of a palpable mass or bulge may be related to musculoskeletal pathology, including sports hernia (athletic pubalgia), ligamentous injury, ilioinguinal strain, and hip abnormalities, such as bursitis, labral tears, femoroacetabular impingement, or avascular necrosis.

WORKUP

Upon more extensive physical examination, our patient is found to have a reducible inguinal mass at the level of the external ring of the inguinal canal on the left side. This bulge extends into his scrotum but reduces easily with manual palpation. There are no overlying skin changes. Examination of the inguinal region on his right side is unremarkable.

The diagnosis of inguinal hernia is based primarily on a good physical examination, which has a reported sensitivity and specificity of 75% and 95%, respectively. In a male patient, the examiner invaginates the scrotum and places a finger through the external ring or directly palpates the inguinal canal. Upon Valsalva, the examiner will feel the hernia sac and any contents at the tip or on the pad of the finger. Classically, an indirect hernia is felt at the tip of the finger, and a direct hernia is felt with the pad of the finger, though the reliability of this finding is questionable. In a female patient, the inguinal area just lateral to the pubic tubercle is palpated for a bulge suggestive of a hernia. The examiner should take care to note the location of the bulge in relation to the inguinal ligament, as hernias below the inguinal ligament are by definition femoral hernias. Both sides should be examined carefully to rule out bilateral hernias. Laboratory studies are not indicated in the diagnosis of inguinal hernias.

When the diagnosis is uncertain, imaging studies may be helpful to confirm the presence of a hernia and to determine its contents. Routine imaging is not necessary and is most helpful in patients in whom physical examination is particularly challenging, as in the obese patient. Ultrasound is helpful in diagnosing testicular or scrotal pathology as well as inguinal lymphadenopathy. A skillful ultrasonographer may also be able to detect a hernia sac and identify its contents (Figure 1-1). Computed tomography (CT) is useful in cases of very large inguinal hernias when the contents cannot be identified and the anatomy may be significantly distorted (Figure 1-2). Finally, magnetic resonance imaging (MRI) may be used for those patients with groin discomfort in the absence of a bulge or palpable mass to assess for musculoskeletal pathology.

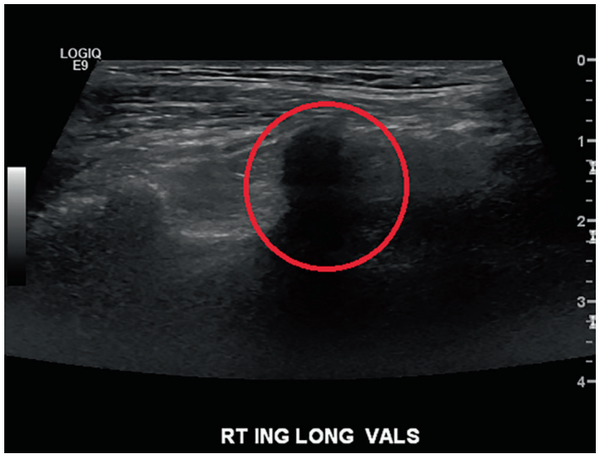

FIGURE 1-1. An ultrasound of the groin with a hernia noted within the *red circle*.

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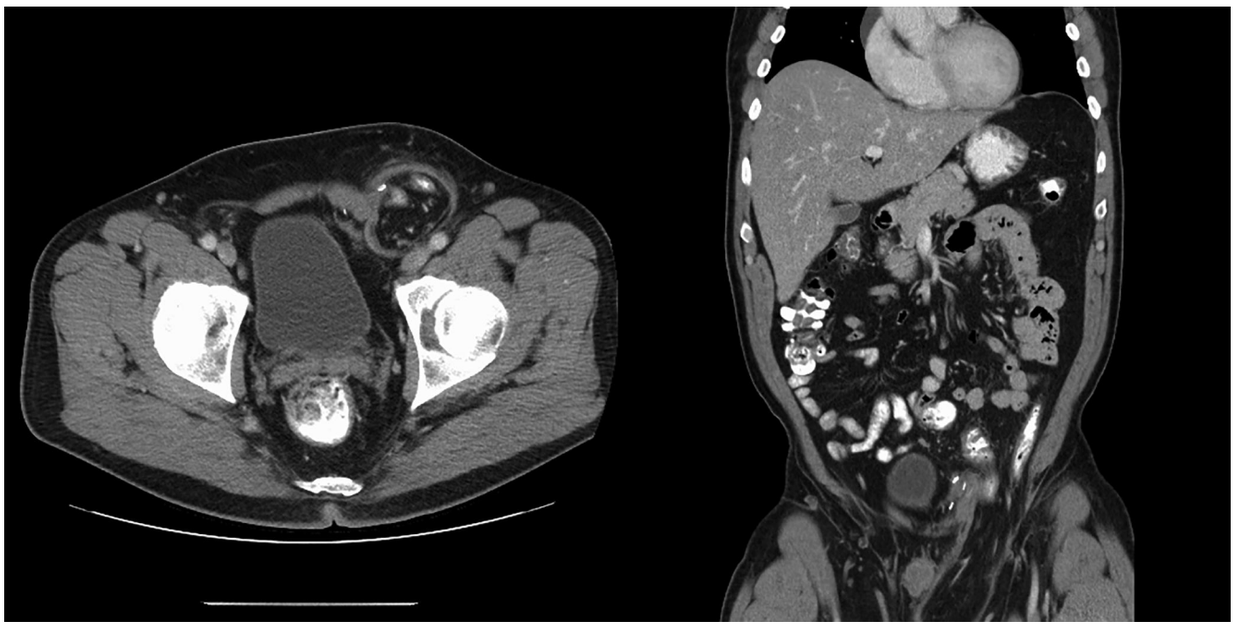

FIGURE 1-2. Axial and coronal computed tomographic views of a large recurrent left inguinal hernia.

DIAGNOSIS AND TREATMENT

Once an inguinal hernia has been diagnosed, the decision to repair it is based primarily on the presence of symptoms and patient preference. In asymptomatic and minimally symptomatic patients, a strategy of watchful waiting is acceptable. Long-term results of randomized clinical trials have demonstrated the safety of this approach; however, patients should be counseled that they are likely to develop symptoms if the hernia is not repaired, particularly if they have an active lifestyle at baseline. Thus, it is reasonable to offer repair to patients who are asymptomatic at the time of initial surgical consultation.

For patients whose hernia causes discomfort that limits their activity, or those that have evidence of incarceration or strangulation, surgical repair is the appropriate treatment. Patients with incarceration or strangulation may have more severe pain or pain that acutely worsens. In advanced cases, there may be overlying skin changes indicating strangulation of hernia contents (e.g., small bowel, colon, or omentum). The timing of surgical repair depends on the danger posed to the patient. Symptomatic, but reducible, hernias may be repaired electively on an outpatient basis. Incarcerated hernias should be repaired more urgently, and strangulated hernias should be repaired emergently to prevent tissue loss and limit ischemia to the hernia contents.

SURGICAL APPROACH

Inguinal hernias may be repaired using an open technique, or may be repaired laparoscopically. Open repairs are suture based (McVay, Bassini, and Shouldice repairs) or use mesh to bolster the repair (e.g., Lichtenstein repair). Laparoscopic repair is performed using one of the following techniques: total extraperitoneal (TEP) or transabdominal preperitoneal (TAPP). A TEP repair does not enter the peritoneal cavity, whereas a TAPP repair does. Additionally, TAPP may be performed robotically. Mesh is used in all laparoscopic and robotic approaches.

The choice of approach is determined by patient and surgeon factors. Meta-analyses of published clinical trials indicate equivalence between laparoscopic and open techniques in terms of hernia recurrence rates. Laparoscopic repairs result in slightly lower rates of postoperative groin pain and numbness, and a quicker return to normal activities. However, there may be slightly higher rates of perioperative complications following laparoscopic repair. Surgeon experience and comfort should guide the choice of approach; this author prefers the TAPP laparoscopic repair. In patients who have bilateral hernias, laparoscopic repair is often preferred as both sides may be fixed through one set of incisions. Prior prostatic or other pelvic surgery (e.g., prostatectomy) or radiation can complicate a laparoscopic approach, making open repair the optimal approach in these patients.

Ultimately, the goal is a tension-free repair to prevent recurrence and minimize postoperative pain or discomfort. To that end, mesh should be used in most cases, as it reduces recurrence rates following repair of primary inguinal hernias. However, mesh should be avoided in contaminated cases in favor of a suture repair (Bassini, McVay, or Shouldice repair). Some authors have advocated the use of biologic mesh in contaminated cases, but this author recommends a suture-based technique for the initial repair followed by a laparoscopic repair if the hernia recurs.

PREOPERATIVE CARE

Prior to arriving in the operating room, all patients should empty their bladder. Spontaneous voiding in the preoperative area immediately prior to surgery is clearly preferable to bladder decompression with a Foley catheter, though this may be necessary to ensure adequate visualization and prevent intraoperative bladder injury. This is particularly essential when a laparoscopic approach is used.

Regardless of approach, the patient is placed supine on the operating table. Knee-high pneumatic sequential compression devices (SCDs) should be placed. We do not routinely administer preoperative heparin. Controversy exists surrounding the utility of preoperative antibiotics to prevent surgical site infection in elective inguinal hernia repair. It is our practice to administer a first-generation cephalosporin preoperatively to cover skin flora. In cases of urgent or emergent inguinal hernia repair for incarcerated or strangulated viscera, antibiotics should be given within 1 hour of incision.

A variety of anesthetic approaches may be used. For elective inguinal hernia repair, local anesthesia either by nerve block or by direct infiltration into the skin may be adequate. Alternatively, spinal or general anesthesia may be administered. For urgent and emergent cases, general anesthesia will be required.

REPAIR TYPES

Open Inguinal Hernia Repair

The "gold standard" for inguinal hernia repair has historically been the open, tension-free Lichtenstein repair using mesh (Table 1-1). Using the pubic tubercle and the anterior superior iliac spine (ASIS) as anatomic landmarks to approximate the course of the inguinal ligament, an oblique incision is made two fingerbreadths superior to the inguinal ligament, angling the incision slightly cephalad as it progresses laterally. The incision is carried down through the subcutaneous tissue until the external oblique aponeurosis is reached. The aponeurosis is incised sharply with a knife and then cut in line with the direction of the muscle fibers using scissors, taking care to elevate the fascia as it is cut to protect the ilioinguinal nerve, which runs just deep to the external oblique aponeurosis along the spermatic cord. The superior and inferior external oblique flaps are dissected free and held in place with a self-retaining retractor. Once the flaps have been raised, the iliohypogastric nerve should be identified running along the interior oblique aponeurosis, superior to the spermatic cord. The spermatic cord is dissected free from the surrounding tissues, taking care to preserve the vessels and vas deferens. The genital branch of the genitofemoral nerve runs posterior to the cord and should be identified and preserved. In female patients, the round ligament may be transected and the internal ring closed. Once the hernia sac has been identified, it may be either reduced through the internal ring or ligated at the level of the internal ring.

Table 1-1 Open Lichtenstein Tension-free Herniorrhaphy

Key Technical Steps

1. An oblique skin incision is made two fingerbreadths superior to the inguinal ligament and carried through the subcutaneous tissues.
2. The external oblique is cut in the direction of its muscle fibers.
3. The cord structures are dissected free from the hernia sac.
4. The hernia sac and its contents are returned to the abdomen.
5. Polypropylene mesh is secured to the pubic tubercle medially, the inguinal ligament inferiorly, and the rectus sheath and internal oblique muscle superiorly.
6. The external oblique is reapproximated and the skin closed.

Potential Pitfalls

- The pubic tubercle must be completely covered by the mesh and the mesh well secured to avoid recurrence.
- All three nerves (ilioinguinal, iliohypogastric, and genital branch of the genitofemoral nerve) must be identified and protected throughout the operation.
- Mesh fixation must be tension free.
- Avoid injury to the cord structures, and return them to their proper position at the end of the operation.

