

Surgical Incisions

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Last Updated:

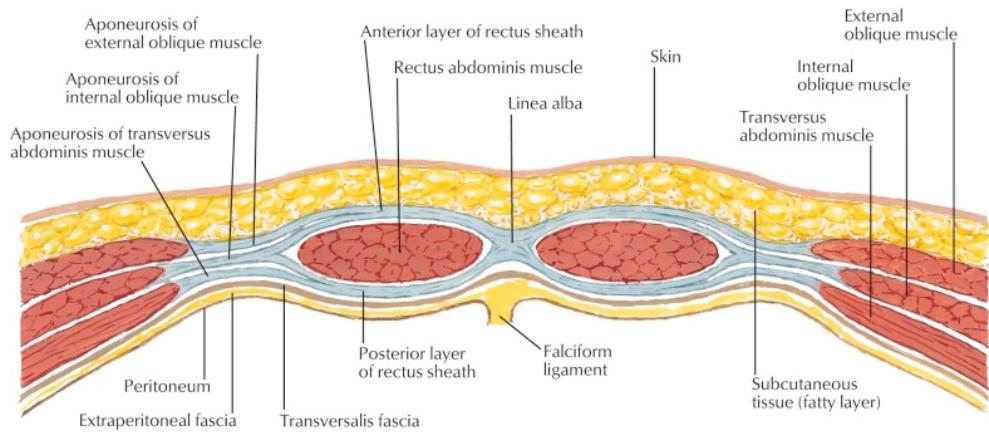
Wednesday, June 14, 2023

1. Introduction

Surgical incisions are the division of tissue to expose the desired operative field. It is therefore important to be familiar with the composition and organization of the tissue. Underneath skin, subcutaneous adipose tissue and Scarpa's fascia, the abdominal wall consists of muscles arranged in layers and their aponeuroses. The external and internal oblique muscles are usually fairly well developed whereas the underlying transversus abdominis muscle can be less prominent. The aponeuroses of all three of those abdominal wall muscles fuse to the rectus sheath towards the center of the abdomen extending from the sternum to the symphysis pubis as shown in [Figure 1](#). The rectus sheath consists of an anterior and posterior layer engulfing the rectus muscles above the arcuate line (approximately the midpoint between umbilicus and symphysis pubis) whereas below this line, the sheath is located solely anterior to the rectus muscles. Underneath the posterior rectus sheath above the arcuate line and directly posterior to the rectus muscle below that line, the transversalis fascia is located, which can be of variable thickness. Preperitoneal adipose tissue and the parietal peritoneum are the remaining tissue layers before entering the abdominal cavity.

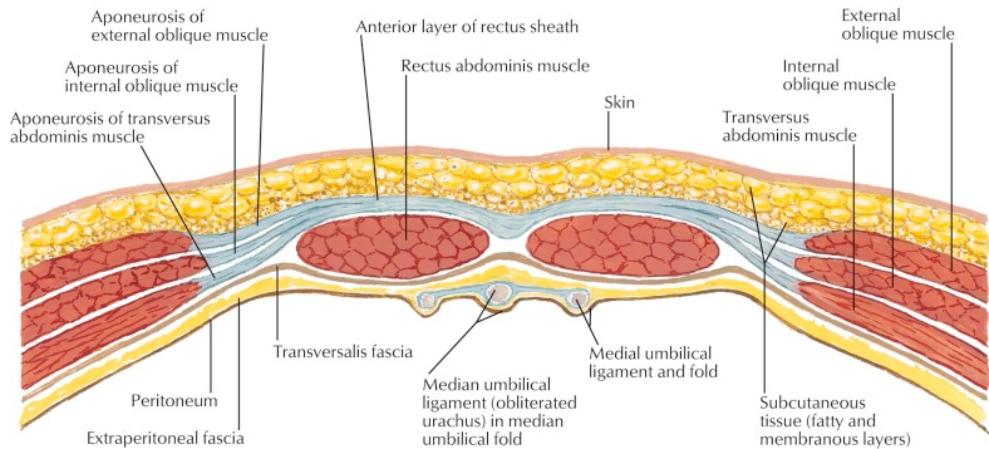
Some additional complexity is present in the flanks as illustrated in [Figure 2](#) and [Figure 3](#). Bundles of the serratus anterior muscle as well as fibers of the latissimus dorsi muscle intersperse at the supero-lateral aspect with the external oblique muscle. Below that, fibers of the internal oblique muscle attach to the 10th rib. After division of the internal oblique muscle the transversus abdominis muscle is encountered with runs from lateral to medial with its tendon joining the rectus sheath.

Section above arcuate line



Aponeurosis of internal oblique muscle splits to form anterior and posterior layers of rectus sheath.
Aponeurosis of external oblique muscle joins anterior layer of sheath; aponeurosis of transversus abdominis muscle joins posterior layer. Anterior and posterior layers of rectus sheath unite medially to form linea alba.

Section below arcuate line



Aponeurosis of internal oblique muscle does not split at this level but passes completely anterior to rectus abdominis muscle and is fused there with both aponeurosis of external oblique muscle and that of transversus abdominis muscle. Thus, posterior wall of rectus sheath is absent below arcuate line, leaving only transversalis fascia.

