Atypical Hernias
Suprapubic, Subxiphoid, and Flank

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INTRODUCTION

Hernias located near bony prominences or off midline can be difficult to repair because of the challenge of obtaining a tension-free repair with wide overlap of mesh prosthetic and adequate fixation. The most common locations for these atypical hernias are in the subxiphoid, suprapubic, and flank, and the location is often related to previous incisions. The 2 techniques most often used for repair are the open and laparoscopic approach. Although there are several different techniques described for these hernias, several principles are important to review.

- Goals of the repair should be individualized and discussed with the patient preoperatively, which can help the surgeon decide between the open and laparoscopic approach.
- Although not mandatory, computed tomography (CT) scanning can help with surgical planning and decisions regarding surgical technique.
- Because of lower recurrence rates, mesh use should be considered in all cases, unless the hernia is small or there is a contraindication. Wide overlap of

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mesh with appropriate fixation is essential for success in these difficult hernias, and the use of bridging techniques with mesh is discouraged.

- In general, synthetic mesh is used, because there are few data regarding the use of biological meshes in atypical hernias, and the data available lack long-term follow-up. When synthetic mesh is not applicable, biological or bioabsorbable mesh can be used. Mesh choice should be based on clinical factors and the surgeon’s preference.
- Adjunctive maneuvers for fascial closure, such as component separation, often cannot be used in atypical hernias because of the location of the fascial defects.

PREOPERATIVE PLANNING

Patients should be prepared as with any patient undergoing a ventral hernia repair, with a few special caveats.

- Patients undergoing flank hernia repair require elevation of the ipsilateral side of the hernia for adequate exposure of the hernia and adequate mesh fixation. This can be achieved by placing a bump or with the use of a bean bag.
- In patients undergoing laparoscopic repair of subxiphoid and suprapubic hernias, tucking and padding both arms help the surgeon and assistant move freely on the side of the patient.
- The use of a 3-way Foley catheter is helpful during laparoscopic suprapubic hernia repair, because many patients require laparoscopic takedown of the bladder.

Patients undergoing repair of atypical hernias should have preoperative antibiotics, deep vein thrombosis prophylaxis, and β-blockers depending on the clinical situation.

SURGICAL TECHNIQUE

The surgical techniques most likely to produce a successful repair facilitate a wide overlap with mesh of the hernia defect with adequate fixation. Whether this is performed using the laparoscopic or open approach should be determined by various patient factors and the goals of the repair.

**Suprapubic Hernia**

*Open approach*

Many techniques are used for the treatment of ventral hernias. The 2 most common techniques are an underlay (the mesh is placed posterior to the hernia defect intraperitoneal, or retrorectus) and an overlay (the hernia defect is closed, and the mesh is placed above the defect). The bridging-type repair, in which the mesh is sewn to the fascia, results in a high recurrence rate and should be used only in special clinical circumstances (Fig. 1).

Our preferred technique for open repair of a suprapubic hernia is the underlay technique, with the mesh in the retromuscular position. The preperitoneal space is dissected to the pubic bone, allowing mesh placement and fixation to the pubis. Thorough knowledge of the relative anatomy and myofascial components of the abdominal wall are essential for a successful operation.

*Preoperative planning*

- Abdominal CT is useful to assess the size and location of the hernia, occult incarceration of bowel or bladder, previous mesh material, and the integrity of abdominal wall musculature.
Screening colonoscopy is needed in some clinical situations before abdominal wall reconstruction.

Nutritional evaluation and smoking cessation are important, because these are risk factors for wound issues after this surgery.6

Positioning

- The patient is positioned supine with arms to the side, a Foley catheter is placed, and antibiotics and deep vein thrombosis prophylaxis are given based on surgeon preference and the clinical situation.
- Most suprapubic hernias are incisional hernias from lower midline or Pfannenstiel-type incisions (Fig. 2).

Fig. 1. Techniques of mesh placement. (A) Onlay technique. (B) Inlay or bridge technique. (C) Retrorectus or underlay technique. (From Shell DH 4th, de la Torre J, Andrades P, et al. Open repair ventral Incisional hernias. Surg Clin North Am 2008;88:69; with permission.)

- Screening colonoscopy is needed in some clinical situations before abdominal wall reconstruction.
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Fig. 2. Preoperative photograph of patient with a multiple recurrent suprapubic incisional hernia.
Abdominal access
- A lower midline incision is often used and can be extended superior to the umbilicus depending on the size of the hernia. If there is a large scar from previous surgery, this can be excised.
- As in all open hernia surgery, careful abdominal entry is required to avoid iatrogenic injury, because intestinal contents and, in the case of suprapubic hernias, the bladder, can be in the hernia sac.

Lysis of adhesions
- After the abdomen is safely entered, adhesiolysis is performed sharply with scissors to clear the right and left side of the abdomen and the superior and inferior borders of the incision.
- All abdominal adhesions should be cleared, if possible, depending on the clinical situation.

Retromuscular dissection
- Obtaining preperitoneal or retrorectus access is an essential skill for hernia surgeons. Creating these planes allows the surgeon to place the mesh in the retromuscular position without contact with the abdominal viscera and is a well-accepted method for hernia repair.\textsuperscript{7,8} Another theoretic advantage of the retromuscular position of mesh, compared with an onlay position, is that in the case of a superficial wound infection, the mesh is still covered by muscle and fascia and potentially avoids mesh infections.
- The retrorectus plane is often easier to obtain in patients with previous surgery. The posterior rectus sheath is incised approximately 0.5 cm from its edge. This incision is usually made at the level of the umbilicus or in the midportion of the wound if the incision is a lower midline. The rectus muscle and the glistening white posterior rectus sheath should be visible (Fig. 3).
- The incision of the posterior rectus sheath is extended superiorly and inferiorly and laterally to the linea semilunaris. Dissection is usually performed bluntly with finger dissection or a peanut. Care must be taken to identify and preserve the intercostal nerves and vessels to maintain a functional abdominal wall.
- The retrorectus plane is taken all the way to the pubis above the bladder. The superior extent of dissection depends on the size of the hernia but should be
dissected at least 4 to 5 cm above the edge of the facial defect to allow for appropriate mesh overlap.