Once the spermatic cord has been skeletonized and the hernia has been reduced, attention is then turned to placement of the mesh. A piece of polypropylene mesh is cut large enough to reach from the inguinal ligament to an overlap of the rectus by 1 to 2 cm. In male patients, a slit is cut on the lateral edge of the mesh to accommodate the spermatic cord. In female patients, no slit is required if the round ligament has been ligated and the internal ring closed. The mesh is placed under the spermatic cord and the medial edge secured to the pubic tubercle using 2-0 polydiaxanone. The inferior edge of the mesh is then secured to the inguinal ligament with a running or interrupted 2-0 polydiaxanone suture. The superior edge is secured to the rectus sheath and internal oblique muscle. The internal ring is then reconstructed by securing the two ends of the cut slit of the lateral edge of the mesh. The lateral tails of the mesh are tucked under the external oblique. The external oblique is reapproximated using 2-0 absorbable suture in a running fashion, again taking care to avoid injuring the ilioinguinal and iliohypogastric nerves.

Total Extraperitoneal Laparoscopic Hernia Repair

The TEP repair aims not to violate the peritoneal cavity (Table 1-2). An incision is made just inferior to the umbilicus. The subcutaneous tissues are dissected down to the level of the rectus sheath. The rectus sheath is sharply incised, and the rectus

Table 1-2 Laparoscopic Totally Extraperitoneal Repair of Inguinal Hernia

Key Technical Steps

1. An infraumbilical incision is made down to the anterior rectus sheath through which a balloon dissector is introduced into the retromuscular space.
2. The balloon dissector is slowly inflated to bluntly dissect the preperitoneal space.
3. Two 5-mm trocars are placed in the lower midline.
4. Careful and complete dissection is performed to adequately identify the relevant anatomy (the inferior epigastric vessels superiorly, Cooper's ligament medially, and the iliopubic tract laterally).
5. The hernia sac is dissected from the cord structures and returned to the peritoneal cavity.
6. Mesh is introduced and positioned to cover the entire myopectineal orifice.
7. Fixation may be used but is not necessary.

Potential Pitfalls

- A complete understanding of the anatomy and its orientation from this perspective is critical.
- Inadequate dissection or dissection in the wrong plane can lead to poor visualization of key anatomy.
- Injury to major vascular structures (epigastric and iliac vessels) should be carefully avoided.

Table 1-3 Laparoscopic Transabdominal Preperitoneal Repair of Inguinal Hernia

Key Technical Steps

1. The first port is placed at the umbilicus. Two additional ports are placed on either side lateral to the rectus sheath.
2. The peritoneum is incised from the ipsilateral medial umbilical fold to the level of the ASIS.
3. The preperitoneal space is bluntly dissected from the anterior iliac spine laterally, to the medial umbilical fold medially, and below Cooper's ligament inferiorly.
4. The hernia sac is dissected from the cord structures and returned to the peritoneal cavity.
5. Mesh is introduced and positioned to cover the entire myopectineal orifice.
6. The peritoneal defect is closed using tacks or sutures.

Potential Pitfalls

- As in TEP repair, a complete understanding of the relevant anatomy from the laparoscopic perspective is critical for safe completion of the operation.
- The mesh should not be allowed to curl or shift during closure of the peritoneal defect.
- Avoid injuring the epigastric vessels during closure of the peritoneal defect, especially if using tacks.

muscle is bluntly dissected laterally to expose the retrorectus space. An endoscopic balloon dissector is introduced into the retrorectus space and advanced to the pubic symphysis. A 10-mm 0° laparoscope is introduced and the balloon dissector is slowly inflated under direct visualization. The balloon is removed and replaced with a standard blunt port. The preperitoneal space is then insufflated to 12 mm Hg. Two additional 5-mm trocars are placed in the lower midline, one 2 cm cranial to the pubic symphysis and the other at least 4 cm cranial to the lower trocar. Complete dissection is performed to clearly identify the inferior epigastric vessels superiorly, Cooper's ligament medially, and the iliopubic tract laterally. The hernia sac is dissected off the spermatic cord structures and reduced into the peritoneal cavity, taking care not to injure the vas deferens or gonadal vessels. Mesh is then introduced and positioned from medial to lateral under the cord structures paying particular attention to cover the entire myopectineal orifice. The mesh may be fixated using tacks, staples, or fibrin glue, or it may be left in place without fixation. If tacks or staples are used for fixation, they should not be placed below Cooper's ligament medially or below the iliopubic tract laterally.

Transabdominal Preperitoneal Laparoscopic Hernia Repair

The TAPP laparoscopic hernia repair is the author's preferred approach (Table 1-3). It may be performed laparoscopically or robotically. The first trocar is placed at the level of the umbilicus via a Hasson technique. Two additional 5-mm ports are placed lateral to the rectus sheath, 1 to 2 cm cranial to the umbilicus. A 5-mm 30° laparoscope is placed in the port ipsilateral to the hernia. The peritoneum is grasped at the medial umbilical fold and incised out laterally with laparoscopic scissors (Figure 1-3). Two blunt graspers are then introduced into the created preperitoneal space and spread to bluntly dissect the space. Care should be taken to avoid inadvertent entry into the retrorectus space. The preperitoneal space is dissected laterally to the level of the ASIS, medially to the ipsilateral medial umbilical fold, and inferiorly to the level of the iliopubic tract. Cooper's ligament is identified and cleared for about 2 cm in anticipation of mesh fixation

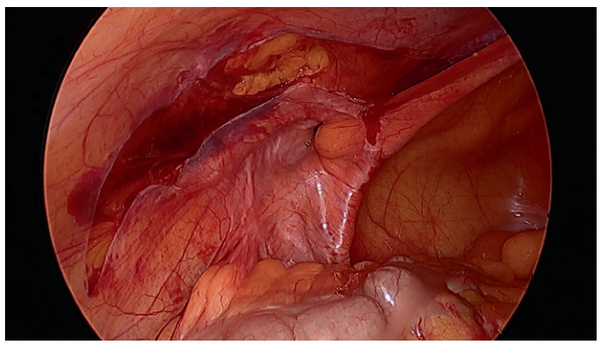

FIGURE 1-3. The peritoneal incision during a laparoscopic TAPP repair.

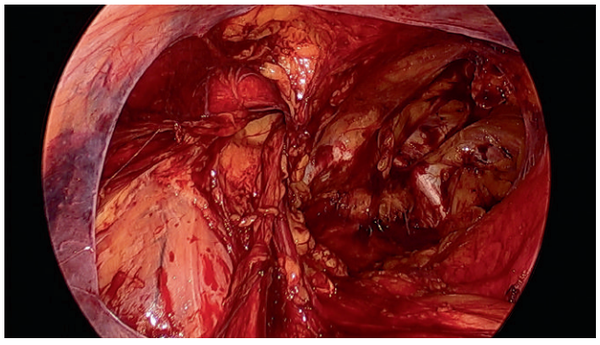

FIGURE 1-4. The exposed myopectineal orifice after hernia completed dissection during a TAPP repair.

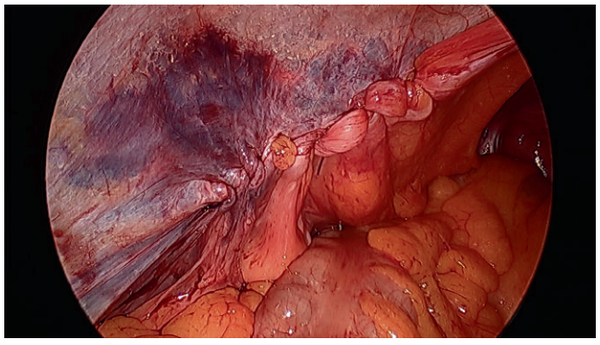

FIGURE 1-6. Sutured peritoneal closure at the end of a TAPP repair.

at its superior aspect. The hernia sac is dissected free of the spermatic cord contents and reduced into the peritoneal space, taking care not to injure the vas deferens or gonadal vessels. Once the hernia sac has been reduced, the peritoneum is further dissected free from the iliac vessels, vas deferens, and gonadal vessels, providing generous exposure of the myopectineal orifice in preparation for mesh placement (Figure 1-4). Mesh is then introduced and positioned similarly to a TEP repair (Figure 1-5). Once the mesh has been placed to satisfaction, the peritoneal defect is closed using tacks or self-retaining sutures (Figure 1-6).

SPECIAL INTRAOPERATIVE CONSIDERATIONS

A complete understanding of the complex anatomy of the inguinal canal and its surrounding structures is essential to the successful repair of inguinal hernias. This is particularly true for laparoscopic approaches as the anatomy of this approach is far different from that of the traditional anterior approach that most surgeons are comfortable performing. Complete dissection and identification of relevant anatomy is crucial in laparoscopic repairs and open repairs.

Careful attention must be paid to identify all three nerves (ilioinguinal, iliohypogastric, genital branch of the genitofemoral) during open repairs. Nerve injury or entrapment can cause significant postoperative groin neuralgia. If nerve injury is detected intraoperatively, the nerve should be ligated and excised proximally to allow retraction into the muscle or preperitoneal space.

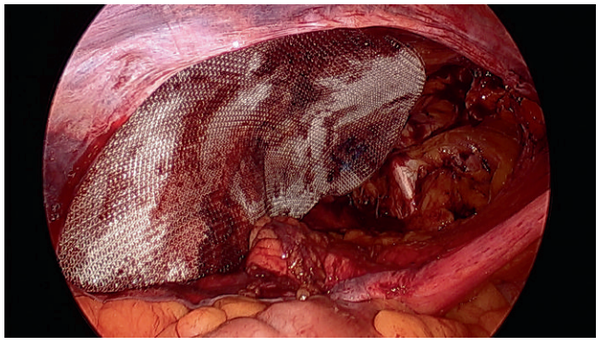

FIGURE 1-5. Mesh placement to cover the entire myopectineal orifice.

Peritoneal violation during laparoscopic repair, whether inadvertent during TEP repair or intentional during TAPP repair, should be closed, when possible, using absorbable suture. Regardless of approach, intraoperative complications, including vascular injury (e.g., femoral vessels or inferior epigastric vessels), bladder or testicular injuries, vas deferens injury, and nerve injury should be carefully avoided.

POSTOPERATIVE MANAGEMENT

Elective, uncomplicated inguinal hernia repair may be done on an outpatient basis, with patients leaving the surgery center within a few hours following the procedure. Prior to discharge, patients should have adequate pain control, and should be ambulating and voiding without difficulty. Urinary retention following inguinal surgery is the most common complication, and higher risk is associated with narcotic administration, older age, prolonged anesthesia time, bilateral hernia repair, and obesity. Patients who had incarcerated or strangulated visceral contents in the hernia sac should be admitted for observation and may be discharged upon return of normal bowel function.

Following discharge, patients may resume their normal activities as their pain level allows. We do not place weight restrictions on postoperative patients, but rather counsel them to be mindful of their own comfort level. Common postoperative complications include seromas and inguinal neuralgia. Seromas generally resolve spontaneously without further intervention. Especially in the presence of mesh, they should not be aspirated or otherwise violated unless there is a high index of suspicion for an infection. Chronic groin pain has been reported in as many as 10% to 14% of cases, and may be caused by nerve injury, by injury to the structures within the inguinal canal, or by anchoring sutures placed too deeply into the pubic tubercle periosteum. Nerve injury

is characterized by hypo- or hyperesthesia, allodynia, and paresthesia, most often in the distribution of the affected nerve(s). Risk factors for postoperative groin pain include young age, operation for recurrent hernia, preoperative groin pain, use of heavyweight mesh, and female sex. Treatment ranges from medical management, including pharmacologic therapies and peripheral nerve blocks, to operative management, including neurectomy of one to all three nerves.