F. Netter M.D.

Figure 1 (Plate 247): Crossection of the abdominal wall. The aponeurosis of the internal oblique and transversus abdominis muscle engulf the rectus muscle superior to the linea alba and are located anterior to it below that line. Note the location of the transversalis fascia as innermost layer anterior to the peritoneum

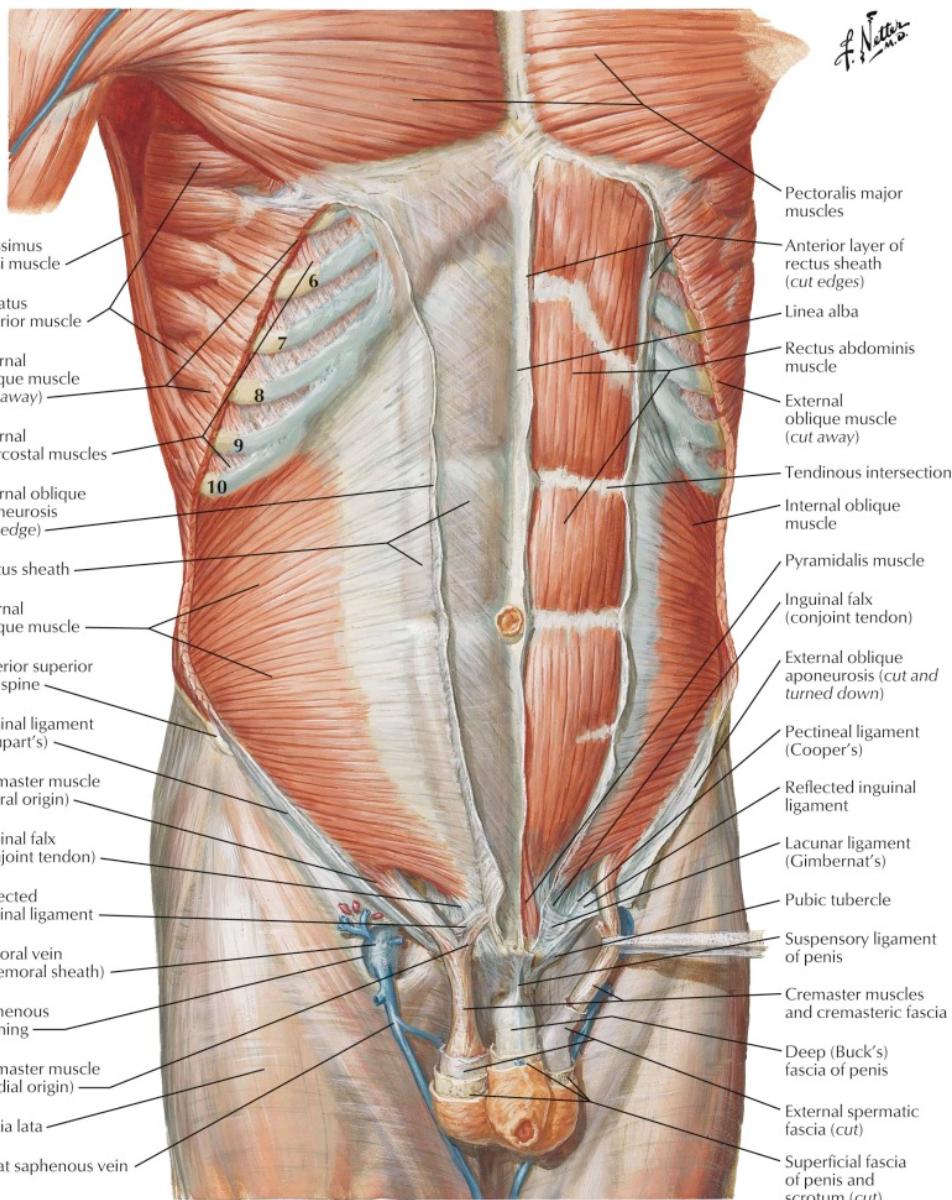


Figure 2 (Plate 245): Abdominal wall with internal oblique muscle.

