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Surgical Anatomy of Anterior Abdominal Wall: Know before you Incise

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Abstract

Incision and closure of the abdominal wall is among the most frequently performed surgical procedures. Anterior abdominal wall is the first structure which a surgeon encounters in any abdominal surgery. Both in open surgery and laparoscopic surgery, correct knowledge of layered structure of the anterior abdominal wall is a must to enter the abdominal wall with maximum efficacy and safety. Hence knowledge of all structures which one encounters on entering abdominal wall layer by layer is essential for surgeon. Here we discuss in detail about anatomy of abdominal wall and different types of incisions.

Keywords: abdominal wall, anatomy, incision

Introduction

Incision and closure of the abdominal wall is among the most frequently performed surgical procedures. Anterior abdominal wall is the first structure which a surgeon encounters in any abdominal surgery. Both in open surgery and laparoscopic surgery, correct knowledge of layered structure of the anterior abdominal wall is a must to enter the abdominal wall with maximum efficacy and safety.[1]

Anatomy

Boundaries of abdominal cavity

- **Superior border :** lower edge of the rib cage (ribs 7 through 12).
- **Inferior border:** Iliac crests, inguinal ligaments, and pubic bones.
- **Posterolateral border :** Lumbar spine and its adjacent muscles

Layers of abdomen :

Skin and Subcutaneous Tissue :

Skin : Dermal layer has fibres which are oriented in a predominantly transverse direction. In the lower part fibres have a subtle curving concave upward line.

Surgical Importance :There is more tension on the skin of a vertical incision and it results in a wider scar and more chances of wound dehiscence. Transverse scars with gentle curve with cephalic concavity are more cosmetic. Placing the incisions in the pubic hair line or in a natural skin crease may enhance the cosmetic result. Avoid incision in deep skin fold of a large panniculus where maceration of the skin can increase the risk of infection.

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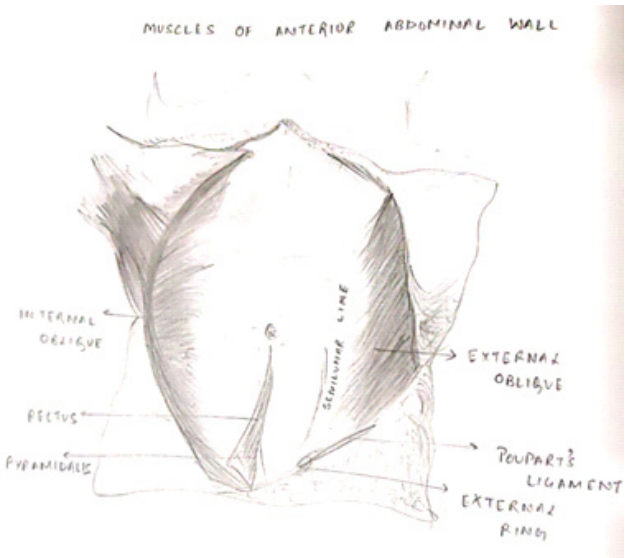
[b]Subcutaneous Tissue : Subcutaneous tissue is made of globules of fat which are held in place and supported by a series of branching fibrous septa. There are two fascias in saubcutaneous tissue:

- **Camper's Fascia :** Camper's fascia is the more superficial portion of the subcutaneous layer where fat predominates, and the fibrous tissue is less apparent.
- **Scarpa's fascia:** It is closer to the rectus sheath where the fibrous tissue predominates relative to the fat. Scarpa's fascia is not seen as a well-defined layer during vertical incisions.

Musculoaponeurotic Layer

Deeper to subcutaneous tissue is the layer of muscle and fibrous tissue which functions to hold the abdominal viscera in place and controls movement of the lower torso. There are two major groups of muscles:

- Vertical muscles
- Oblique flank muscles



Vertical Muscles

Vertical muscles are the rectus abdominis muscle which is found on either side of the midline and pyramidalis muscle which is located just above the pubes. Rectus abdominis muscle originates from the sternum and cartilages of ribs 5th to 7th and inserts into the anterior surface of the pubic bone. The pyramidal muscles arise from the pubic bones and insert into the linea alba in an area several centimetres above the symphysis.

Surgical Importance: Strong attachment of pyramidalis to the midline makes separation of their attachment difficult by blunt dissection.