Case Conclusion

Our patient underwent a TAPP laparoscopic hernia repair at an outpatient surgery center 1 month after his initial consultation. He had an uneventful recovery and was seen in clinic 3 weeks later. His incisions had healed well, and he had no postoperative pain. He was back at work and had resumed his normal activities. On exam, there was no evidence of recurrence, seroma, or hematoma.

TAKE HOME POINTS

- Inguinal hernias are common, and their repair is one of the most common surgical procedures performed worldwide.
- Asymptomatic and minimally symptomatic inguinal hernias may be safely managed nonoperatively, but are likely to become symptomatic. Symptomatic inguinal hernias should be repaired to relieve symptoms and prevent future incarceration or strangulation.
- Inguinal hernias may be repaired open, laparoscopically, or robotically, depending on patient factors and surgeon comfort. Regardless of approach, the goal is a tension-free repair, almost always involving mesh.
- Seromas, groin neuralgia, and hernia recurrence are the most common postoperative complications.

SUGGESTED READINGS

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Recurrent Inguinal Hernia (Transabdominal Preperitoneal Repair)

2

JONATHAN F. FINKS

Based on the previous edition chapter "Recurrent Inguinal Hernia" by Jonathan F. Finks

Presentation

A 60-year-old man presents with a 6-month history of a right groin bulge. Although reducible, the patient has noted increasing discomfort associated with the bulge over the last few weeks. He denies any obstructive symptoms and has had no symptoms on the left side. He has a history of two previous open right inguinal hernia repair procedures with mesh, most recently 5 years ago. He also has a history of a robotic-assisted prostatectomy 2 years ago for prostate cancer and remains cancer-free. The patient has a body mass index of 35. Physical exam demonstrates some fullness in the right groin, but the exam is limited by the patient's body habitus.

DIFFERENTIAL DIAGNOSIS

The leading diagnosis based on these symptoms is a recurrent right inguinal hernia. Other considerations would include hydrocele; lymphadenopathy; soft tissue mass, such as a lipoma or sarcoma; and hematoma related to trauma.

WORKUP

The most appropriate study to evaluate for a recurrent hernia is a computed tomography (CT) of the abdomen and pelvis with an hernia protocol that includes both standard and Valsalva images. This approach allows for better identification of hernia contents within the inguinal canal. Groin ultrasound is an alternative imaging option. However, these studies can be difficult to interpret, especially in the setting of obesity, and may be user-dependent.

DIAGNOSIS AND TREATMENT

In this case, cross-sectional imaging demonstrated a recurrent right inguinal hernia containing a nonobstructed loop of small bowel. The left inguinal canal was normal in appearance. Given the symptomatic nature of this hernia, repair is warranted.

There are several options for surgical management. An open or anterior approach would be very difficult and unlikely to produce durable results, given the patient's body habitus and significant scarring from the previous open repairs. A preperitoneal approach is preferred in this case because it would allow for the repair to be done in an unviolated tissue plane. The preperitoneal approach also allows access to the entire myopectineal orifice, ensuring identification of occult femoral hernia that may not be appreciated with open repairs. Preperitoneal repairs can be done with an open technique using a Pfannenstiel incision. In this case, however, the open approach would be difficult given the patient's obesity. A laparoscopic total extreaperitoneal (TEP) repair would be contraindicated because of the previous prostatectomy, which would greatly increase the risk for a bladder injury during development of the preperitoneal space.

In this case, the optimal repair would entail a laparoscopic transabdominal preperitoneal (TAPP) approach. This method would facilitate safe dissection of the preperitoneal space, starting lateral to the bladder to promote better visualization of this structure and lower risk for injury. The transabdominal route also allows the surgeon to avoid the lower abdominal wall pannus that can be present in patients with obesity. A TAPP approach can also be useful in cases of large scrotal hernias, as these can be more easily reduced from the peritoneal cavity than from the preperitoneal space. Moreover, the transabdominal approach also allows for assessment of bowel viability in cases of acutely incarcerated hernias. Finally, conversion to TAPP repair is a good fallback option if technical difficulties arise during a TEP procedure.

SURGICAL TECHNIQUE

The TAPP procedure for inguinal hernia repair involves entry into the preperitoneal space via a transverse incision of the lower abdominal wall peritoneum. Once in the preperitoneal space, assessment of the entire myopectineal orifice is made. This includes the direct, indirect, femoral, and obturator spaces. Hernia contents are reduced, and the peritoneum is dissected well off of the cord structures or round ligament to make room for the mesh. The mesh is then placed such that it adequately covers all of the potential hernia defects. The peritoneum is then secured up to the abdominal wall to cover the mesh.

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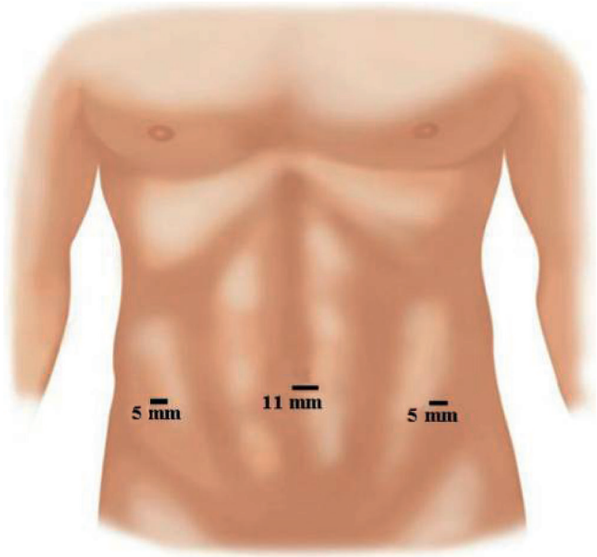

FIGURE 2-1. Port placement for transabdominal preperitoneal (TAPP) hernia repair. (Reprinted under Creative Commons License from Carter J, Duh QY. Laparoscopic repair of inguinal hernias. *World J Surg.* 2011;35(7):1519-1525.)

The procedure is performed under general anesthesia with the patient supine, both arms tucked to the side, and in slight Trendelenburg position. It is important to ensure that the patient's thumbs are up in order to prevent ulnar nerve injury and that the elbows and wrist are adequately padded. The patient should void in the preoperative area to empty the bladder, as a Foley catheter is usually not required. There should be at least one monitor at the head of the table for visualization during access to the abdomen and one at the foot of the table to be used during the repair.

Access to the peritoneal cavity is obtained using a Veress needle below the left costal margin (Palmer's point) and pneumoperitoneum is established. The surgeon stands on the side opposite the hernia, with the assistant on the ipsilateral side. An 11-mm trocar is placed above the umbilicus in the midline for placement of the laparoscope and later insertion of the mesh into the peritoneal cavity. Some surgeons prefer to work through 5-mm ports on both sides of the midline so as to effect proper triangulation (Figure 2-1). However, in the obese individual, the surgeons' working ports (both 5 mm in diameter) should both be on the side contralateral to the hernia, usually on either side of the midclavicular line and below the level of the umbilicus. In some cases, an additional 5-mm assistant's port may be placed on the ipsilateral side, at the midclavicular line above the level of the umbilicus. In the case of bilateral inguinal hernia repair, the working trocars are generally placed at or above the level of the umbilicus. A 10-mm 30° laparoscope is placed in the midline supraumbilical port.

The procedure begins with an inspection of the lower abdominal wall bilaterally. The median umbilical ligaments and epigastric vessels should be identified on either side of the bladder. A direct or indirect hernia may be seen from within the peritoneal cavity (Figure 2-2), although smaller defects may not be apparent until the peritoneum

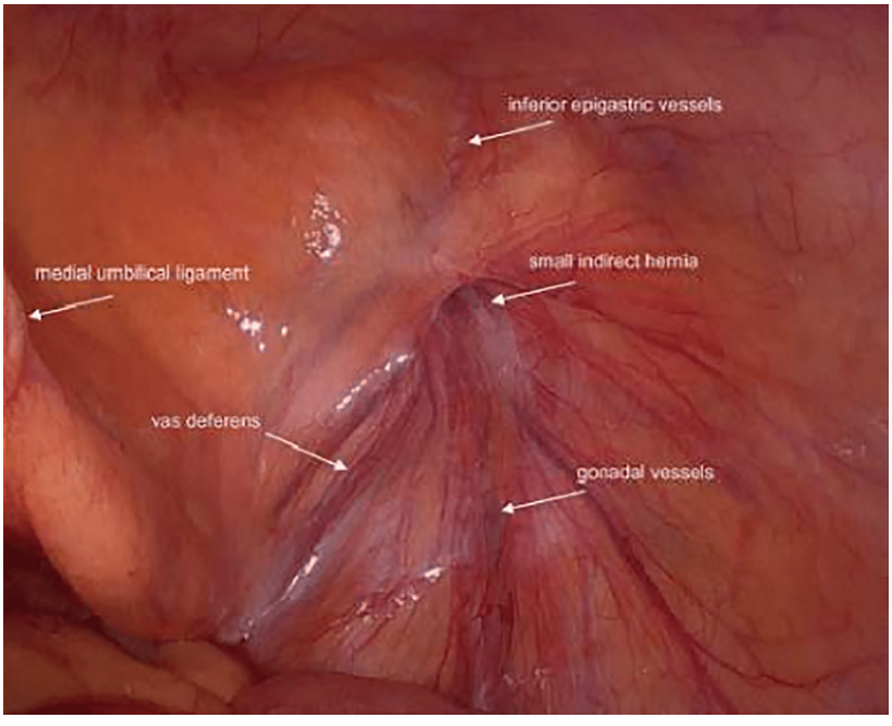

FIGURE 2-2. Transabdominal view of the right inguinal region with a small indirect inguinal hernia. (Reprinted under Creative Commons License from Carter J, Duh QY. Laparoscopic repair of inguinal hernias. *World J Surg.* 2011;35(7):1519-1525.)

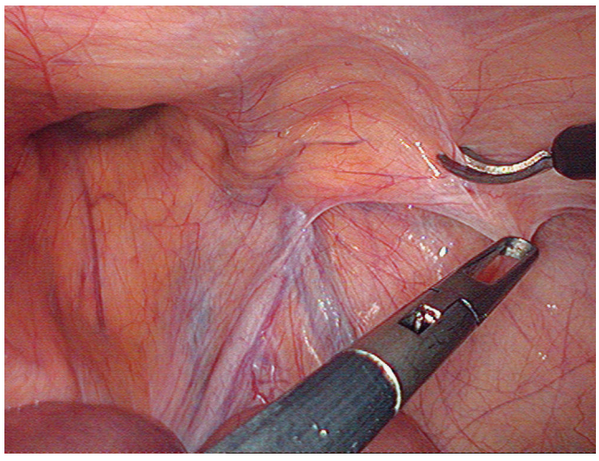

FIGURE 2-3. Incision of the peritoneum in the right inguinal region in a patient with a direct inguinal hernia. (Reprinted from Kapiris S. Laparoscopic transabdominal preperitoneal hernia repair (TAPP): stapling the mesh is not mandatory. *J Laparoendosc Adv Surg Tech A.* 2009;19(3):419-422, with permission.)