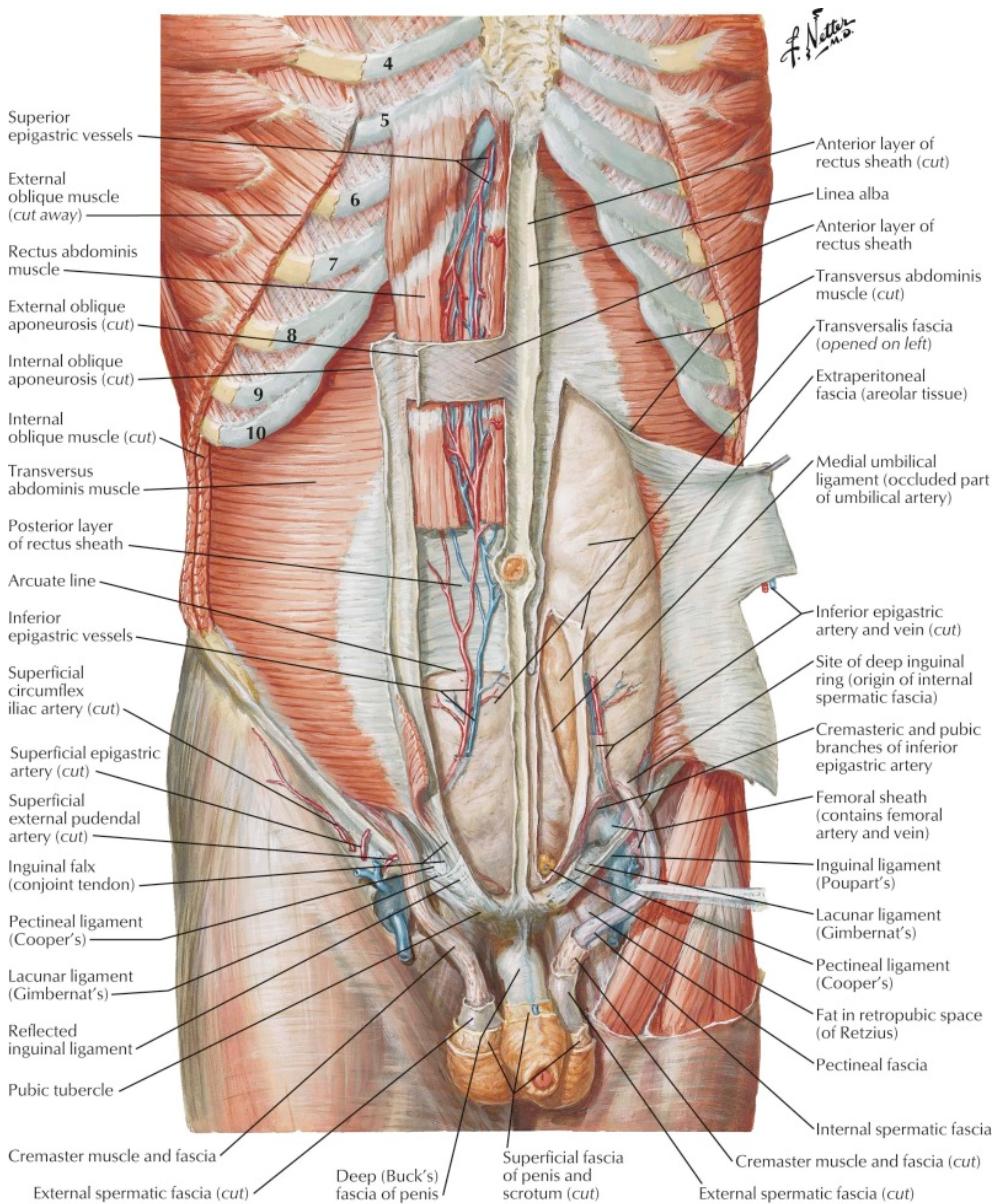


Figure 3 (Plate 246): Abdominal wall with transversus abdominis muscle.