Flank Muscles

Lateral to vertical muscles are the flank muscles: the external oblique, internal oblique, and transverse abdominal. External oblique is most superficial of all flank muscles. Its fibers run obliquely anteriorly and inferiorly from their origin on the lower eight ribs and iliac crest. It's fibres run obliquely downward. Internal Oblique muscles: fibers of the internal oblique muscle fan out from their origin in the anterior two thirds of the iliac crest, the lateral part of the inguinal ligament, and the thoracolumbar fascia in the lower posterior flank.

Surgical Importance : Vertical incisions are more prone for dehiscence than transverse incisions due to transverse pull of their attached muscular fibers placed in the rectus sheath.

Rectus Sheath [Conjoint Tendon] : Rectus sheath is the broad, sheet- like tendons of these muscles which form aponeuroses that unite with their corresponding member of the other side, forming a dense white covering of the rectus abdominis muscle. The conjoined aponeuroses of the flank are separable lateral to the rectus muscles but fuse near the midline. Rectus sheath in its lower one fourth lies entirely anterior to the rectus muscle. Above that point, it splits to lie both ventral and dorsal to it. The transition between these two arrangements occurs midway between the umbilicus and the pubes and is called the arcuate line. Cranial to this line, the midline ridge of the rectus sheath, the linea alba, unites these two layers. Linea Alba (the white line) is completely avascular. The lateral border of the rectus muscle is marked by the semilunar line of the rectus sheath. During a transverse lower abdominal incision, the external and internal oblique aponeuroses are often separable near the midline.

Surgical Importance : Linea alba is the preferred location for incision and intra-abdominal access in emergency. Due to lack of muscular coverage this area is weak and incisions are prone for the formation of the majority of post-surgery ventral hernias.

Transversalis Fascia, Peritoneum, and Bladder Reflection

The peritoneum is a single layer of serosa supported by a thin layer of connective tissue that lines the abdominal cavity. Five vertical folds are formed by underlying ligaments or vessels that converge at the umbilicus.

- The abdominal wall reflection of the bladder, which fuses with the urachus
- The single middle umbilical ligament (the obliterated urachus)
- The paired medial umbilical ligaments (remnants of the obliterated umbilical arteries)
- Lateral umbilical ligaments associated with the deep inferior epigastric vessels

Surgical Importance :

- Bladder reflection is frequently incised or bluntly dissected off the bladder to take the tissues in this region "down by layers".
    - During laparoscopy lateral umbilical ligaments should be localised to prevent injury to deep epigastric vessels during secondary port placement.
    - Paired medial umbilical ligaments are important landmarks during laparoscopy for pelvic surgery.

Vasculature[3]

The blood supply of the abdominal wall is comprised of superficial and deep vascular supplies.

Superficial arteries : The superficial vasculature is located in the subcutaneous tissues and supplies the tissues superficial to the external oblique aponeurosis and the anterior rectus sheath. The muscles and tissues below these layers are supplied by the deep vessels that are located in the musculofascial layers.

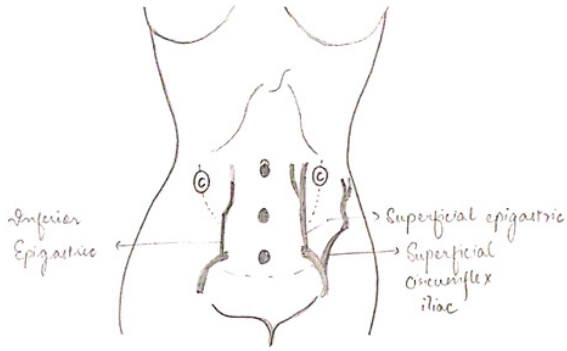
Deep arteries

Superior epigastric arteries: The superior epigastric artery is a terminal branch of the internal thoracic artery. Deep branches of this vessel supply the posterior rectus sheath and the peritoneum with muscular branches and anterior perforating branches supplying skin and subcutaneous tissues.

Inferior epigastric arteries: Inferior epigastric arteries are the branches of the external iliac artery. The inferior epigastric artery and its two veins originate lateral to the rectus muscle. They run diagonally toward the umbilicus. These intersect the muscle's lateral border midway between the pubis and umbilicus. Below the point at which the vessels pass under the rectus, they are found lateral to the muscle deep to the transversalis fascia.