- Preperitoneal dissection is also an option, although it is often more technically difficult. If the thin layer of peritoneum can be dissected, it should be dissected laterally as far as needed for sufficient mesh overlap, to the pubic bone inferiorly, and 4 to 5 cm above the fascial defect superiorly.

- One benefit of the preperitoneal space compared with the retrorectus space is the ability to place larger pieces of mesh, because the lateral dissection plane is not confined by the lateral border or the rectus sheath, and dissection all the way toward the retroperitoneum and kidney can be performed.

- One drawback of preperitoneal placement is not cutting the posterior rectus sheath, which does not produce the component release that may be needed to help close the midline fascia above the mesh.

- One potential solution to these problems may be the newly described posterior component separation with transversus abdominus release. This technique involves dividing the transversus abdominal muscle medial to the linea semilunaris, allowing mesh to be placed laterally in the position between the transversalis fascia and the lateral edge of the divided transversus abdominus muscle.

Closure of retromuscular tissue

- After the preperitoneal or retrorectus dissection has been completed and holes or fenestrations closed with absorbable suture, the tissue is closed in the midline using absorbable suture (we use a 0 Vicryl suture).

- Before closure, make sure the needle, sponge, and instrument count is correct and there are no problems in the abdomen, because closure excludes the abdominal cavity to the surgeon for the rest of the operation.

- After the peritoneum or posterior rectus sheath is closed, the space available for mesh placement can be measured.

Mesh choice/placement

- Because the mesh has been excluded from the abdominal cavity, a mesh with adhesion barriers is usually not needed (unless there are fenestrations or holes in the tissue allowing mesh to contact bowel). Synthetic meshes are preferred unless not clinically appropriate. We prefer large, macroporous, reduced-weight polypropylene mesh.

- After the mesh is chosen, it is placed in the sublay/retromuscular position.

Mesh fixation

- The inferior of the mesh is fixed to the pubis and Cooper ligament with monofilament sutures. This can be achieved by suturing the mesh directly onto the pubis and Cooper ligament or by bringing out transfascial sutures just above the pubis.

- The most likely area of recurrence in suprapubic hernias is inferiorly, so adequate fixation in this area is crucial. Depending on the size of the defect, 1 to 5 sutures are placed in this area with tack fixation if needed.

- Additional full-thickness, transfascial sutures are placed using a suture passer or Reverdine needle. The number of sutures needed varies based on the defect size and amount of mesh overlap obtained (usually 1–3 sutures for the superior portion of the mesh and 1–2 on the right and left side of the mesh).

- Mesh fixation should be taut, because the mesh buckles with anterior fascial closure, which should be attempted in all cases.
One or 2 closed suction drains are placed above the mesh, below the fascial closure. These drains are usually left in for several days until the output is less than 30 mL/d.

**Fascial closure**
- After the mesh is secure, anterior fascial closure should be attempted in all cases. This is achieved with a slowly absorbing running or interrupted suture. This technique allows for medicalization of the rectus muscle and coverage of the mesh, protecting it from exposure in the event of wound infection if wound opening is required.
- If the fascia cannot be closed, the hernia sac is closed over the mesh to provide coverage.
- In suprapubic hernias, because of the location of the defect, fascial closure with the aid of a component separation is not an option (for the suprapubic part of the fascia).
- If the defect is large and obtaining fascial closure is impossible, every effort should be made to preserve the hernia sac during the initial dissection.

**Closure/postoperative care**
- The wounds are irrigated, drains sutured in, and skin approximated with skin staples.
- Patients usually require hospital admission for pain control and return of bowel function. Routine postoperative care includes slow advancement of diet and activity and monitoring of the wound and drain output.

**Laparoscopic approach**
The laparoscopic approach to the suprapubic hernia is an excellent option for repair in some patients. Laparoscopic repair for the suprapubic hernia follows the same initial steps as that for any other midline ventral hernia.

**Positioning/draping**
- The patient is placed supine with bilateral arms tucked. We typically use an Ioban-type drape, although these have not been shown to decrease mesh infections.

**Obtain safe laparoscopic access**
- Although obtaining safe laparoscopic access can be straightforward, it can also be complicated in patients with many previous operations, which in some cases can preclude using the laparoscopic approach.
- In general, the surgeon should use the access technique that they are most skilled with.

**Port placement**
- Three to 5 trocars are used for laparoscopic repair based on the complexity of the case. One of the trocars should be an 11-mm or 12-mm trocar to help with mesh placement and facilitate a 10-mm camera if better visualization is needed for difficult adhesiolysis.
- The ports are usually placed on the lateral right and left abdomen but can be placed in a semicircular configuration depending on the size of the hernia.
- It is helpful to have at least 2 ports on each side of the abdomen to assist when tacking the mesh, which provides visualization from all angles.
Diagnostic laparoscopy and laparoscopic lysis of adhesions
- Diagnostic laparoscopy and laparoscopic lysis of adhesion is one of the most critical portions of the operation and can result in complications such as bleeding or enterotomy if not approached carefully. It can also be straightforward or challenging depending on the tenacity and extent of adhesions.
- In general, lysis of adhesion is performed sharply with laparoscopic scissors. When the surgeon is certain that the adhesions contain only omentum and no bowel, energy sources can be used with caution.
- Complete lysis of all abdominal adhesions is generally recommended but depends on the size of the defect and size of mesh used.
- After lysis of adhesions, inspect the omentum and bowel for bleeding and occult bowel injury.