2. Flank Incisions, Subcostal Incision, and Thoracoabdominal Incision

2.1. Flank Incisions

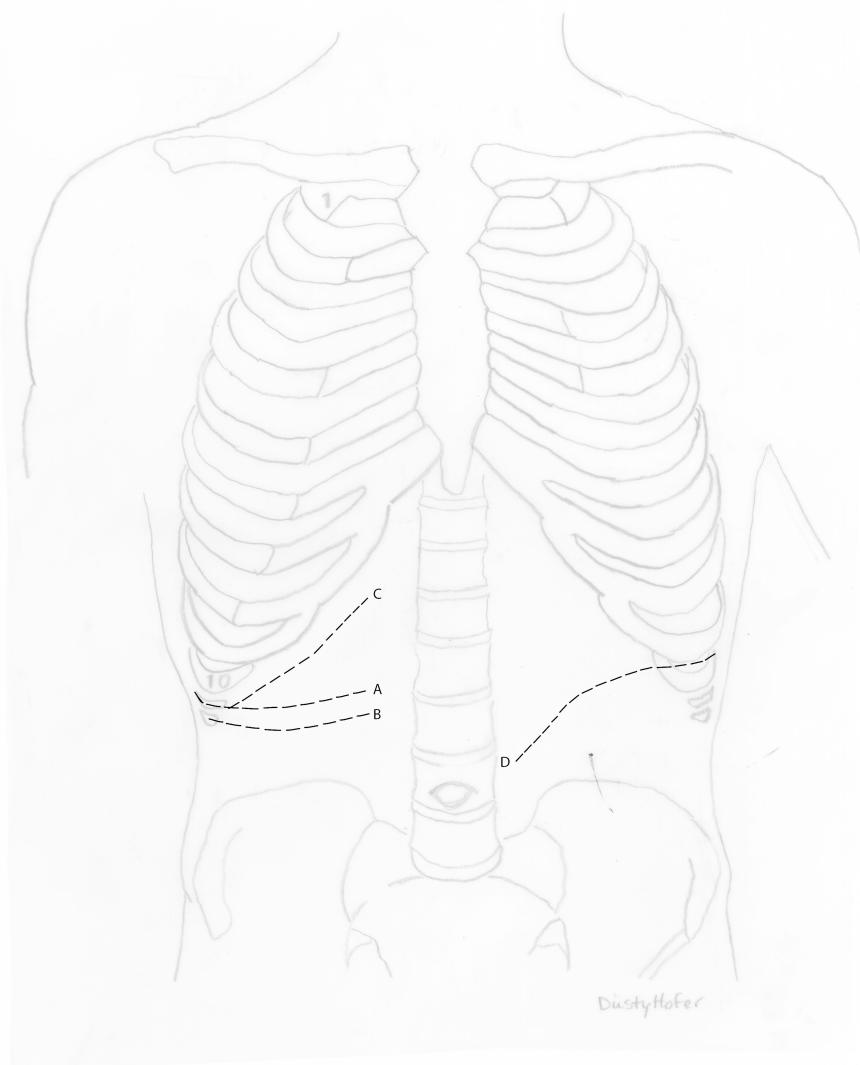


Figure 4: Overview of the 11th rib (A), 12th rib (B) and subcostal incision (C) as well as thoracoabdominal incision (D) in relationship to bony landmarks.

While used predominantly for nephrectomies, flank incisions (11th and 12th rib incisions) can be used for any surgery in the retroperitoneum. There are several advantages of flank incisions compared to abdominal or thoracoabdominal incisions:¹ First, it gives direct access to the retroperitoneum without having to open the peritoneum and needing to reflect bowel; secondly, anatomical landmarks can be

followed avoiding nerve injury. Lastly, they avoid entering the pleural space. However, as not every incision is optimal for every patient presentation and because flank incisions provide comparably less exposure, the subcostal and thoracoabdominal incisions are discussed as well. With these outlines the most retroperitoneal surgeries can be accomplished.

Multiple variations of how to perform flank incisions have been described^{1,2} with the most common being the 11th rib incision, the 12th rib incision, and the subcostal incision (**Figure 4**). For flank incisions, the patient is positioned at an approximately 45 degree angle which allows exposure of the area to be incised and also displaces abdominal contents such as bowel away from the operative field by gravity. Padding bony prominences and avoiding stretch to the arm that is draped over the body avoiding brachial plexus injury are essential. Ensure that the patient is secured with adhesive tape or straps. Kidney rests provide some advantage but contribute to morbidity. Breaking the table over the kidney to ‘open up’ the flank has a similar effect.

As a rule of thumb, following the course of the 12th rib medially will point to the position of the renal hilum.¹ The decision whether to incise over the 11th rib or at the tip of the 12th rib depends on the patient’s body habitus, the location of the kidney, and the location of the tumor. If an 11th rib incision is chosen one needs to be prepared to remove part of that rib. The incision is extended from the rib to the lateral border of the ipsilateral rectus muscle. The skin is incised and the adipose tissue and Scarpa’s fascia divided with cautery. Next, the incision is deepened at the lateral aspect: fibers of the latissimus dorsi and if present the serratus anterior muscles are divided with cautery and the incision carried down to the level of the rib. At this point the abdominal wall muscles are divided layer by layer from lateral moving medial. As the external oblique muscle has already been divided to expose the rib this level of the incision is carried medially. Next, intercostal tissue is divided at the cranial aspect of the lower rib as vessels and nerves run in a groove underneath each rib. This is applicable when an excision of the 11th rib is planned or necessary (see below for technique). Next, the internal oblique muscle is divided followed by the transversus abdominis muscle. The transversalis fascia is at this point visible and can be incised providing access to the retroperitoneal cavity. The peritoneum (and abdominal cavity with its contents) is located medial and also anterior to the incision. It can often simply be pushed medially with a spongestick to expose the retroperitoneum and to allow the insertion of a self-retaining retractor. Care should be taken not to open the peritoneum inadvertently but if it happens, it usually can be closed with running 3-0 chromic sutures. A nephrectomy or adrenalectomy can now be performed.

Excision of the 11th rib

The muscle fibers of the intercostal muscle at the superior aspect can be incised with cautery. An Alexander periosteal elevator is used in a brushing motion from medial to lateral to clear off the periosteum superiorly and inferiorly to deflect the neurovascular bundle away from the rib. The Doyen costal elevator can now be inserted to free the rib posteriorly and the rib cut with a rib cutter. The use of a Kocher clamp is helpful for stabilization during cutting. Bone wax can be applied to the cut surface to smoothen the surface.

Pitfalls

If the 11th rib incision is carried out too posteriorly, the pleura can be inadvertently opened. This does not affect the surgery as the patient is ventilated but it needs to be addressed during the closure. Either a chest tube can be placed or the defect can be closed and the remaining air in the interpleural space ‘bubbled out’: A small red rubber catheter (12F) is placed in the pleural cavity through the defect and a purse string suture with absorbable suture placed around it. The other end of the catheter is immersed in a bowl of saline. The patient is brought into Trendelenburg position and anesthesia is asked to hold the breathing at the point of maximum inspiration. Air in the pleural space can be seen exiting through the catheter producing bubbles in the bowl. This maneuver should be repeated and once all bubbling has subsided, the catheter is removed while simultaneously tying the purse string suture. A post-operative X-ray and one the next day is recommended to ensure resolution of the pneumothorax.