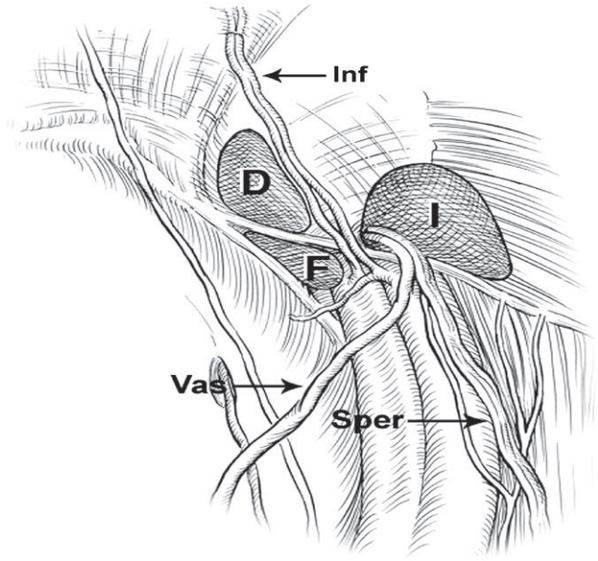

FIGURE 2-4. Preperitoneal anatomy of the right inguinal region. D, direct hernia; I, indirect hernia; F, femoral hernia; Inf, inferior epigastric vessels; Sper, spermatic (testicular) vessels. (Reprinted from Takata MC, Duh QY. Laparoscopic inguinal hernia repair. *Surg Clin North Am.* 2008;88(1):157-178, with permission.)

is taken down. The preperitoneal space is then developed beginning with an incision in the peritoneum using electrocautery (Figure 2-3). The incision begins laterally at the level of the anterior superior iliac spine and is carried transversely above the level of the hernia defects to the median umbilical ligament. The incision is then carried cephalad along the ipsilateral median umbilical ligament. In cases of a bilateral inguinal hernia, a mirror incision is made on the opposite side. Bilateral hernia are repaired through separate dissections and using separate pieces of mesh. Blunt and sharp dissection is then used to develop the preperitoneal space, staying close to the peritoneum. This dissection begins lateral to the cord structures, in Bogros' space, and extends medially toward the retropubic space. Medially, the bladder is carefully dissected off of the anterior abdominal wall, exposing the symphysis pubis and Cooper's ligament. Care must be taken not to injure *corona mortis*, which refers to the venous connection between the inferior epigastric and obturator veins. This structure courses inferiorly along the lateral aspect of Cooper's ligament and can be difficult to control if lacerated or avulsed.

At this point, the myopectineal orifice is evaluated to identify any hernia defects (Figure 2-4). Indirect hernias are located superior to the inguinal ligament and lateral to the epigastric vessels. Direct hernias occur through Hesselbach's triangle, bordered laterally by the inferior epigastric vessels, medially by lateral edge of the rectus muscle, and inferiorly by the inguinal ligament. Femoral hernias occur through the femoral space, bordered laterally by the femoral vein, posteriorly by Cooper's ligament, and anteriorly by the inguinal ligament. Obturator hernias occur posterior to Cooper's ligament through the obturator foramen.

An assessment for femoral and direct hernia defects occurs during the medial dissection. Careful attention is paid to identify the critical structures: inferior epigastric vessels, Cooper's ligament, and the femoral vein. Direct and femoral hernias may contain a peritoneal sac, although more commonly the hernia contents include only preperitoneal fat. It is not uncommon for direct hernias to contain the urinary bladder. The hernia contents are reduced with gentle blunt dissection. With a direct hernia, there is usually a clear transition between transversalis fascia and the hernia contents. These structures can often be separated by applying cephalad and posterior retraction of the hernia contents and anterior and caudad retraction of the transversalis fascia.

In the setting of a large direct defect, large seromas may develop. To help minimize the risk for seroma formation, the transversalis fascia may be reduced from within Hesselbach's triangle and tacked to Cooper's ligament. When reducing femoral hernia, care must be taken to carefully delineate between hernia contents and the adipose/lymphatic tissue intimately associated with the femoral vein. Injudicious dissection can lead to injury to the femoral vein. The medial dissection may also reveal an obturator hernia, which can be reduced by blunt dissection and may require an additional medially placed mesh to cover the defect.

An indirect hernia is identified during the lateral dissection. The hernia sac is bluntly dissected away from the underlying spermatic cord structures, namely, the vas deferens and the testicular vessels, in a man or the round ligament in a woman. The sac must be dissected free from the cord structures prior to reduction of the sac from within the deep

inguinal ring to avoid inadvertent laceration or transection of the vas deferens or testicular vessels. It is critical to avoid dissection posterior to the spermatic cord or round ligament in the "triangle of doom," as this can risk injury to the femoral vessels. The hernia sac is then reduced by application of cephalad and posterior retraction on the hernia sac, with anterior and caudad retraction of the transversalis fascia. One should minimize use of cautery during this dissection, especially in the space lateral to the cord structures, the "triangle of pain," as this can risk injury to the genital branch of the genitofemoral nerve, which courses anterior to the psoas muscle in the pelvis and passes through the inguinal canal along with the cord in the lateral bundle of the cremasteric fascia.

Care must be taken to ensure that the hernia sac remains free from the cord structures along its entire length during the reduction process, particularly in the setting of a large scrotal sac. If the peritoneal sac is very large and cannot be easily reduced, it may be transected, with the distal aspect allowed to retract into the scrotum. The proximal aspect of the sac must then be closed during reperitonealization following the mesh repair to prevent bowel adhesions to the mesh. Transection of the sac is safe but may lead to development of a hydrocele in some cases. Preperitoneal fat within the deep inguinal ring (cord lipomas) should be completely reduced from that space in order to prevent the patient's sensation of a persistent bulge following hernia repair.

Once the hernia sac has been reduced, the peritoneum is dissected further off of the cord structures in a cephalad direction. Adequate parietalization of the cord is essential, as it prevents the peritoneum from slipping underneath the bottom edge of the mesh, which can lead to indirect hernia recurrence. Similarly, herniated preperitoneal fat must also be dissected well off of the cord so that it cannot slip beneath the mesh. This dissection continues cephalad to the level of the anterior superior iliac spine and laterally to the iliac wing, allowing for exposure of the psoas muscle. Medially, this continues to the transition to the urinary bladder, which is then itself dissected off of Cooper's ligament and the pubis in order to clear a space for placement of the mesh. Gentle medial retraction on the bladder allows for better delineation between prevesicular fat and fat associated with the femoral vein and helps reduce the risk of inadvertent injury to the vein.

Once hemostasis has been assured, the next step involves placement of a large piece of nonabsorbable mesh (Figure 2-5). We employ a contoured woven polypropylene mesh that is 4 inches in height by 6 inches in width. The mesh must be large enough to cover the direct, indirect, and femoral spaces (myopectineal orifice) and the posterior aspect of Cooper's ligament. The mesh is rolled and inserted into the abdomen through the 11-mm port. It is inserted into the preperitoneal space and unrolled such that the posterior aspect is draped over the cord structures and psoas muscle laterally and Cooper's ligament and pubic symphysis medially. The anterior aspect of the mesh then covers the anterior abdominal wall above the level of the iliopubic tract, including the inferior epigastric vessels and the rectus muscle medially. We tack the mesh medially to Cooper's ligament with a single 5-mm spiral tack to prevent the mesh from sliding and will tack to the rectus muscle in cases of a large direct hernia to prevent the mesh from herniating through the defect. One should avoid tack placement laterally to prevent injury to the ilioinguinal and iliohypogastric nerves.

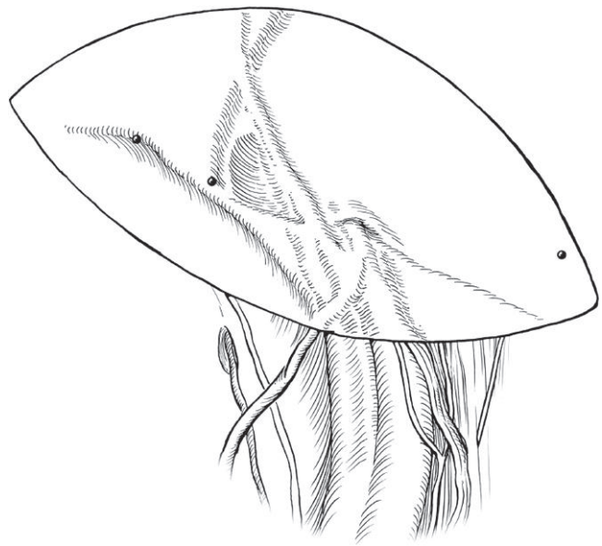

FIGURE 2-5. Repair of the right inguinal hernia with a contoured polypropylene mesh. (Reprinted from Takata MC, Duh QY. Laparoscopic inguinal hernia repair. *Surg Clin North Am.* 2008;88(1):157-178, with permission.)

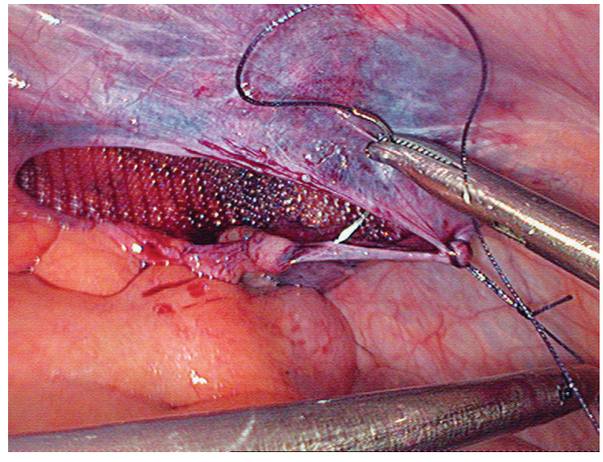

FIGURE 2-6. Suture closure of the peritoneal defect following TAPP inguinal hernia repair. (Reprinted from Kapiris S. Laparoscopic transabdominal preperitoneal hernia repair (TAPP): stapling the mesh is not mandatory. *J Laparoendosc Adv Surg Tech A.* 2009;19(3):419-422, with permission.)

Table 2-1 Recurrent Inguinal Hernia (Transabdominal Preperitoneal Repair)

Key Technical Steps

1. Incision of the peritoneum and development of the preperitoneal space
2. Reduction of direct, femoral or obturator hernias medially
3. Dissection of an indirect hernia sac off of the cord structures/round ligament and subsequent reduction of the sac and cord lipoma from within the deep inguinal ring
4. Extensive peritoneal dissection with parietalization of the cord
5. Placement of nonabsorbable mesh to cover the entire myopectineal orifice
6. Closure of the peritoneum

Potential Pitfalls

- Injury to femoral vessels from dissection in the "triangle of doom" deep to the cord structures
- Injury to genital branch of the genitofemoral nerve from injudicious use of cautery in the "triangle of pain" lateral to the cord structures
- Injury to the cord structures during reduction of an indirect hernia if the sac is not adequately dissection off of the cord prior to reduction of the sac
- Early recurrence if the peritoneum is not adequately dissected prior to mesh placement

Once the mesh has been placed, the peritoneum is closed. This is facilitated by reducing the pneumoperitoneum pressure as low as possible while still permitting adequate visualization. The entire peritoneum must be secured and the mesh covered to prevent bowel adhesions to the mesh or incarceration of a bowel loop within the preperitoneal space. This can be accomplished using absorbable tacks, absorbable suture, or a combination of these. The 11-mm port should be removed and a transfascial absorbable suture placed using a suture passing device, with a 5-mm laparoscope in one of the lateral ports (Figure 2-6). The suture should not be tied down, as the port will be reinserted. The laparoscope is then placed in the 11-mm port so that the 5-mm ports can be removed under direct visualization. This added step is done to ensure that there is no bleeding from inadvertent port injury to the epigastric vessels or branches thereof (Table 2-1).

SUGGESTED READINGS

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Hussain A. Technical tips following more than 2000 transabdominal preperitoneal (TAPP) repair of the groin hernia. *Surg Laparosc Endosc Percutan Tech.* 2010;20(6):384-388.