Laparoscopic takedown of the bladder
- This part of the procedure is unique to the laparoscopic repair of suprapubic hernias. This bladder takedown is greatly aided by the use of a 3-way Foley catheter placed at the beginning of the operation.
- When preparing to take down the bladder, the drainage part of the Foley catheter is clamped, and approximately 300 mL of sterile normal saline is introduced into the bladder until it is identified (Figs. 4 and 5).
- The peritoneum is incised in the midline, and flaps are extended laterally. This procedure is often bloody, so scissors with cautery or energy devices are helpful.
- The plane is developed all the way to the pubic bone bilaterally, keeping the distended bladder inferior to the dissection (Fig. 6).

Measuring the hernia defect
- After all the adhesions and bladder have been taken down, intracorporeal measurement of the hernia defect is recommended. This measurement can be made using spinal needles and a suture or a ruler.
- The longitudinal and transverse diameter of the defect are measured and documented.

Mesh choice
- Several factors including surgeon preference contribute to the choice of mesh.

Fig. 4. A 3-way Foley catheter is helpful in laparoscopic suprapubic hernia repair. The Foley catheter is instilled with saline and clamped to allow for the bladder to distend, which allows intraoperative visualization.
Because the mesh used in the laparoscopic repair has contact with the abdominal viscera, use a coated polypropylene or polyester mesh or a Gore-Tex-based mesh, either alone or as a composite-type mesh, with the Gore-Tex side placed toward the viscera.

- Mesh size should be based on the size of the hernia; however, at least a 4-cm overlap on each side is recommended.

### Mesh preparation/placement

- Although there are many techniques for mesh placement and fixation, 1 common technique involves placing 4 sutures at the periphery of the mesh at the midpoint of the superior, inferior, and right and left lateral side.
- With a low suprapubic hernia, place the inferior stitch 2 to 4 cm off the periphery of the mesh. This strategy provides an extra 2 to 4 cm of mesh overlap on the pubic bone for tack fixation on the pubis.
- The mesh is then rolled as a scroll and placed through 1 of the large 11-mm or 12-mm trocars. Except for extremely large pieces of meshes, most can be placed through 1 of the larger trocars.

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Fig. 5. With instillation of the bladder with saline, the bladder is easily visualized, making dissection easier.

Fig. 6. Suprapubic hernia with large central defect requiring laparoscopic takedown of the bladder to facilitate mesh placement and fixation to the pubic bone and Cooper ligament.
One technique is to place a grasper from the opposite side of the abdomen through the 11-mm or 12-mm trocar and remove the head of the trocar (or entire trocar). Pull the mesh in by twisting and constant pressure.

After the mesh is inside the abdomen, orient it correctly so the appropriate side of the mesh is facing the viscera (if applicable). The 4 sutures are then brought up through the abdominal wall using a suture passer.

For suprapubic hernias, it is important to pull up the inferior stitch, which should be brought up at the pubic bone or right above, first. Doing so ensures that the mesh is placed appropriately.

**Mesh fixation**

- Controversy about mesh fixation relates to whether suture fixation is needed for adequate fixation, and there is no consensus on this issue.\(^{11}\)
- The 2 most common techniques for fixation are a combination of suture and tack fixation and the double-crown technique of placing 2 rows of tacks only for fixation.\(^{12,13}\)
- Whichever technique is chosen, recurrence is most likely in the inferior/pubic region. Additional suture fixation is warranted in this area.
- In addition, to avoid neurovascular injuries when placing tacks in the suprapubic region, bimanually palpate the tip of the tacker externally to ensure that the tacks are placed above the iliopubic tract.
- The mesh should be adequately fixed and taut, because it relaxes when the pneumoperitoneum is removed (Figs. 7 and 8).

Fig. 7. Mesh placement in laparoscopic repair of suprapubic hernia. The mesh is adequately fixed to the pubic bone with transabdominal sutures and tacks. (From Polouse BK. Laparoscopic repair of atypical hernias. In: Rosen M, editor. Atlas of abdominal wall reconstruction. New York: Elsevier; 2011; with permission.)
The 2 main options for tack fixation involve permanent and absorbable tacks. Although some animal studies have compared different types of tack fixation, there is no strong clinical evidence that shows the superiority of either type of tack fixation, so this is left to the surgeon’s discretion.14,15

**Closure**
- After mesh placement, the omentum and bowel are examined again to rule out bleeding or occult bowel injury.
- Ports larger than 5 mm are closed using an open or laparoscopic technique.
- Ports should be removed under direct vision and incisions closed.

**Postoperative care/considerations**
- Most patients require admission to the hospital for pain control and observation. Patient-controlled analgesia pumps can be used, depending on the clinical situation.
- Because postoperative pain can be a difficult problem, we use several preoperative and postoperative adjuncts, including placing local anesthesia before port and transfascial suture placement and using nonsteroidal antiinflammatory medications.
- Depending on the amount of adhesiolysis, patients can develop an ileus, which is managed with ambulation, bowel rest, and time.
- Because of the nature of the laparoscopic repair, many patients with large hernia defects develop a postoperative seroma. Although these are seldom problematic, patients should be aware of this possibility preoperatively.
Subxiphoid hernia Subxiphoid hernias are most often encountered as incisional hernias after upper midline surgery, cardiac surgery, and occasionally recurrent hernias above a previously placed mesh. These hernias are difficult, because of the limit of the coastal margin and xiphoid process for transfascial fixation. Laparoscopic and open approaches are successfully used for repair of these difficult hernias.