Surgical Importance: The inferior epigastric vessels are bounded only by loose areolar tissue below the arcuate line. Trauma to this portion of the deep inferior epigastric artery may result in considerable hemorrhage. Hematomas commonly dissect into the retroperitoneal space, large quantities of blood may be lost before outward evidence of hematoma is detectable.

- Lateral laparoscopic trocars are placed in a region of the lower abdomen where injury to the inferior epigastric and superficial epigastric vessels may occur.Laparoscopic surgeon should know the average location of these blood vessels which helps in choosing insertion sites that will minimize their injury and the potential hemorrhage and hematomas that this injury can cause.
- Surface marking of these vessels is just above the pubis symphysis, inferior epigastric vessel and superficial epigastric vessels lie approximately 5.5 cm from the midline, whereas at the level of the umbilicus, they are 4.5 cm from the midline. Trocars should be placed lateral to it.
- **Control of bleeding of superficial vessels:**
- Smaller vessel in subcutaneous tissue constrict by itself but persistently bleeding vessels should be managed with limited use of electrocautery.
- **Control of bleeding from Inferior epigastric vessels:** It is best accomplished by isolating the vessel through dissection, clamping it with a hemostat, and suture ligating it at both torn ends.



Nerve Supply: The skin and muscles of the anterolateral abdominal wall are supplied by T7 to T12 and L1 spinal nerves. The iliohypogastric and ilioinguinal nerves pass medial to the anterosuperior iliac spine in the abdominal wall. Ilioinguinal nerves supplies the lower abdominal wall, and by sending a branch through the inguinal canal, it supplies the upper portions of the labia majora and medial portions of the thigh.

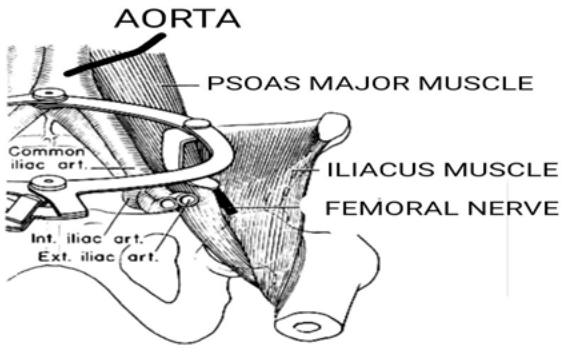
Surgical Importance:[4]

The genitofemoral (L1 and L2) and femorocutaneous (L2 and L3) nerves can be injured during gynecologic surgery if transverse skin incision goes more laterally.

- Genitofemoral and femorocutaneous nerves can be entrapped in the lateral closure of a transverse incision and may lead to chronic pain syndromes.

The femoral cutaneous nerve can be compressed either by a retractor blade lateral to the psoas or by too much flexion of the hip in the lithotomy position, causing anesthesia over the anterior thigh,diminished knee jerk, and weakness of extension of the knee, which creates a specific problem climbing stairs.

- Genitofemoral nerve lies on the psoas muscle. During prolonged surgery where pressure from a retractor can damage this nerve.It leads to anaesthesia in the medial thigh and lateral labia.
- The "Transverse Abdominis Plane [TAP] "Block is a peripheral nerve block designed to anesthesize the nerves supplying the anterior abdominal wall [T6 to L1] by deposition of local anesthetic between the internal oblique and transversus abdominis muscles to target the nerves passing through them. It provides good postoperative pain relief.



Lymphatics Drainage: Superficial lymphatics above the umbilicus pass in a superior direction to the axillary nodes, below the umbilicus passes in an inferior direction to the superficial inguinal nodes.

Incisions on Anterior Abdominal Wall

Choice of incision — Points to be taken care while choosing an incision:[5]

1. Provide adequate exposure for the anticipated procedure.
2. Taking into account the possibility that the planned procedure may change depending upon intraoperative findings or complications.
3. Should interfere minimally with abdominal wall function by preserving important abdominal structures.
4. Should heal with adequate strength.