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Incarcerated/Strangulated Inguinal Hernia

3

SARAH P. SHUBECK, MATTHEW W. RALLS, AND JUSTIN B. DIMICK

Based on the previous edition chapter "Incarcerated/Strangulated Inguinal Hernia" by Matthew W. Ralls

Presentation

A 61-year-old man presents to the emergency department with obstipation and left groin mass for 3 days. His past medical history was notable for chronic obstructive pulmonary disease, type 2 diabetes, obesity, hyperlipidemia, and schizophrenia. His surgical history was significant for two prior inguinal hernia repairs on the left side. Due to his schizophrenia, he resides in an assisted living facility and comes in with a caregiver today. He describes an increase in abdominal pain and distention over the 3-day period. His oral intake has decreased, and he reports minimal urine output over the past 2 days. Physical exam is notable for a well-healed scar in the right lower quadrant at McBurney's point and a large, 12 × 12-cm bulge in the left inguinal region. The mass is tender to palpation, erythematous, and nonreducible. Although the bulge has intermittently been present, both the patient and caregiver state that the size and tenderness are new in the past 2 days. Laboratory values were notable for a WBC of 8.7 and hematocrit of 42.4.

DIFFERENTIAL DIAGNOSIS

In a patient with an intermittent groin bulge that is now fixed, tender, and erythematous, complications of a groin hernia should be the first consideration in the differential diagnosis. However, there are several other possible etiologies to consider. Subcutaneous pathology can also present as a groin mass, including lipoma, groin abscess, or inguinal adenopathy. Testicular pathology including torsion and epididymitis should also be considered, especially when the mass involves the scrotum. Vascular etiologies, such as aneurysmal or pseudoaneurysmal disease, should be considered in patients with a history of vascular disease and/or previous interventions at or near the femoral vessels.

Once the surgeon suspects groin hernia, it is important to discern inguinal from femoral hernia. To some degree, this can be ascertained on physical exam. For patients presenting with a femoral hernia, the bulge is below the inguinal ligament. In contrast, in an inguinal hernia, the bulge would be above the inguinal ligament (Figure 3-1). However, this distinction can be difficult to assess if the bulge is large, tender, and inflamed, or if the patient is obese and/or has a large overhanging pannus.

Early identification of groin hernia complications, such as incarceration or strangulation, is essential. Patients presenting with these complications require immediate intervention. Incarcerated hernias by definition cannot be reduced and therefore may progress to strangulation, if not already present on presentation. Strangulated hernias occur when the blood supply of the viscus is compromised. In contrast, for an easily reducible groin hernia, surgical intervention can be delayed and scheduled electively and therefore performed under more controlled circumstances. Suspected incarceration and/or strangulation are surgical emergencies.

WORKUP

History and physical examination in patients with suspected incarcerated and/or inguinal hernia are often diagnostic. The decision to operate is often made without further evaluation (Figure 3-2). Laboratory values such as complete blood count, comprehensive metabolic panel, and lactate level can provide information about the patient's hydration status and whether there is systemic inflammatory response, which are important in assessing the likelihood of strangulation. However, these tests have a high sensitivity and low specificity, that is, many patients with incarceration and strangulation (especially if presenting early) will have normal or near-normal laboratory values. To avoid a high false-negative rate (i.e., missing the diagnosis when

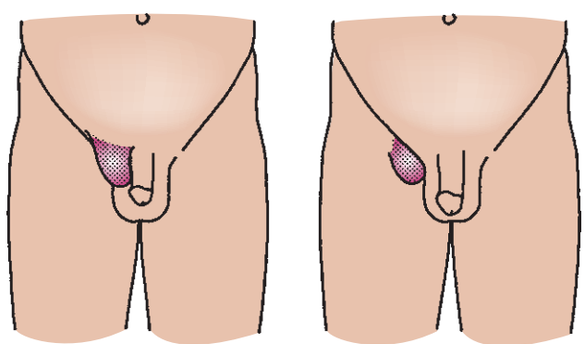

FIGURE 3-1. Landmarks in discerning inguinal **(A)** versus femoral **(B)** hernia. (Reprinted from Mulholland MW, et al. *Greenfield's Surgery: Scientific Principles & Practice*. 4th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2011, with permission.)

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FIGURE 3-2. Erythema and swelling over left groin concerning for incarcerated hernia. This exam finding, coupled with appropriate presentation, is sufficient cause for exploration.

it is present), surgeons should err on the side of exploring patients when incarceration/strangulation are suspected.

If there is substantial uncertainty regarding the diagnosis, imaging studies can be obtained. If the patient is obstructed at the site of incarceration, plain films of the abdomen will show signs of distended loops of bowel and air–fluid levels if the patient is obstructed (Figure 3-3). Computed tomography (CT) imaging is the standard in emergency evaluation (Figure 3-4) if the clinical diagnosis is in question

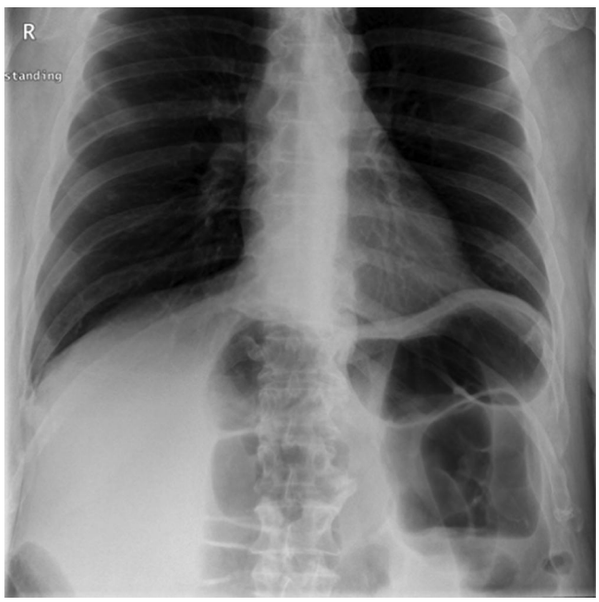

FIGURE 3-3. Plain film of patient described in this clinical scenario. Distended loops of large bowel are concerning for a distal large bowel obstruction.

FIGURE 3-4. CT showing left inguinal hernia.

after history, physical, and plain abdominal radiographs. It is important to note that it should be the rare patient who obtains a CT scan to diagnose an incarcerated hernia. Most cases will be diagnosed by history and physical examination, and obtaining a CT scan may often be viewed as an unnecessary delay.

DISCUSSION

Inguinal hernia repair is one of the most commonly performed surgical procedures worldwide. Over 800,000 inguinal hernia repairs are performed in the United States each year. Despite being a very common operation, the relevant anatomy is complex and often difficult for students and surgical trainees to fully understand. An intimate knowledge of this anatomy is important, especially for addressing incarcerated or recurrent inguinal hernias. In these settings, the distortion of the tissues makes operative repair extremely challenging. In 1804, Astley Cooper stated, "no disease of the human body, belonging to the province of the surgeon, requires in its treatment a greater combination of accurate anatomic knowledge, with surgical skill, than hernia in all its varieties."

Over the past two centuries, there have been many advances in groin hernia repair. The most frequently used technique in contemporary surgical practice is the tension-free mesh repair or Lichtenstein's repair. Laparoscopic techniques including totally extraperitoneal (TEP) and transabdominal preperitoneal (TAPP) are minimally invasive approaches that allow for quicker recovery, less pain, and similar or lower recurrence rates in experienced hands. Primary tissue repairs, such as the Bassini and McVay, are rarely used. However, in certain settings, such as contaminated fields with infection or bowel resection, a working knowledge of primary tissue repairs is essential.

Symptomatic inguinal hernias that are reducible should be repaired on an elective basis. As discussed above, incarcerated or strangulated hernias should be addressed more expeditiously as surgery within 6 hours may prevent loss of bowel. Emergent repair differs little from elective repair. Either open or laparoscopic techniques are acceptable, although it is the preference of the author to utilize the transabdominal preperitoneal laparoscopic approach if at all possible. The rationale for using this approach is that a laparoscopic exploration can be used to assess the viability of the bowel before and after reduction. A peritoneal flap can then be created to repair the hernia in the preperitoneal space. After completion of the repair, the viability of the bowel can be reassessed. Moreover, with adequate closure of the peritoneum, a laparoscopic bowel resection can be performed without contaminating the mesh.

DIAGNOSIS AND TREATMENT

The patient in our case presents with a scenario worrisome for incarcerated or strangulated inguinal hernia. He has a fixed bulge that is tender to palpation, which is typical of incarceration. He also presents with erythema in the overlying skin, which suggests possible strangulation. The patient also presents with radiographic evidence of large bowel obstruction (Figure 3-3) with resultant obstipation, abdominal pain, and associated nausea and vomiting. This hernia can be approached by either open or laparoscopic procedures depending on surgeon preference and expertise.

SURGICAL APPROACH FOR OPEN MESH REPAIR OF INCARCERATED INGUINAL HERNIA REPAIR (TABLE 3-1)

Open repair can often be done under general, spinal, or local anesthetic with sedation. Regardless of the anesthesia, the patient is placed in the supine position. Reverse Trendelenburg's position is advocated by some to aid in reduction of the hernia. The patient is prepped and draped in the standard sterile fashion. Local anesthetic is injected in the subcutaneous space above and parallel to the inguinal ligament. The patient can be further anesthetized with varying forms of nerve block if necessary. A 6- to 8-cm incision is made above and parallel to the inguinal ligament. The incision is deepened through the soft tissue with a combination of blunt dissection and Bovie electrocautery to the level of the external oblique aponeurosis. The muscle is then cut along the line of the external oblique fibers from the level of the internal ring and through the external ring.

At this point, groin exploration is warranted in the case of suspected incarceration/strangulation. If the viability of the bowel is in question, a resection can be performed via the inguinal incision. If that is not feasible, it may be necessary to perform laparotomy (see Special Intraoperative Considerations). Great care is taken to not injure the ilioinguinal nerve that is underlying this layer. Tissue flaps are mobilized. Through blunt finger dissection, the cord (and hernia sac) are freed circumferentially and encircled in a Penrose drain. If there is no bowel compromise, the procedure moves forward as with an uncomplicated hernia repair.

The dissection is now turned to identification and separation of the hernia sac from the cord structures with division of the cremasteric fibers. Classically, the sac of an indirect hernia will be anterior and medial with respect to the cord. The internal ring is inspected for evidence of indirect hernia. If found, the sac is dissected free and ligated under direct vision. Care is taken to avoid injury to the contents of the hernia prior to reducing the contents back into the peritoneal cavity. If a direct hernia is encountered, the hernia is reduced. The inguinal floor should be inspected for weakness.

Attention is then turned to repairing the ring and floor with mesh. A polypropylene mesh (precut or 6 inch^2) is typically used. The medial point is secured to the lateral aspect of the pubic tubercle, suturing to the periosteum and not the bone itself. The prosthesis is positioned over the inguinal

Table 3-1 Open Inguinal Hernia Repair with Mesh

Key Technical Steps

1. Verify laterality.
2. Prophylaxis with antibiotics.
3. Groin incision.
4. Expose and incise the external oblique in the direction of the fibers to the external ring.
5. Identify and protect the ilioinguinal nerve.
6. Mobilize flaps of external oblique.
7. Attempt reduction of hernia contents to better establish anatomical landmarks.
8. Encircle the spermatic cord (round ligament if female) at the external ring with a Penrose drain.
9. Identify the hernia sac on the anteromedial surface of the cord and dissect it free from the surrounding structures.
10. In the case of an indirect hernia, open the sac, reduce the contents, and highly ligate with suture ligature.
11. If direct hernia, free sac from surrounding attachments and reduce into the abdomen.
12. Assess the floor of the canal and prepare the mesh.
13. Begin medially at the pubic tubercle and secure the mesh in place to the shelving edge inferiorly and the conjoined tendon superiorly.
14. Avoid narrowing the internal ring or incorporating nervous tissue into the repair.
15. Ensure hemostasis.
16. Close the external oblique aponeurosis and Scarpa's fascia in layers.
17. Approximate the skin edges and apply a dressing.