Open approach

Preoperative planning
- Patients undergo standard evaluation for hernia surgery with CT scanning.
- Patients should be appropriate candidates for repair and understand the goals of the surgery.

Positioning
- The patient is positioned supine with arms to the side.
- A Foley catheter is placed, and appropriate antibiotics and deep vein thrombosis prophylaxis are given.

Abdominal access
- An upper midline incision is used and can be extended inferiorly to the umbilicus depending on the size of the hernia.
- A large scar from previous surgery can be excised.
- Careful abdominal access must be gained to avoid injury to abdominal contents, which can be present in the hernia.

Lysis of adhesions
- Complete abdominal wall adhesiolysis should be performed and the abdomen explored to rule out disease/abnormalities.

Retromuscular dissection/closure
- Although an onlay-type open repair of a subxiphoid hernia is feasible, getting into the preperitoneal or retrorectus space likely facilitates more mesh overlap.
- Depending on the size of the defect and the surgeon’s preference, either a preperitoneal or retrorectus repair is chosen.
- A retrorectus dissection usually allows adequate mesh overlap, except in large hernias.
- The most difficult location for mesh overlap and fixation is at the xiphoid. Fascial defects going all the way to the xiphoid can be challenging to repair.
- After the preperitoneal space or retrorectus space has been dissected (as previously described), the tissue is closed in the midline. Even in difficult subxiphoid hernias, several centimeters of mesh overlap underneath the xiphoid should be possible (Fig. 9).
- Place suture fixation on the lateral borders of the xiphoid, if needed.

Mesh choice/placement
- Because the mesh is excluded in this type of repair, an uncoated polypropylene or polyester mesh can be used. We recommend a large, macroporous, reduced-weight mesh.

Mesh fixation
- Mesh fixation can be difficult in subxiphoid hernias. The mesh can be fixed just below the xiphoid or sutures brought up on the lateral side of the xiphoid, using suture passers.
The upper edges of the mesh should overlap the ribs, and transfascial sutures can be placed just below the coastal margin. This technique usually provides adequate fixation.

The superior portion around the xiphoid and costal margin are fixed first, then the inferior and lateral portions of the mesh.

Four to 8 transfascial sutures are usually required, depending on the size of the defect.

Fascial closure

- Fascial closure should be per the surgeon’s preference.
- Because external component separation imparts little advantage in the upper-most fascia/subxiphoid region, this technique is seldom required, unless there is a large hernia low in the abdomen.
- Fascial closure can be difficult just below the xiphoid. A standard running closure with slowly absorbing suture is recommended.\textsuperscript{16,17}
- Before fascial closure, 1 to 2 closed suction drains can be placed to lie above the mesh.

Closure/postoperative care

- Wounds are irrigated, drains sutured in, and skin approximated with skin staples.
- Transfascial suture sites can be covered with a surgical glue, Steri-Strips, or other dressing.
- Patients usually require hospital admission for pain control and return of bowel function.
- Routine postoperative care includes slow advancement of diet and activity and monitoring of the wound and drain output.

Laparoscopic approach

Patient positioning/draping

- The patient is placed supine with both arms tucked and padded. Ioban drapes are used per the surgeon’s preference.

Laparoscopic access

- Laparoscopic access uses either an open or closed technique. Subxiphoid hernias usually occur in patients with previous surgery, so laparoscopic access should be gained cautiously.
Avoid entering the abdomen at previous incision sites, because of the likelihood of adhesions.

**Port placement**
- Three to 5 trocars are used based on the complexity of the case, with 1 trocar being 11 mm or 12 mm. Three trocars are usually placed on the left lateral abdomen and 1 or 2 on the right lateral abdomen, depending on the hernia size.
- If the hernia is confined to the upper abdomen, the inferior trocars are brought in medially in a semicircular configuration. However, in general, trocars should be placed as lateral on the abdominal wall as possible to facilitate range of motion of instruments and allow wide mesh overlap and visibility.

**Diagnostic laparoscopy and laparoscopic lysis of adhesions**
- Diagnostic laparoscopy should be performed to identify adhesions and associated abdominal disease.
- Depending on the amount and tenacity of adhesions, it is sometimes prudent to convert to an open operation early to save time and avoid the possibility of iatrogenic enterotomy.
- Careful, sharp lysis of adhesions is then pursued.

**Laparoscopic takedown of the falciform** This part of the procedure is unique to laparoscopic repair of subxiphoid hernias.
- Takedown of the falciform ligament is mandatory in most subxiphoid hernias to allow for adequate mesh overlap.
- After the abdominal wall is cleared of adhesions and the hernia is visualized, the falciform should be taken down using cautery and scissors all the way up to the diaphragm (Fig. 10).
- Energy devices can be used, because hemostasis is crucial, and bleeding often occurs at the beginning of the dissection.
- Part of the falciform can be within the hernia defect, so every effort should be made to reduce this and take the ligament down close to the abdominal wall.

**Measuring the hernia defect**
- The hernia defect is measured intracorporeally, as described earlier, obtaining a transverse and longitudinal measurement.

![Fig. 10](image-url). Laparoscopic takedown of the falciform ligament is mandatory in repairing subxiphoid hernias to allow adequate mesh overlap. This takedown can be achieved with energy devices or scissors with electrocautery.
Mesh choice
- Several mesh types are used for this repair, but the mesh should be appropriate for intra-abdominal placement. This mesh is usually an absorbable coated polyester or polypropylene, composite mesh with polypropylene and Gore-Tex, or plain Gore-Tex mesh.