Closure of Flank Incisions

The closure of a flank incision consists of four layers. The first layer is the transversus abdominis with the internal oblique muscle along with their fascias. It is preferable to start this suture laterally and moving medially because the separation of the abdominal wall muscles is easier recognized laterally. The closure is carried out medially closing the aponeurosis of the external oblique muscle with a thick resorbable monofilament suture (e.g. 0-loop Maxon) but that is a matter of preference. The second layer can be closed with also for example 0-loop Maxon running from lateral to medial approximating the divided external oblique muscle and its fascia. If the aponeurosis of the external oblique muscle has been closed in the first layer then the closure of the second layer does not have to fully extent medially. The subcutaneous tissue can be approximated with interrupted 2-0 absorbable sutures (e.g. Vicryl) and the skin can be closed with subcuticular running suture or staples.

Summary of Layers to be Incised:

- Skin
- Adipose tissue
- Scarpa's fascia
- Adipose tissue
- External oblique muscle
- Internal oblique muscle
- Transversalis abdominis muscle
- Transversalis fascia

2.2. Subcostal Incision

This incision is preferred for a transabdominal approach to perform a nephrectomy when vena cava access is necessary such as in cases of a tumor thrombus or when full exposure to the renal hilum is desired for early clamping (renal bleeding, large medially located tumors, or when intravascular spread of tumor cells is feared). ¹

In supine position the patient is slightly bumped up with a blanket roll with the surgical side up. Breaking the table increases exposure to the abdomen. The incision is typically made from the tip of the 11th rib medially towards the xiphoid process 2-3 fingerbreadths below the ribcage and following its outline (**Figure 5**). The medial border of the incision is the lateral aspect of the ipsilateral rectus muscle but it can be extended medially by dividing the rectus muscle. This incision can also span both body halves (Chevron incision) for maximum exposure.¹

After the skin incision and dissection of the subcutaneous fat, the external oblique muscle followed by the internal oblique muscle and then the transversus abdominis are divided from lateral to medial. The underlying peritoneum can be pushed posteriorly with a finger or spongestick. The ipsilateral rectus muscle (and anterior and posterior rectus sheath) can be divided, partially or completely if necessary although this adds to significant post-operative pain. Elevating the rectus muscle with an Army-Navy retractor inserted underneath facilitates its transection and helps in avoiding inadvertent injury to bowel.¹ It is important to pay attention to the superior epigastric vessels that will run underneath the rectus. Ligation is preferable to other means of obliteration given the caliber.

Next, the peritoneum is incised in the center of the incision by elevating it with two forceps cutting with scissors in between them. Inserting a finger underneath the peritoneum when opening the peritoneum further using cautery protects the bowel. A self-retaining retractor can now be inserted and the further surgery performed.

Closure

The peritoneum is typically not closed but if it is desired a running absorbable suture can be used (e.g. 2-0 chromic). The fascia of the posterior rectus sheath and the fascia of the transversus abdominis and internal oblique muscle can be closed with a thick absorbable suture, for example 0-loop Maxon in running fashion. The same suture can be used for the second layer of closure containing the anterior rectus sheath and the external oblique fascia. Several interrupted subcutaneous sutures with for example 2-0 Vicryl aid in reapproximation of the skin, which can be closed with subcuticular running suture or staples.

Summary of Layers to be Incised:

- Skin
- Adipose tissue
- Scarpa's fascia
- Adipose tissue
- External oblique muscle
- Internal oblique muscle
- Transversalis abdominis muscle
- Transversalis fascia
- Peritoneum