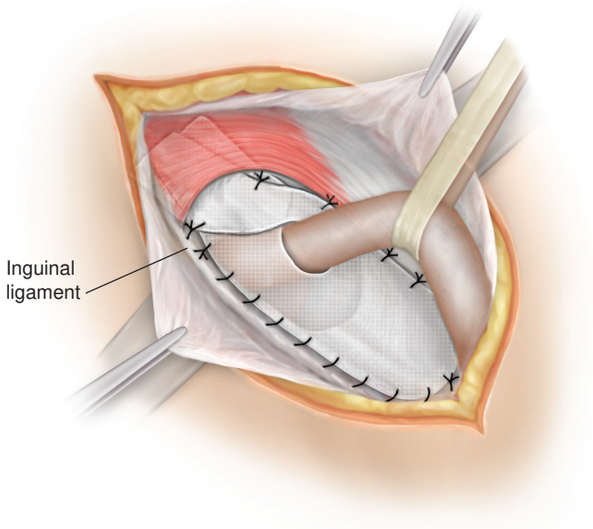

FIGURE 3-5. Mesh placement during standard open (Lichtenstein) hernia repair. (From Mulholland MW, et al. *Operative Techniques in Surgery*. Wolters Kluwer Health. Philadelphia, PA; 2015.)

floor and secured to the lateral edge of the rectus sheath (i.e., the conjoint tendon or area). The cord structures are placed through a slit in the lateral portion of the mesh, and the two tails are secured to each other to create a new internal ring. The inferior leaflet of the mesh is secured to the shelving edge of the inguinal ligament (Figure 3-5). The external oblique aponeurosis and Scarpa's fascia are closed in layers. The skin is approximated.

SURGICAL APPROACH TO LAPAROSCOPIC REPAIR OF INCARCERATED INGUINAL HERNIA (TABLE 3-2)

Depending on a surgeon's experience and preference, it is reasonable to approach incarcerated or strangulated hernias laparoscopically. If the hernia is recurrent, or multiply recurrent, laparoscopic hernia repair is more likely to produce better long-term results including lower rates of recurrence, as a laparoscopic repair allows for repair of the hernia through tissue planes that are undisturbed by prior surgery.

As discussed above, the author's preference is to approach incarcerated/strangulated hernias via a TAPP approach. The patient is placed in the supine position and then prepped and draped in standard sterile fashion. General anesthesia is induced. The first trocar is placed at the umbilicus to establish pneumoperitoneum, and two 5-mm ports are placed on either side of the umbilicus just lateral to the rectus sheath (Figure 3-6). The surgeon then performs an initial exploration with assessment of the viability of the potentially incarcerated bowel and hernia contents. Once this step is complete, and we are convinced

Table 3-2 TAPP Inguinal Hernia Repair with Mesh

Key Technical Steps

1. Verify laterality.
2. Prophylaxis with antibiotics.
3. Infraumbilical incision for the 10- to 12-mm trocar followed by insufflation.
4. Placement of two 5-mm trocars at the level of the umbilicus, lateral to the rectus sheath.
5. Creation of peritoneal flap starting lateral to inferior epigastric vessels.
6. Dissection of contents of inguinal canal and identification of a hernia sac.
7. Skeletonize the cord structures.
8. If direct: reduce the sac and preperitoneal from the internal ring by gentle traction.
9. If indirect: mobilize the sac from the cord structures, and reduce into the peritoneum.
10. Place precut lateralized mesh in proper orientation to completely cover direct, indirect, and femoral spaces.
11. Place tacking suture on the medial aspect of the mesh in Cooper's ligament securing mesh in place.
12. Tack peritoneal flap back to the abdominal wall to fully cover newly introduced mesh.
13. Desufflation and trocar removal under direct visualization.

the bowel is viable, a peritoneal flap is created to enter the preperitoneal space (Figure 3-7). The peritoneum is then incised starting lateral to the inferior epigastric vessels to establish a preperitoneal plane that extends laterally to the anterior superior iliac spine.

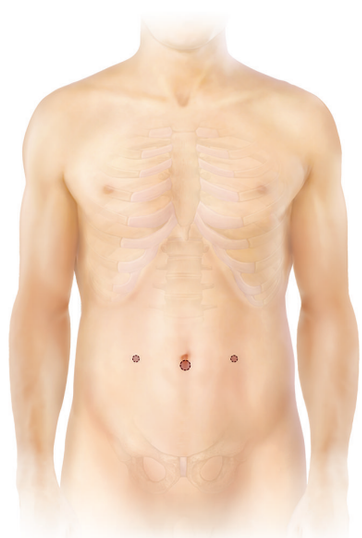

FIGURE 3-6. Port placement for TAPP inguinal hernia repair. (From Mulholland MW, et al. *Operative Techniques in Surgery*. Philadelphia, PA: Wolters Kluwer Health; 2015.)

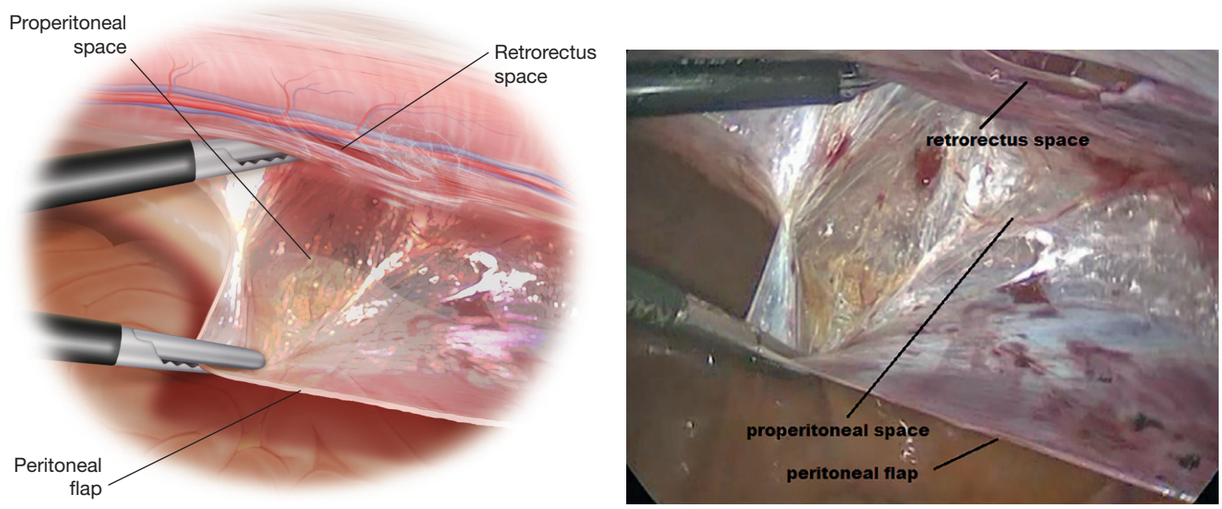

FIGURE 3-7. Creation of peritoneal flap during TAPP. **A:** Illustration. **B:** Intraoperative Laparoscopic Image. (From Mulholland MW, et al. *Operative Techniques in Surgery*. Philadelphia, PA: Wolters Kluwer Health; 2015.)

Dissection then proceeds identify a possible indirect hernia sac. Once identified, the sac and contents can be reduced to facilitate identification of the remaining cord structures. After dissecting cord structures free from the hernia sac and determining bowel contents of the hernia sac are viable, mesh is introduced via the umbilical port. The mesh will again be placed covering direct, indirect, and femoral spaces. The mesh is tacked in place with minimal points of fixation (Figure 3-8). The peritoneal flap is then closed with tack fixation followed by desufflation, previously incarcerated bowel reexamined for viability, and trocar removal under direct visualization. The procedure is finished with closure of the port sites and skin approximation.

The complex anatomy must be well understood by the surgeon (Figure 3-9). Blunt graspers are used to free the cord and hernia sac from the surrounding areolar tissue.

Two pitfalls of this portion of the operation are to dissect in the triangle of doom and the triangle of pain. The triangle of doom is bordered by the vas deferens medially, spermatic vessels laterally, and external iliac vessels inferiorly. The contents of this space comprise the external iliac artery and vein and the deep circumflex iliac vein. Damage to these vessels

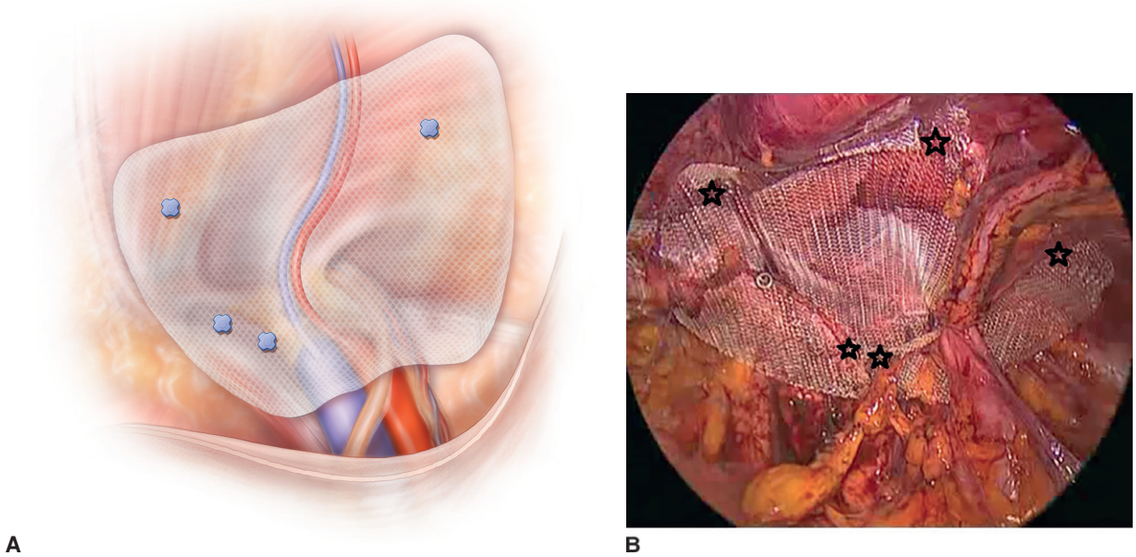

FIGURE 3-8. Mesh fixation. **A:** Illustration. **B:** Intraoperative Laparoscopic Image. (From Mulholland MW, et al. *Operative Techniques in Surgery*. Philadelphia, PA: Wolters Kluwer Health; 2015.)