Mesh preparation/placement
- Mesh preparation and placement are similar to suprapubic hernias, as described earlier. However, for subxiphoid hernias, the superior-most stitch placed in the mesh often must be brought down several centimeters so that it can be brought out just below the xiphoid.
- Placing the stitch several centimeters below this position facilitates mesh overlap above the xiphoid, which is key for a successful repair (Fig. 11).
- After 4 sutures are placed, the mesh is rolled as a scroll and pushed or pulled through one of the 11-mm or 12-mm port sites.

Mesh fixation
- Mesh fixation follows the same principles as for the suprapubic hernia repair, with a few caveats.
- In subxiphoid hernia repair, fixation above the coastal margins is generally not recommended, because fixation in this area can cause chronic pain, and tack fixation can cause pericardial injury.\(^{18}\)
- For subxiphoid hernias, tacks are placed at the costal margin, and, if warranted, additional transfascial suture fixation can be placed just below the costal margin.
- An important key to successful laparoscopic repair is to ensure adequate mesh overlap up to the diaphragm, even if it cannot be adequately fixed. This mesh is pushed up by the liver and allows for wide overlap of the hernia. Alternatively, the excess mesh above the costal margin and xiphoid can be glued to the abdominal wall.

Closure
- After mesh placement, the omentum and bowel are examined for possible bleeding or occult bowel injury.

Fig. 11. Placing the initial transfascial suture several centimeters below the cephalad portion of the mesh allows mesh overlap above the xiphoid and costal margin. This upper portion of the mesh can be fixed with fibrin sealant or the liver can hold the mesh in place. (From Polouse BK. Laparoscopic repair of atypical hernias. In: Rosen M, editor. Atlas of abdominal wall reconstruction. New York: Elsevier; 2011; with permission.)
- Ports larger than 5 mm are closed using an open or laparoscopic technique, and ports should be removed under direct vision.
- The incisions are closed per the surgeon’s preference.

Postoperative care/considerations
- Routine postoperative care is used, and most patients require admission to the hospital for observation and pain control.
- Depending on the size of the hernia, patients often develop seromas at the site of the hernia.
- These seromas are usually asymptomatic and require no intervention.
- The possibility of seroma development should be discussed with the patient preoperatively to alleviate anxiety after surgery.

Flank hernia  Flank hernias are a challenge, because they are bordered by several bony structures and sometimes provide limited tissue to work with. Incisional hernias from iliac bone harvest, trauma, and retroperitoneal surgery for aortic disease, urologic/kidney disease, or spine exposure are the most commonly encountered flank hernias; however, there are some congenital flank hernias that warrant mentioning. The congenital or lumbar-type hernias can be subclassified into superior triangle (Grynfeltt) or inferior triangle (Petit) defects. The proximity of many of these hernias to bony structures, such as the iliac crest and 12th rib, make them especially challenging to fix. Laparoscopic and open approaches to these difficult hernias are discussed, including the importance of wide mesh overlap with appropriate fixation for durable repair.

Open approach
Preoperative planning
- CT scanning is recommended to help determine the size and location of the hernia and previous mesh or foreign material, which may be encountered at the time of surgery.
- The CT scan also helps distinguish a true hernia from laxity of the flank region, which can occur from denervation of the thoracic nerves.
- Because these repairs often require large incisions and dissections, postoperative pain management can be problematic. Placement of epidural catheters or other pain management adjuncts is advised in these cases.
- Appropriate preoperative antibiotics and deep vein thrombosis prophylaxis should be administered.

Patient positioning/preparing
- Patients are placed in the lateral decubitus position using a beanbag or roll.
- The approximate degree of laterality should be determined by the size and location of the hernia.
- The patient is padded and secured to the bed with an axillary roll.
- A wide preparation including the midline of the abdomen is recommended. Ioban-type dressings may be used to assist in draping.

Incision/abdominal access
- For flank incisional hernias, the incision is typically made overlying the previous incision, and the scar can be excised if unsightly or per the patient’s preference.

Dissection/adhesiolysis
- Dissection is carried down through the Camper and Scarpa fascia to identify the musculature of the abdominal wall.
If the hernia sac is encountered, this can be carefully opened or left intact and dissected laterally to the fascial edges. It is preferable to leave the hernia sac intact and use it to dissect into the preperitoneal space without having to enter the abdomen.

If the abdominal cavity is entered, careful adhesiolysis is needed.

If the hernia sac cannot be located, the layers of the abdominal wall are divided, including the external oblique, internal oblique, and transversus abdominis.

The preperitoneal plane is the ideal plane to place the mesh in flank hernias, because it allows large overlap of a mesh prosthetic. This preperitoneal plane can be dissected at the fascial edges if the abdominal cavity/hernia sac is entered or by dissecting the hernia sac to the lateral edges of the fascia.

After the preperitoneal space is entered, it is bluntly dissected to allow for a large area for mesh placement. It can be dissected to the diaphragm superiorly, posteriorly to the psoas muscle, medially to the rectus sheath or linea alba, and inferiorly to the Cooper ligament and the pelvis (Fig. 12).

The peritoneum is closed if it was entered and all holes closed with an absorbable suture, excluding the space from abdominal viscera.

Mesh placement

- The preperitoneal space is measured to choose the appropriate size of mesh.
- The mesh is oriented and placed in the space to gauge the appropriate size.
- Cutting mesh is not usually recommended; however, most meshes can be cut to size without damaging the mesh to achieve an appropriately taut and well-fitted mesh.
- The mesh is fixed posteriorly first with transfascial sutures using a suture passer under direct vision. The amount of space available to place transfascial sutures is limited by the iliac crest and other structures.
- Several approaches can be used to achieve adequate fixation. Bone anchor fixation has been described.19,20
- Alternatively, mesh can be fixed at the edge of the iliac crest, and the mesh can overlap into the preperitoneal space. This excessive mesh without suture fixation can be glued into place using commercially available surgical glues.
- The recommended method of fixation starts posteriorly, then medially, then inferiorly, and superiorly, but this can be based on the surgeon’s preference (Fig. 13).
- The important point is wide overlap with adequate fixation and for the mesh to be under physiologic tension.
- It is helpful to be sure that the bed is neutral and not flexed (if this was used to expose this area at the beginning of the operation).