2.3. Thoracoabdominal Incision

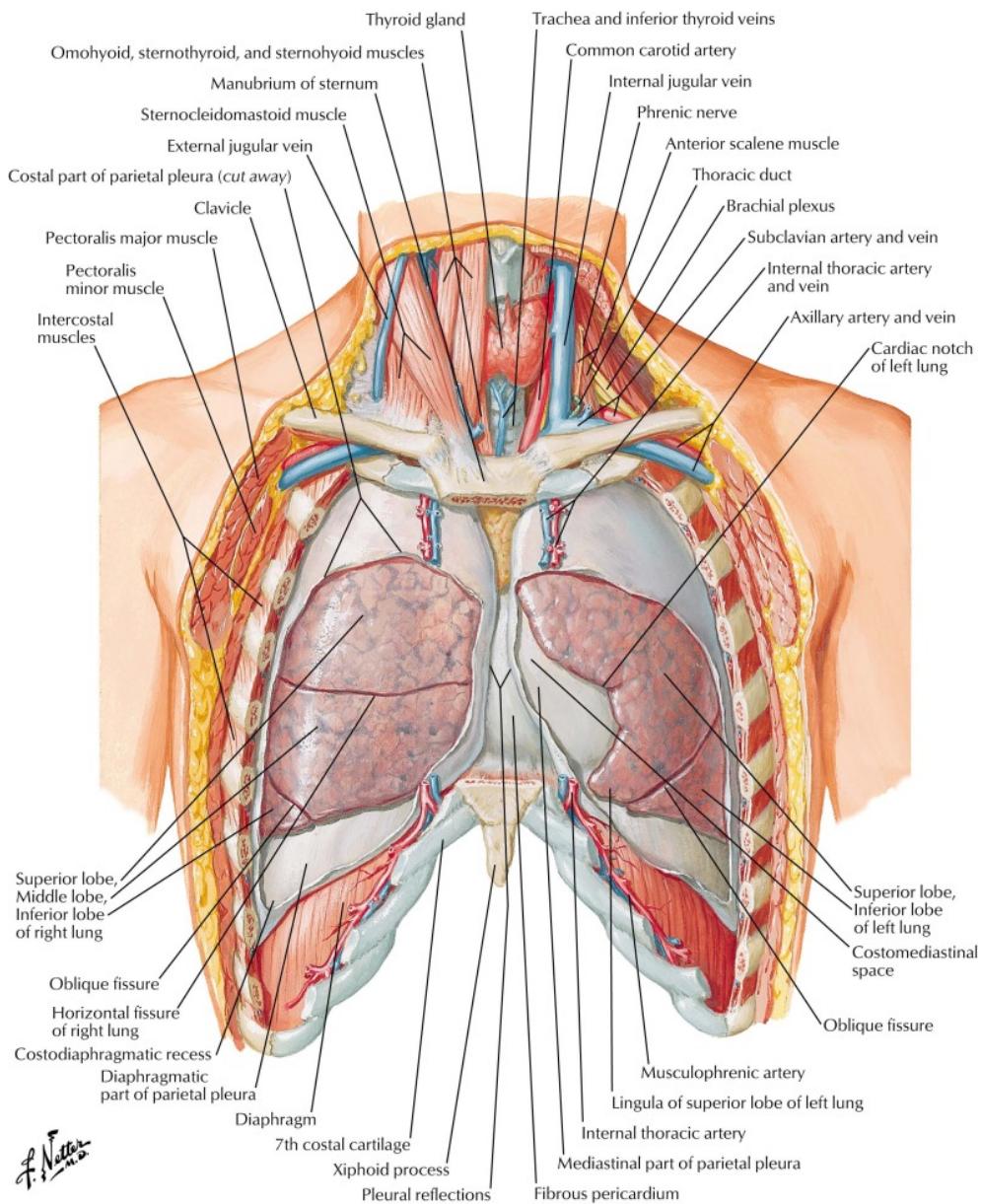


Figure 5 (Plate 194): Thoracic cavity with location of the pleura, lungs and diaphragm in relationship to the ribs and ribcage.

The thoracoabdominal incision provides the best exposure to the operative field but is also the most morbid. Most renal tumors are now diagnosed at smaller sizes and this incision is becoming less frequent. It is indicated for large tumors, adrenal tumors, or for upper pole tumors especially on the left side as the spleen is easier avoided as in other incisions.¹ The main advantage of a thoracoabdominal incision is that both the pleural and the peritoneal cavity are entered at the surgeon's terms. This also mandates more caution and the closure of this incision is more complex.

Patient positioning is essential and consists of near 45-degree rotation at the ipsilateral shoulder and a flat (supine) position at the hips. This results in an about 30-degree rotation at the level of the pelvis. The break in the table should be just above the iliac crest in order to provide maximum stretch and exposure when breaking the table. The kidney rest can be used for further exposure.

The incision typically spans from the intercostal space between 9th and 10th rib in the midaxillary line laterally then following the intercostal space inferior-medially and then crosses over the abdomen obliquely to just above the umbilicus (**Figure 4**). Variations can be made according the body habitus of the patient. The skin and the subcutaneous adipose tissue are divided. The latissimus dorsi and potentially serratus anterior are divided from lateral to medial followed by division of the external oblique and the anterior rectus sheath. Next, the intercostal muscles are cut and care should be taken to divide them at the superior aspect of the inferior rib to avoid injury to the neurovascular bundle. Part of the ribs can be removed as described above. The cartilage at the tip of the rib(s) is incised or removed. Following the incision medially, the internal oblique and transversus abdominis muscle and then the rectus muscle are divided.

After division of the intercostal muscles the pleura can now be identified in between the ribs. The diaphragm is located inferior and posterior to the pleura (**Figure 5**). The pleura can be opened sharply after elevation to avoid a lung injury (preferably during an expiration movement as the lung retracts even further). The pleural incision is extended medially beyond the tip of the ribs. The diaphragm is now cut between the 9th and 10th rib at the medial aspect of the thoracic cavity. Division along the course of its fibers avoids injury of the phrenic nerve.¹

Abdominally, the peritoneum is now incised as described in “Subcostal Incision”. Self-retaining retractors are inserted to expose the operative field from the thoracic to the abdominal cavity.