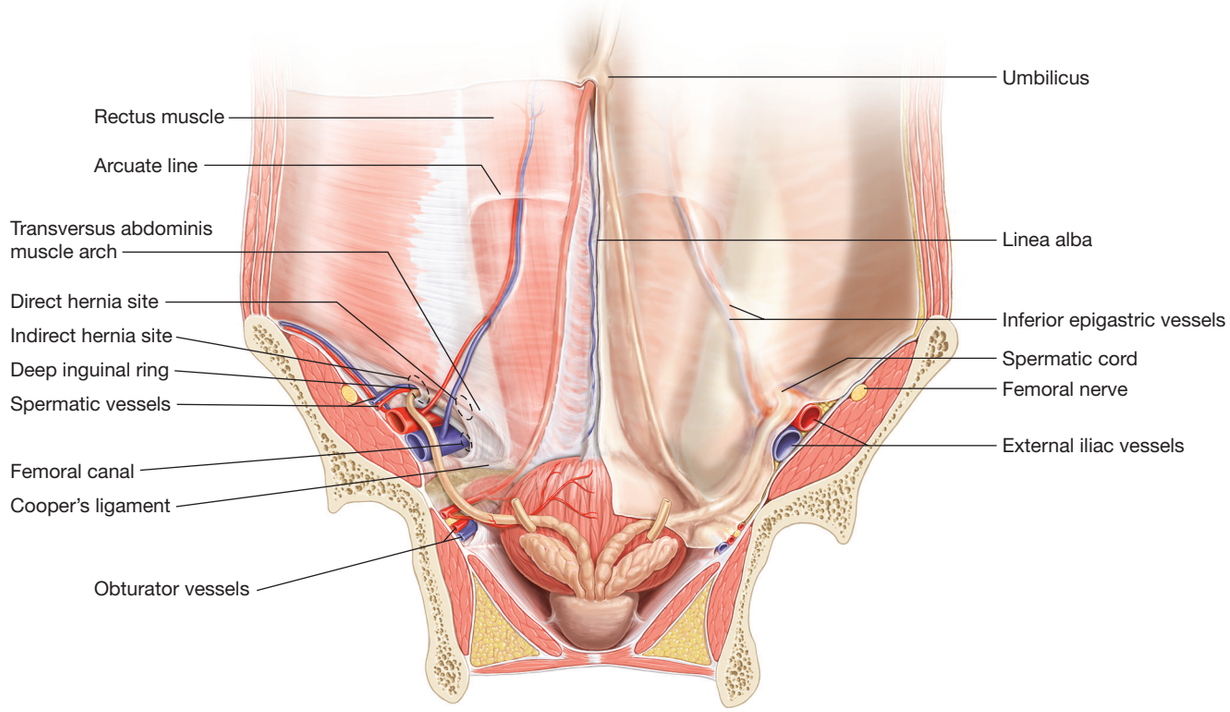

FIGURE 3-9. Anatomy of inguinal canal. (From Mulholland MW, et al. *Operative Techniques in Surgery*. Wolters Kluwer Health. Philadelphia, PA; 2015.)

can cause major bleeding and should be avoided. The triangle of pain is defined as spermatic vessel medially, the iliopubic tract laterally, and inferiorly the inferior edge of skin incision. This triangle contains the lateral femoral cutaneous nerve and anterior femoral cutaneous nerve of the thigh. Manipulation, dissection, and tacking should be avoided as nerve damage or entrapment can cause neuralgia.

SPECIAL INTRAOPERATIVE CONSIDERATIONS

As with many urgent or emergent general surgery situations, intraoperative decision-making is essential to optimize outcomes. Incarceration or strangulation increases the odds of gross spillage of bowel contents. In the case of bowel resection or other contamination, the surgeon will need to utilize biologic mesh or primary tissue repair. For a straightforward primary inguinal hernia with contamination, a Bassini repair would be a good choice. For this procedure, the lateral edge of the rectus sheath (i.e., conjoined tendon) is approximated to the inguinal ligament. A relaxing incision is made if there is any tension. For a femoral hernia with contamination, a Bassini repair will not be adequate because the femoral canal has not been addressed. In this case, a McVay (Cooper's ligament) repair is appropriate. With a McVay repair, the lateral edge of the rectus sheath (i.e., conjoined tendon) is approximated to Cooper's ligament. To perform these primary tissue repairs, the surgeon must be able to correctly identify these anatomical structures. In recurrent hernias or where acute inflammation obscures the anatomy, an alternative is to perform a Lichtenstein repair with biologic mesh. However, using biologic mesh will likely result in recurrent hernia as it is incorporated and weakens.

In certain circumstances, a laparotomy may be necessary. If there is any question of bowel compromise during inguinal exploration that cannot be managed with evaluation or resection via the inguinal incision, a laparotomy should be performed to further inspect the bowel and perform resection. In some cases, intra-abdominal adhesions may be too dense to adequately reduce the hernia through an inguinal incision. When forced to make a laparotomy, a lower midline laparotomy below the umbilicus is usually adequate. With this approach, the operator can choose to enter the peritoneal cavity or stay preperitoneal. Once a laparotomy is performed, it is also possible to perform an open preperitoneal repair, which is useful in recurrent hernias with anterior scarring and distortion of the relevant anatomy.

POSTOPERATIVE MANAGEMENT

Postoperative care for patients undergoing surgery for incarcerated inguinal hernias is mostly supportive, including correcting lab aberrations, providing intravenous hydration, optimizing pain control, and awaiting the return of bowel function. The period of observation should be dictated by the severity of presenting illness as well as postoperative

clinical progression. It is important to avoid the reduction of necrotic bowel into the peritoneal cavity. If this is the case, the patient will likely have continued or worsening bowel obstruction with overall deterioration of the clinical picture. If left untreated, abdominal sepsis will ensue.

Case Conclusion

The patient was taken emergently to the operating room (OR) for laparoscopic evaluation and repair. Upon initial diagnostic laparoscopy, portions of the small bowel as well as the sigmoid colon were found to be in a large direct hernia sac. Once fully reduced, it was apparent that all bowel was viable. Given the distorted anterior anatomy from previous hernia repair, a transabdominal preperitoneal approach with placement of prosthetic mesh was performed. A laparoscopic transabdominal preperitoneal approach is an excellent option for multiply recurrent hernias. Following the procedure, the patient was monitored, resuscitated, and had an uneventful postoperative course.

TAKE HOME POINTS

- Suspected incarceration or strangulation mandates immediate surgical intervention.
- The gold standard approach to suspected incarceration or strangulation is groin exploration to assess bowel viability and repair hernia.
- If the hernia cannot be managed through a groin incision, due to questionable bowel viability, intra-abdominal adhesions, or an inability to safely reduce the hernia contents, a lower midline laparotomy should be made.
- When bowel resection is necessary due to strangulation, prosthetic mesh should not be used. Instead, a primary tissue repair (e.g., Bassini or McVay) can be performed.
- Laparoscopic or open preperitoneal approaches can be used for multiply recurrent hernias, but it is essential to ensure viability of hernia contents before proceeding with these techniques.

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Ventral Incisional Hernia

4

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Based on the previous edition chapter "Ventral Incisional Hernias" by Vivian M. Sanchez and Kamal M.F. Itani

Presentation

A 73-year-old woman with a medical history notable for rheumatoid arthritis requiring immunologic therapy presents to outpatient surgery clinic with complaints of an abdominal bulge with associated discomfort. The symptoms have been present for more than 2 years with escalating severity. The pain occurs daily and is described as a constant, nonradiating, ache centered about the bulge that is worsened with standing and straining. No associated gastrointestinal obstructive symptoms are elicited. The patient is very active and works extensively in her community and exercises routinely. The bulge affects her ability to perform these activities. Her past surgical history is notable for total abdominal hysterectomy complicated by vaginal vault prolapse resulting in three subsequent operative interventions: anterior/posterior colporrhaphy, perineorrhaphy and retropubic urethropexy; cystocele repair; and abdominal sacral colpopexy with abdominal fascial harvest. All operations were done through a Pfannenstiel incision. On examination, her vital signs were within normal limits and her body mass index (BMI) is 28. She has a well-healed low transverse incision with an underlying ventral incisional hernia. The hernia is nontender and reducible with a palpable abdominal wall defect of approximately 5 cm. No overlying skin changes were noted.

DIFFERENTIAL DIAGNOSIS

The diagnosis of a ventral incisional hernia is usually straightforward, simply requiring the presence of an abdominal bulge with associated fascial defect in a patient with a prior history of an abdominopelvic operative intervention. The ascertainment of a fascial defect can be difficult in obese patients or with hernias that are chronically incarcerated. Incarceration generally describes the inability to completely reduce the hernia contents through the hernia defect.

Hernias can be chronically or acutely incarcerated. Chronically incarcerated hernias may remain asymptomatic for years, whereas an acute incarceration episode is often an emergent event. Reducibility generally describes the ability to spontaneously or manually place the hernia contents through the hernia orifice. A reducible and/or chronically incarcerated hernia usually does not merit an urgent operation, whereas acute incarceration of a hernia often warrants urgent evaluation and intervention to prevent progression of dire sequelae including strangulation or bowel obstruction. Strangulation refers to the condition in which the blood supply of the herniated viscus is so constricted by swelling and congestion as to compromise its circulation. Combining patient history and physical exam can most often lead to the accurate distinction between incarceration/reducibility and associated chronicity. Patients exhibiting signs and symptoms of acute incarceration/strangulation will often complain of acutely worsened pain over the site of the hernia and possibly obstructive gastrointestinal symptoms (nausea, emesis, obstipation, constipation). Concomitant physical exam will reveal an acutely tender bulge that is not reducible. Overlying skin inflammatory changes may also be present. Patients with chronic incarceration usually will not exhibit signs and symptoms of acute inflammation yet the hernia contents itself will not reduce.

Additionally, when evaluating a patient for a ventral incisional hernia, it is important to distinguish a ventral hernia from rectus diastasis. As opposed to a hernia, rectus diastasis refers to separation of the rectus abdominis muscles from the midline without a concomitant fascial defect. Diastasis recti will clinically present as a symmetric protrusion of the midline, extending from xiphoid to the umbilicus. This entity should be distinguished from incision-associated diastasis where no fascial defect may be discernable, but a previous operation has occurred in the area of a bulge. These entities are poorly understood in terms of best management. Treatment should be individualized and should generally include compression garments and physical therapy if impacting a patient's quality of life. The benefit of surgical intervention is unclear in diastasis recti, and most surgeon do not offer repair.

DIAGNOSIS AND TREATMENT

Though the diagnosis of ventral incisional hernia may appear obvious based on history and physical exam, it is prudent to entertain a differential diagnosis for the presenting symptoms, primarily abdominal pain. Among others, such diagnoses include small bowel obstruction, biliary processes (symptomatic cholelithiasis, chronic cholecystitis, and choledocholithiasis), pancreatitis, and urogynecologic pathologies. Abdominal and abdominal wall tumors should also be considered.

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FIGURE 4-1. CT scan revealing a 4 cm fascial defect of the lower midline with a 15 cm hernia sac containing multiple loops of nonobstructed small bowel with a septation propagating through the midportion of the sac.

Adjunct imaging for ventral incisional hernia management is usually employed in two situations: to establish the diagnosis of ventral incisional hernia and for operative planning. Surgeon-performed ultrasound has been shown to be an effective way to diagnose and characterize ventral incisional hernia with comparable results to computed tomography (CT) evaluation. This offers the benefit of reduced radiation exposure and quick assessment of the abdominal wall. Surgeon physical exam often has a higher false-negative rate in obese patients. In this patient, hernia repair by open approach with myofascial release via retromuscular repair is planned. The risks and benefits were thoroughly outlined and accepted. Medical optimization strategies prior to surgery, including weight loss and perioperative cessation of immunologically active rheumatologic medications, were initiated. Based on known medical history and current physiologic status, no further preoperative studies to assess cardiac and/or pulmonary status were felt necessary for the patient.

The patient in our case study underwent biochemical evaluation that revealed normal white blood cell count, liver function, and pancreatic enzymes. Subsequently, she underwent CT to confirm the diagnosis of ventral incisional hernia, to rule out concomitant pathologic processes, and to assist with operative planning. The CT revealed a 4 cm fascial defect of the lower midline with a 15 cm hernia sac containing multiple loops of nonobstructed small bowel with a septation propagating through the midportion of the sac (Figure 4-1). Notably, there was no radiographic evidence of bowel, gynecologic, urinary, biliary, or pancreatic pathology. The diagnosis of a symptomatic ventral incisional hernia was confirmed.

DISCUSSION

Ventral incisional hernias are an important entity to all surgeons who operate in the abdomen and pelvis, because they occur up to 30% of the time following laparotomy. As such, ventral incisional hernia repair is the most common reason for reoperation following laparotomy. The cost of hernia repair in the United States is approximately $4,000 to $16,000 for outpatient and inpatient repairs, respectively. Both the cumulative incidence and estimated costs are rising over time.