Closure

- After suture fixation of the mesh, closed suction drains are placed above the mesh, depending on the amount of dissection.
- The area is irrigated, and the fascia closed using a slowly absorbing monofilament running suture.

Postoperative care

- Routine postoperative care is used, with a special emphasis on pain control. Abdominal binders are useful for patient comfort and for a feeling of stability. Closed suction drains are left until the output is less than 30 mL/d.
Laparoscopic approach

Flank hernias can be successfully repaired laparoscopically, but to be safely performed, this requires advanced laparoscopic and dissection skills and knowledge of the details of the retroperitoneal anatomy.

Fig. 12. Dissection of the preperitoneal space for flank hernias. The dissection can be carried out toward the diaphragm superiorly, posteriorly to the psoas muscle and spine, medially to the linea alba, and inferiorly to the Cooper ligament. (From Philips MS, Rosen MJ. Open flank hernia repair. In: Rosen M, editor. Atlas of abdominal wall reconstruction. New York: Elsevier; 2011; with permission.)
Preoperative planning

- CT scanning is recommended, because of the complexity and operative planning required to repair this hernia (Fig. 14).
- Appropriate preoperative antibiotics and deep vein thrombosis prophylaxis should be administered.

Fig. 13. The mesh placement for open flank hernia repair with the mesh being placed and fixed in the preperitoneal space. (From Philips MS, Rosen MJ. Open flank hernia repair. In: Rosen M, editor. Atlas of abdominal wall reconstruction. New York: Elsevier; 2011; with permission.)
Patient positioning/prepping
- Patients are placed in a semilateral or full lateral decubitus position depending on the size and location of the hernia defect, which can be assessed with CT scanning and clinical examination.
- This positioning can be achieved with either a beanbag or a roll.
- The patient should be adequately secured and padded with an axillary roll. Ioban or similar dressings are helpful in preparing and facilitating easy marking on the patient.

Laparoscopic access
- Laparoscopic access is obtained using an open or closed technique per the surgeon’s preference.
- Access can be difficult, because the patient is not supine, and landmarks used for safe access are not available.
- Safe laparoscopic access is essential and should be performed with caution, especially in the reoperative abdomen.

Port placement
- Three to 5 trocars arranged in a semicircular configuration are placed opposite the hernia.
- One port should be an 11-mm or 12-mm port to facilitate easy mesh placement, but can vary based on mesh type used and hernia size.
- Ports are placed to facilitate good triangulation, visualization of the hernia defect, and dissection of the colon.

Diagnostic laparoscopy and laparoscopic lysis of adhesions
- Diagnostic laparoscopy can rule out occult hernias or disease not identified on CT scanning. It also shows the surgeon the anatomy around the hernia and in the lateral position.
- As always, safe adhesiolysis with laparoscopic scissors is performed to clear the entire abdominal wall of adhesions.

Fig. 14. CT scan in a patient with a flank incisional hernia. Flank hernia seen on the right side of the CT scan (patient’s left) above the iliac crest. CT scans can help define anatomy and help in surgical planning.
Laparoscopic mobilization of colon
- Depending on the size and location of the hernia, the right or left colon likely needs to be partially or fully mobilized to permit adequate visualization and fixation of the hernia.
- This procedure is similar to open and laparoscopic colon mobilization and is aided by having the patient in the lateral position.
- Dissection ensues along the white line of Toldt up to the splenic or hepatic flexure, depending on how much of the colon needs to be mobilized.

Taking down peritoneum
- Although not mandatory, taking down the peritoneum at the level of the hernia posteriorly provides a pocket for the mesh and a way for the mesh to be partially covered by the peritoneum.
- Taking down the peritoneum is similar to a transabdominal preperitoneal repair.
- The surgeon grabs the thin peritoneum and blunt dissects posteriorly toward the psoas muscle. This dissection is performed as much as needed to provide mesh overlap posteriorly and laterally.
- Although laparoscopic repair of the flank hernia does not mandate taking down the peritoneum and the mesh can be placed totally intra-abdominally as in a standard laparoscopic hernia repair, taking down the peritoneum allows wider mesh overlap and reduces the amount of fixation necessary.

Hernia measurement
- The hernia defect is measured intracorporeally as described earlier, obtaining a transverse and longitudinal measurement. This measurement is used to choose the size of the mesh.

Mesh preparation/placement
- The correct size and type of mesh are chosen (mesh compatible with intra-abdominal placement must be used). This type is usually barrier mesh, using either an absorbable or permanent barrier, or Gore-Tex mesh.
- Four nonabsorbable sutures are placed at the midpoint of the superior, inferior, left and right lateral portion of the mesh, and it is rolled as a scroll to be placed in the abdomen.
- The mesh can be pulled or pushed into the abdomen, usually through the 11-mm or 12-mm trocar.
- The mesh is unrolled inside the abdomen. The 4 sutures are then pulled up through the abdominal wall using a suture passer.
- If the mesh overlaps the iliac crest or ribs on the superior or inferior portion of the mesh and transfascial suture fixation is impossible, the options are to place the sutures off the periphery of the mesh, where the suture can be brought out through tissue and fascia, or to use bone anchors to secure the mesh.
- If a large preperitoneal space has been created superiorly and inferiorly, a third option is to tuck the mesh in this space and use surgical glue for fixation.