The closure of a thoracoabdominal incision is more complex than that of other incisions. After flexion of the table and letting the kidney rest down, the diaphragm is closed with interrupted mattress sutures using 2-0 non-absorbable sutures (e.g. poly-prolene). Knots are placed on the inside to avoid constant irritation during breathing.¹ A chest tube is inserted through a separate incision in the midaxillary line at the level of the nipples and secured to the skin. The ribs can be reapproximated with 2-0 absorbable sutures looping adjacent ribs together. The costal arch is stabilized medially with figure-of-8 sutures (e.g. 1-0 Vicryl) passed through the cartilaginous ends of the ribs. Interrupted figure-of-8 sutures of 1-0 Vicryl are passed through all layers of the chest wall approximating the intercostal muscles. The fascia of the latissimus dorsi and serratus anterior muscles are approximated with interrupted sutures of e.g. 1-0 Vicryl.

The abdominal part of the incision is closed as described under “Subcostal Incision” in two layers.

Summary of Layers to be Incised:

- Skin
- Adipose tissue
- Scarpa's fascia
- Adipose tissue
- Latissimus dorsi muscle (and serratus anterior muscle)
- External oblique muscle and rectus sheath
- Intercostal muscles
- Internal oblique muscle

- Transversalis abdominis muscle
- Rectus muscle
- Pleura
- Diaphragm
- Transversalis fascia
- Peritoneum

3. Lower Abdominal Incisions

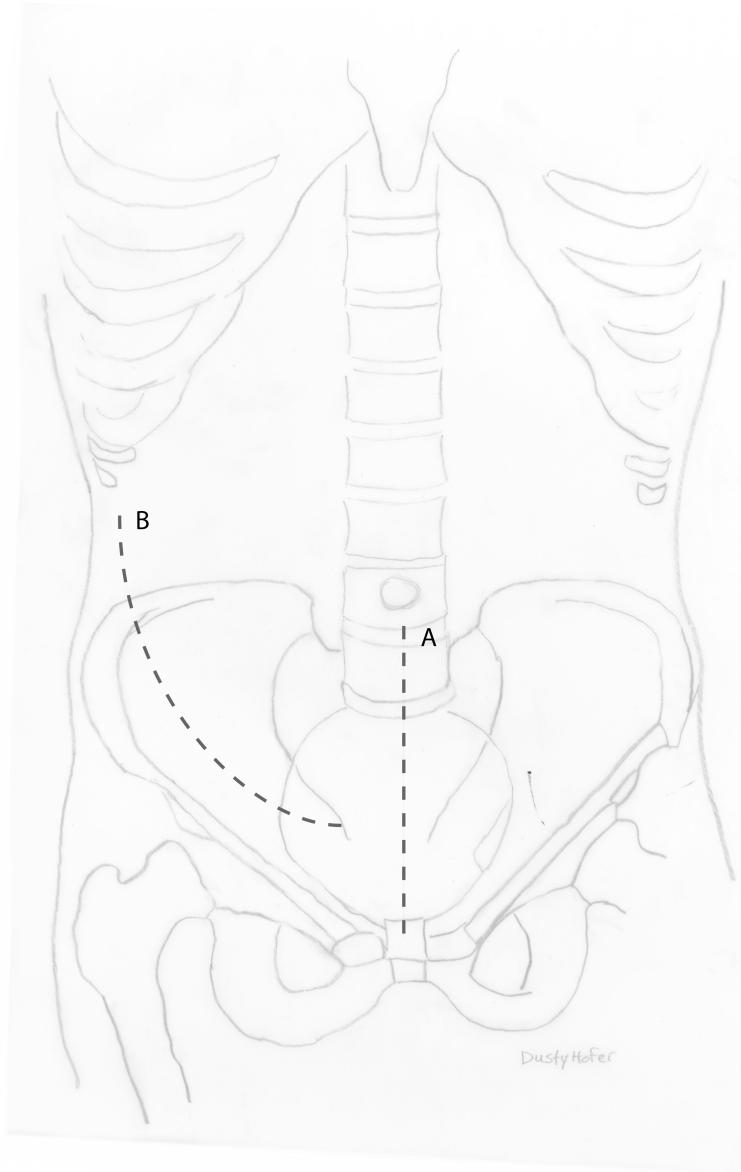


Figure 6: Overview of the midline (A) and Gibson (B) incisions in relationship to bony landmarks.

Midline Incision

Midline Incisions are used for a variety of urologic procedures. They can be adjusted in size for access to the extraperitoneal space below the peritoneum or carried upward to include the abdominal cavity. Midline incisions have comparably low morbidity because the division of tissue is limited to fascia and avoids muscle. The patient is positioned supine and if prostate surgery is planned the legs can be separated on spreader bars.

For extraperitoneal incisions, mainly prostate or bladder (with the exception of radical cystectomy when the peritoneum is typically opened), the incision runs from the symphysis pubis superiorly towards the umbilicus (**Figure 6**).