Ventral incisional hernias occur as a result of a combination of patient, perioperative, and technical factors. Patient factors increasing the risk of hernia formation include obesity, tobacco abuse, diabetes mellitus, malnourishment, connective tissue disorders, chronic obstructive pulmonary disease, use of immunosuppressant medications, and repeat abdominal operations. Perioperative and technical factors include surgical wound classification, surgical site infection, and technique for abdominal closure. Regarding technique, one of the most effective preventive measures is a "small bites" technique, which has been shown to reduce subsequent hernia formation.

Indications for acute operative repair of a ventral incisional hernia include strangulation and/or acute incarceration. Indications for elective repair of a ventral incisional hernia include bothersome symptoms (pain, discomfort, respiratory dysfunction, cosmetic concerns) and/or functional concerns (impact on quality of life, impairment of abdominal wall function). The majority of hernia operations are performed electively.

Though the approach to ventral incisional hernia repair will be discussed at length in the subsequent section, most agree that utilization of mesh in ventral incisional hernia repair is necessary to minimize the risk of recurrence. In a prospective study of ventral incisional hernia <6 cm, the recurrence rate was 24% and 43% (at 3 years) and 32% and 63% (at 10 years) for primary repair and repair with mesh, respectively. Beyond health benefit to the patient, recurrence minimization is important, for data reveal that a global 1% reduction in hernia recurrence would result in a $32 million yearly savings in procedural costs alone. Though use of mesh is widely utilized and endorsed, it should be noted that as outcomes are longitudinally tracked and assessed, mesh-related complications occur approximately 5% of the time.

SURGICAL REPAIR OF VENTRAL INCISIONAL HERNIAS

Approach

When planning an operative repair of a ventral incisional hernia, the surgeon must decide between a minimally invasive versus open repair and type of mesh. If an open technique is chosen, the location of mesh placement must also be considered.

The minimally invasive approach, typically performed laparoscopically, currently accounts for close to 30% of ventral incisional hernia repairs. When performing a laparoscopic approach, the mesh is typically placed in an intraperitoneal, sublay, position. Technically, the operative

approach requires safe peritoneal entry, careful lysis of adhesions with minimal use of thermal energy, placement of mesh with appropriate mesh/fascial overlap (>4 cm), and mesh fixation. The type of mesh utilized is dictated by sublay position. Typically, a permanent mesh that has an antiadhesive barrier is used for intraperitoneal placement. The repair is based on the principle of transmission of fluid pressure. Application of this principle dictates that as intra-abdominal pressure increases, the applied force is displaced equally across the mesh. Advantages to the laparoscopic approach include shorter operative time, decreased length of hospital stay, quicker patient recovery, and decreased wound complications. Disadvantages of a laparoscopic approach mainly concern the low but increased risk of unrecognized hollow viscus injury, which can lead to potentially catastrophic sequelae. Contraindications to laparoscopic repair include inability to tolerate general anesthesia or abdominal insufflation, strangulated hernia, hostile/frozen abdomen, and/or infected/contaminated field. Controversies yet to be resolved include the need for fascial closure, type of mesh fixation required, and the utility of robotically assisted minimally invasive approaches.

Beyond decreased recurrence rates, proponents of open repair often cite better functional outcome with restoration of normal abdominal wall anatomy and the reduced risk of unrecognized hollow viscus injury. Open ventral incisional hernia mesh placement techniques include inlay (bridging the defect with mesh), onlay (covering the defect with mesh and fascia overlap), and sublay repair (placing the mesh in a retromuscular, preperitoneal, or intraperitoneal position). Although mesh inlay and onlay techniques have benefit in specific settings, the sublay repair with retromuscular mesh placement has been deemed as the Americas Hernia Society preferred method of repair. Such preference is secondary to decreased recurrence rates and mesh-related complications. Technically, the repair requires peritoneal entry, adhesiolysis, retromuscular dissection, reconstruction of the posterior sheath, mesh placement, and reconstruction of the anterior layer. If further mobilization is required, transversus abdominis or external oblique releases may be required. The type of mesh utilized in this reconstruction is dependent largely on risk of wound complications. In low-risk wounds (typically clean), midweight or heavyweight permanent meshes are usually employed. In higher-risk wounds (clean contaminated or contaminated), an array of mesh types can be considered including biologics, bioabsorbables, or lightweight/midweight macroporous polypropylene products. In heavily contaminated settings, permanent prosthetics and slowly resorbable meshes should be avoided.

Postoperative Management

The postoperative management following ventral incisional hernia repair starts with preoperative planning. Patients often benefit from preoperative placement of an epidural or regional nerve block for adjunctive pain management. These patients not only benefit from improved pain control, but narcotic minimization also has multiorgan system benefits. Diet advancement is often based on the extent of lysis of adhesions and need for concomitant procedures (e.g., bowel resection). In general, most patients can tolerate a clear liquid diet when awake with advancement of diet upon return of bowel function. To distribute tension across the abdominal wall, all patients should wear an abdominal binder for the first four weeks after operation. Following Surgical Care Improvement Project (SCIP) guidelines, preoperative antibiotics are given prior to incision and are generally carried out for the remainder of the 24 hour perioperative setting. Additionally, patients are provided both mechanical and pharmacologic venous thromboembolism prophylaxes. Most often, operative drains are left superficial to inserted mesh and deep to created lipocutaneous flaps, if present. Retromuscular drains are usually left until output is <50 mL per day and/or the patient is discharged from the hospital (usually 3 to 5 days). Subcutaneous drains are usually left in place until output is <30 mL per day.

Postoperative Complications

Wound complications are the most common issues after ventral incisional hernia repair. Surgical site infections and surgical site occurrences have been well defined for this clinical entity. Infections should be treated with antibiotics and drainage, as indicated. Depending on clinical response and degree of infection, mesh excision may be required, but mesh salvage can usually be achieved depending on prosthetic type and patient factors. Noninfectious wound complications (hematoma, seroma, flap necrosis, etc.) should be managed expectantly. Pulmonary complications following ventral incisional hernia repair are not uncommon. Postintubation status, poor respiratory effort and clearance secondary to inadequate pain control, and decreased compliance given increased intra-abdominal pressure often lead to plugging, pneumonia, hypoxia, and hypercarbia. Hernia repair patients are also at risk for aspiration given likelihood of ileus secondary to concomitant bowel manipulation during adhesiolysis. Another feared complication is the creation of intra-abdominal hypertension (IAH). The acute increase in intra-abdominal pressure may adversely affect venous return/cardiac output, pulmonary compliance, and renal blood flow and function. The management of IAH first requires appropriate recognition and diagnosis. Most surgeons advocate following intraoperative change in plateau airway pressures as a marker of dynamic changes in intra-abdominal pressures. The postoperative management of IAH is supportive: continued mechanical ventilation with paralysis for elevated airway pressures with consequent hypercarbia and judicious fluid management to augment the decrease in preload and subsequent decrease in cardiac output. Decompressive laparotomy is rarely needed to treat IAH induced by abdominal wall reconstruction.

Case Conclusion

The patient underwent an open ventral incisional hernia repair with posterior rectus sheath mobilization and mesh insertion. First, a lower midline incision was created and the abdomen was entered sharply through the hernia sac. Adhesions from the omentum and transverse colon to the anterior abdominal wall were lysed. A 9 × 5 cm hernia defect was noted. The fascia was noted to be of good quality bilaterally. The space of Retzius was entered inferiorly and the preperitoneal space was developed to the pubis. Similarly, the preperitoneal space in the midline was mobilized toward the upper abdomen. Next, bilateral retromuscular mobilizations were performed by separating the posterior rectus sheath from the rectus muscle (Figure 4-2). This facilitated advancement of the linea alba to midline. The posterior rectus sheath was reapproximated using running absorbable suture. Next, a 25 × 15 cm midweight, macroporous, polypropylene mesh was inserted into the retromuscular and preperitoneal spaces and sutured to the abdominal wall. Two closed suction drains were then placed over the mesh. The linea alba was closed with running absorbable suture. The subcutaneous tissue and skin were then closed in successive layers with running absorbable suture.

The patient underwent epidural insertion preoperatively. Postoperatively, given the minimal amount of adhesiolysis required, she was given a clear liquid diet. As her bowel function returned, her diet was advanced to a regular diet. Her pain control was weaned from an epidural to a multimodal oral pain regimen. She was able to void spontaneously after catheter removal. Following her clinical progression, she was discharged to home on postoperative day 4. Her drains were removed prior to discharge, as is usually the case in patients undergoing open retromuscular ventral incisional hernia repair. Routine follow-up after this type of repair includes postoperative visits at 4 weeks with continued evaluation for 1 to 3 years after operation depending on practice preference.

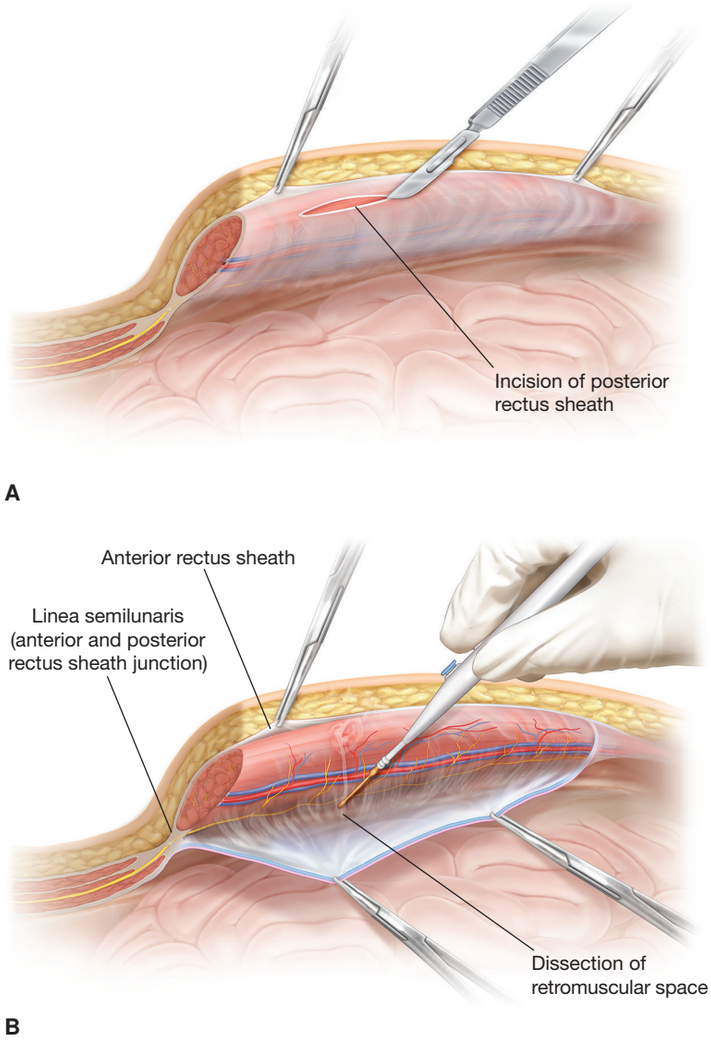

FIGURE 4-2. **A:** The posterior rectus sheath is incised 1 cm lateral to the linea alba to gain access to the retrorectus space. **B:** The posterior rectus sheath is separated off the rectus muscle until the lateral edge of the rectus is identified by the presence of the perforating neurovascular bundles. (Reprinted from Hawn M. *Operative Techniques in Foregut Surgery*. Philadelphia, PA: Wolters Kluwer; 2015, with permission.)

TAKE HOME POINTS

- Incisional hernia is a common consequence of laparotomy.
- Laparoscopic and open incisional hernia repair are both reasonable options. Laparoscopic repair is associated with decreased wound complications and shorter hospitalizations/recovery. Open repair via retromuscular sublay technique offers decreased recurrence rates and improved abdominal wall function.
- Use of mesh is recommended in the repair of an incisional hernia. The type of mesh utilized is dictated by anatomic location of insertion and wound risk.

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