Mesh fixation
- The mesh can be fixed with additional transfascial sutures if the surgeon prefers and there is adequate fascia and soft tissue to place additional sutures.
- The mesh can also be tacked to the abdominal wall and peritoneum using permanent or absorbable tacks.
- Tacks should not be placed where the adjacent soft tissue with bimanual palpation cannot be felt or in areas where neurovascular bundles run.
• Careful attention to the anatomy is crucial to avoid neurovascular injuries or chronic pain from a misplaced tack or suture.

Closure
• After mesh fixation, the peritoneum, if dissected, is tacked or glued to partially cover the posterior portion of the mesh.
• The abdominal contents are again evaluated for occult bowel injury and bleeding, and the ports are removed under direct vision, making sure to close trocar sites greater than 10 mm.

Postoperative care/considerations
• Most patients require hospital admission for pain control and observation.
• Routine postoperative care is administered, with an emphasis on pain control and early ambulation.

Clinical Results in the Literature
Although atypical hernias are not rare, there are few reports specifically related to outcomes of these, because they are often grouped with other midline hernias. Several series have been published on atypical hernias and the unique problems associated with their repair. Less has been published on open repair of atypical hernias, especially the suprapubic and subxiphoid hernias, because again these are often grouped with all open ventral hernia repairs.

Several series (Table 1) have examined the laparoscopic approach to the suprapubic hernia. Although their outcomes are similar, variations in techniques and types of mesh must be accounted for when evaluating the data. In a series by Carbonell and colleagues,21 all patients underwent laparoscopic repair with expanded polytetrafluorethylene mesh; however, over the period of the study and in response to some recurrences early in the series, the repair evolved to include transabdominal suture fixation to the pubic bone, Cooper ligament, and above the iliopubic tract. Palancevu and colleagues22 used laparoscopic repair with Parietex mesh (Covidien, Mansfield, MA) in all cases, transabdominal suture fixation, and intracorporeal suture closure of the hernia defect. Varnell and colleagues23 reported a series from several surgeons using various meshes, including Gore-Tex Dual Mesh (Gore WL, Flagstaff, AZ), Proceed (Johnson & Johnson, Cincinnati, OH), and Parietex Composite (Covidien, Mansfield, MA), and transabdominal suture fixation. Sharma and colleagues24 reported the largest and most recent series using a transabdominal partial extraperitoneal technique using Proceed and transabdominal suture fixation. Jenkins and colleagues25 reported on clinical predictors of complexity in laparoscopic ventral hernia showing suprapubic hernias to be one of many predictors of longer placement time of adhesiolysis mesh.

For subxiphoid hernias, there is literature related to the natural history and incidence after certain procedures, outcome data on the open and laparoscopic repair, and a review article. Kim and colleagues26 evaluated the incidence and risk factors of developing subxiphoid hernias after coronary bypass grafting in 1656 patients with a mean follow-up of 49.5 months. These investigators reported an incisional hernia rate requiring operation of 0.8% and risk factors for occurrence being female gender and low cardiac output syndromes.26 Another study by Barner27 reported a technique of a modified median sternotomy in 2500 patients that resulted in a 0 incidence of subxiphoid incisional hernia. Outcome data for published series of open and laparoscopic repair specific to subxiphoid hernia are presented in Table 2. The data are from small series with limited follow-up and are all retrospective. The largest series by Mackey
Table 1: Published series on laparoscopic repair of suprapubic hernias

<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Number of Patients</th>
<th>Mean Follow-Up (mo)</th>
<th>Operating Room Time (min)</th>
<th>Length of Hospital Stay (d)</th>
<th>Conversion to Open (%)</th>
<th>Complication Rate (%)</th>
<th>Recurrence Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonell et al.</td>
<td>36</td>
<td>21.1</td>
<td>178.7</td>
<td>2.4</td>
<td>2.7</td>
<td>16.6</td>
<td>5.5</td>
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<td>Palanivelu et al.</td>
<td>17</td>
<td>9</td>
<td>95</td>
<td>1.5</td>
<td>0</td>
<td>29.4</td>
<td>5.8</td>
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<td>Varnell et al.</td>
<td>47</td>
<td>2.6</td>
<td>130</td>
<td>3</td>
<td>2.1</td>
<td>38</td>
<td>6.3</td>
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<tr>
<td>Sharma et al.</td>
<td>72</td>
<td>57.6</td>
<td>116</td>
<td>2.2</td>
<td>0</td>
<td>27.8</td>
<td>6.9</td>
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</table>

Data from Refs. 21-24
<table>
<thead>
<tr>
<th>Author/Year</th>
<th>Technique of Repair</th>
<th>Number of Patients</th>
<th>Mean Follow-Up (mo)</th>
<th>Operating Room Time (min)</th>
<th>Length of Hospital Stay (d)</th>
<th>Complication Rate (%)</th>
<th>Recurrence Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohen &amp; Starling, 1985</td>
<td>Polypropylene onlay</td>
<td>14</td>
<td>4–36</td>
<td>NR</td>
<td>NR</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Davidson &amp; Bailey, 1987</td>
<td>Open primary repair</td>
<td>8</td>
<td>22</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>0</td>
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<tr>
<td>Bouillot et al, 1997</td>
<td>Retromuscular repair with polypropylene mesh</td>
<td>23</td>
<td>1–5 y</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>0</td>
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<tr>
<td>Muscarella et al, 2000</td>
<td>Laparoscopic</td>
<td>1</td>
<td>6</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>0</td>
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<tr>
<td>Landau et al, 2001</td>
<td>Laparoscopic</td>
<td>10</td>
<td>—</td>
<td>55</td>
<td>—</td>
<td>30</td>
<td>10</td>
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<tr>
<td>Mackey et al, 2005</td>
<td>Open and laparoscopic primary and mesh repair</td>
<td>45</td>
<td>48</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
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<td>Eisenberg et al, 2008</td>
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<td>122</td>
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<td>50%</td>
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<td>Open double-mesh technique</td>
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<td>4–80</td>
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Abbreviation: NR, not recorded.