The skin is incised and the subcutaneous fat and Scarpa's fascia divided with cautery. The rectus sheath (anterior only as the incision is typically below the arcuate line) is then approached. Especially in children but also some adults, Scarpa's fascia can be fairly thick thus mimicking the rectus sheath. The sheath should be incised in the midline to avoid incising the rectus muscle. The midline can be identified by the convergence of fascial fibers but if this is not apparent moving towards the superior aspect and elevating the fascia with a Kocher clamp close to the umbilicus can visualize the midline. The fascia should not be cleaned off the subcutaneous fat as small blood vessels are inadvertently removed and the fascia can become atrophic [Hinman]. The sheath is incised in the center of the incision and the fascial incision extended inferiorly and superiorly over a finger. Inferiorly, the pyramidalis muscle is encountered which is divided in its midline. The incision typically stops over the pubic bone. Superiorly, insertion of the finger underneath the sheath pushes the peritoneum out of the way when extending the incision. Should a peritoneal tear occur it can be closed with figure-of-8 sutures using for example 3-0 chromic. Both rectus muscles can now be gently pushed laterally and a self-containing retractor inserted.

If the incision is carried out superiorly to include the abdominal cavity, the umbilicus should be avoided and the incision curved around it laterally on the left. After incision of the skin and subcutaneous fat, the anterior rectus sheath is divided. Above the arcuate line, the posterior rectus sheath will be encountered and after its division the transversalis fascia, which might be rather thin. Pre-peritoneal fat can be seen and pushed aside before the peritoneum comes into view.

Layered closure of the incision: The anterior rectus sheath is closed in one layer incorporating some of the muscle, for example with a thick monofilament suture such as 0-loop Maxon. Wide enough bites should be taken (1.5-2 cm) to avoid tearing of the fascia. Also, thick enough sutures should be used to avoid cheese wiring of the thread through the fascia. Especially for long incisions, additional figure-of-8 sutures using non-absorbable sutures can be placed to both add in additional strength of the closure and to avoid fascial dehiscence should the running suture break in one location. The bodies of the rectus muscle may be approximated with for example 2-0 chromic. The subcutaneous skin is aligned with interrupted absorbable sutures, for example 2-0 Vicryl, and the skin closed with subcuticular running suture or staples.

Summary of Layers to be Incised:

- Skin
- Adipose tissue
- Scarpa's fascia
- Rectus sheath
- Pyramidalis muscle

Gibson Incision

A Gibson incision is useful for surgeries of the distal ureter. It is made in a hockey stick fashion in the right or left lower quadrant with the medial aspect just lateral to the rectus sheath (Figure 6). It is then curved upward and lateral approximately 3 cm superior to the inguinal ligament and 2 cm of the anterior superior spina iliaca. The incision can be extended superiorly if needed.

The skin is incised followed by division of the subcutaneous fat and Scarpa's fascia until the aponeurosis of the external oblique muscle (part of the rectus sheath) is encountered at the medial aspect of the incision. The aponeurosis is divided in the direction of its fibers and the incision carried out through the external oblique, internal oblique, transversus abdominis muscle, and transversalis fascia moving from medial to lateral. Using blunt dissection, the peritoneum that will be encountered at the superior aspect of the incision can be bluntly pushed away and a self-retaining retractor be inserted.

For a layered closure begin laterally and close the transversus abdominis and internal oblique muscle in the first layer with a thick monofilament suture such as 0-loop Maxon. The external oblique muscle aponeurosis can be included in this layer. In the second layer the external oblique muscle is closed and this layer extended until the previously closed aponeurosis is encountered. The third layer consists of interrupted figure-of-8 sutures with an absorbable suture, for example 2-0 Vicryl to approximate the subcutaneous tissue followed by skin closure with a running absorbable suture or staples.

Summary of Layers to be Incised:

- Skin
- Adipose tissue
- Scarpa's fascia
- External oblique muscle and its aponeurosis
- Internal oblique muscle
- Transversalis abdominis muscle
- Transversalis fascia

4. Perineal Incisions

Perineal Incision

Perineal incisions are used for operation on the urethra such as urethroplasty or insertion of an

artificial urinary sphincter. The patient is placed in high lithotomy position. Care should be taken to have the legs in a flat angle in the stirrups to avoid thrombus formation due to impeded circulation. The anus should be covered with a towel and its upper edge stapled to the skin.

The incision is made in the midline of the perineum, which can often be identified by the raphe from posterior to the scrotum to anterior to the anus. A Foley catheter can be placed on the field to help palpating and identifying the urethra. After incising the skin the subcutaneous tissue and Colles' fascia are divided until the bulbospongiosus muscle is encountered. Insertion of a Scott or LoneStar retractor with gradual adjustment of the hooks aids in obtaining exposure. The bulbospongiosus muscle is divided in its midline with scissors to avoid inadvertent thermic injury to the corpus spongiosum and urethra. The urethra is now exposed from mid-bulb to almost the penile urethra. Further dissection posteriorly of the muscle and transsection of the perineal body will expose the proximal bulbar urethra. Extending the incision anteriorly (and splitting the scrotum if necessary) will expose the proximal penile urethra.

The layered closure consists of closing the bulbospongiosus muscle with a running monofilament suture, for example 2-0 Monocryl followed by a second layer of Colles' fascia and subcutaneous tissue with the same suture. The skin can be closed with interrupted, horizontal mattress, or baseball sutures using for example 3-0 Vicryl.

Summary of Layers to be Incised:

- Skin
- Adipose tissue
- Colle's fascia
- Bulbospongiosus muscle

Videos

Performing a Flank Incision

Open Surgical Approaches: Pfannenstiel Incision

References

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