Data from Refs. 28,32–38
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<th>Author/Year</th>
<th>Technique of Repair</th>
<th>Number of Patients</th>
<th>Mean Follow-Up (mo)</th>
<th>Operating Room Time (min)</th>
<th>Length of Hospital Stay (d)</th>
<th>Complication Rate (%)</th>
<th>Recurrence Rate (%)</th>
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<td>Shekarriz et al, 2001</td>
<td>Laparoscopic</td>
<td>3</td>
<td>12</td>
<td>138</td>
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<td>Petersen et al, 2002</td>
<td>Open retromuscular</td>
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<td>33</td>
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<td>15</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Zieren et al, 2007</td>
<td>Open retromuscular and onlay</td>
<td>15</td>
<td>60</td>
<td>101</td>
<td>NR</td>
<td>NR</td>
<td>13</td>
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<tr>
<td>Edwards et al, 2009</td>
<td>Laparoscopic</td>
<td>27</td>
<td>3.6</td>
<td>144</td>
<td>3.1</td>
<td>3.7</td>
<td>0</td>
</tr>
<tr>
<td>Fei &amp; Li, 2010</td>
<td>Open retromuscular</td>
<td>23</td>
<td>24.5</td>
<td>NR</td>
<td>NR</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Open extended retromuscular</td>
<td>18</td>
<td>26.2</td>
<td>NR</td>
<td>NR</td>
<td>27.8</td>
<td>0</td>
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<tr>
<td>Veyrie et al, 2012</td>
<td>Open retromuscular</td>
<td>61</td>
<td>47</td>
<td>136</td>
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<td>18</td>
<td>4.9</td>
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<td>Phillips et al, 2012</td>
<td>Open retromuscular</td>
<td>16</td>
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</table>

Abbreviation: NR, not recorded.

Data from Refs. 39-45
and colleagues\textsuperscript{28} evaluated a few patients undergoing primary repair (14), laparoscopic repair with mesh (10), and open repair with mesh (21), with recurrence rates of 43\%, 30\%, and 33\%, respectively. These investigators also reported that previous sternal wound infection was a risk factor for recurrent hernias after repair, with 6 of 16 patients with recurrences also having a previous sternal wound infection.\textsuperscript{28}

Data related to incidence and outcomes of flank hernias, resulting mostly from traumatic injuries and incisions, are also a mixture of open and laparoscopic cases. Although not true hernias, there are data related to the incidence of flank bulging after retroperitoneal incisions and possible mechanism of this occurrence. Chatterjee and colleagues\textsuperscript{29} evaluated 70 patients undergoing flank incisions for nephrectomy and reported 49\% of patients complaining of flank bulging. Gardner and colleagues\textsuperscript{30} performed an analysis of flank bulge using neurophysiologic testing, cadaver dissection, and clinical data on 63 patients. These investigators reported an 11\% incidence of flank bulge and showed that this phenomenon is related to intercostal nerve injury with subsequent paralysis of the abdominal wall musculature. Data from series (>1 patient) on open and laparoscopic repair of flank hernias are shown in Table 3. In general, these series report on standard techniques of the open and laparoscopic repair of the flank hernia, adhering to the principles of wide overlap of mesh with appropriate fixation. However, because of patient factors, slight differences in techniques, and use of mesh, there is some variability in the outcomes.

A few other published reports on the topic of atypical hernia repair deserve mention, although they do not fit specifically into 1 category of hernia repair. Ferrari and colleagues\textsuperscript{31} reported on a series of 39 patients undergoing laparoscopic repair of suprapubic (18), subxiphoid (15), and lateral hernias (6). These investigators showed acceptable outcomes, with a 3\% conversion rate, 18\% complication rate, mean hospital stay of 5.1 days, and at a mean follow-up of 38 months, a 7.7\% recurrence rate. There are also 2 reports on the use of bone anchor fixation for atypical hernias. Carbonell and colleagues\textsuperscript{19} reported on 10 patients undergoing open retromuscular repair of lumbar hernias with the use of bone anchors for fixation. These investigators reported excellent outcomes, with a mean hospital length of stay of 5.2 days, no postoperative complications, and at a mean follow-up of 40 months, no recurrences.\textsuperscript{19} Yee and colleagues\textsuperscript{20} evaluated bone anchor fixation in laparoscopic repairs in 30 patients, with 17 suprapubic, and 13 lateral. These investigators reported an average length of hospital stay of 5.2 days, 23.3\% complication rate, 3.3\% mortality, and a 6.7\% recurrence rate at a mean follow-up of 13.2 months.

SUMMARY

Atypical hernias or hernias located at the abdominal borders can be challenging to repair. Thorough knowledge of anatomy, appropriate preoperative planning, and reliance on the principles of hernia repair, including wide mesh overlap and fixation, ensure successful outcomes. Many options for repair, including technique and mesh choice, are available for the surgeon. The hernia surgeon should be well versed in the open and laparoscopic approaches and apply them based on the individual clinical presentation. Long-term outcomes related to suprapubic, subxiphoid, and lateral hernia repairs are limited; however, open and laparoscopic repairs using wide mesh overlap and adequate fixation have acceptable outcomes and recurrence rates. Future research will likely focus on comparative studies based on patient factors, techniques, mesh, and cost to help surgeons choose the appropriate repairs for individual patients.
REFERENCES