Other factors guiding incision

- Need for rapid entry
- Certainty of the diagnosis
- Body habitus
- Location of previous scars
- Potential for significant bleeding
- Minimizing postoperative pain
- Cosmetic outcome

Scalpel versus Electrosurgery for incision[6]

Neither scalpel nor electrosurgery holds a significant benefit over the other. However, use of

electrocautery for incision is associated with lower postoperative analgesic requirements. With use of scalpel a surgeon should not practice multiple strokes which result in greater tissue damage and increase the susceptibility to infection.

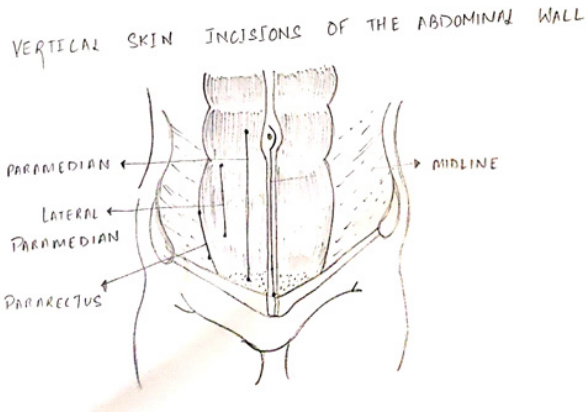
Types of incisions for a pelvic surgery:

There are generally two main types of incision: longitudinal and transverse/oblique.

However. data strongly supporting one incision over another are lacking, the choice of incision remains the preference of the surgeon.

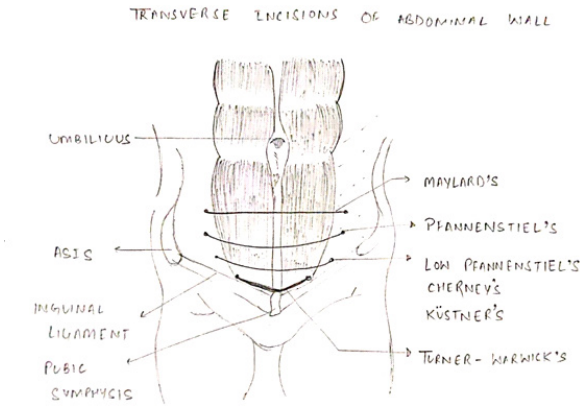
Longitudinal Incisions:

1. Midline incision
2. Paramedian incision
3. Lateral paramedian incision
4. Pararectal incision



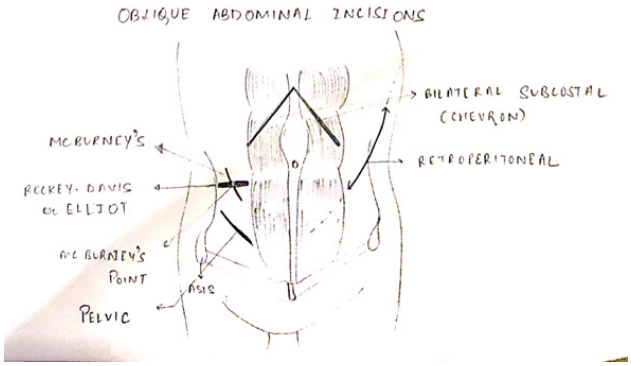
Transverse Incisions :

1. Pfannenstiel's incision
2. Cherney's incision
3. Maylard's incision
4. Kustner's incision
5. Turner -Warwick's incision



Oblique Incisions:

1. McBurney's incision
2. Subcostal incision
3. Thoracoabdominal incision



Mostly low transverse incisions and midline incisions are used in gynaecology.

Advantages and disadvantages of both these incisions are given below :[7]

	Transverse Incision	Midline Incision
Advantages	More suited in planned surgery Less wound dehiscence Cosmetic Lower incidence of adhesion formation and postoperative bowel obstruction Less painful and have less impact on pulmonary function compared to a longitudinal, midline incision, particularly in the early postoperative period. Lower incidence of incisional hernias	More suited in emergency or if diagnosis or location of bleeding is uncertain Most rapid entry, suited patients in shock or sepsis More exposure to upper abdomen Extensibility if need arises Midline incision is associated with less bleeding and less potential for nerve injury
Disadvantages	Limited exposure provided to the upper abdomen Limited extensibility Increased surgical time Relatively larger blood loss Problematic if the pannus is large.	More wound dehiscence and hernia Cosmetically less satisfactory More analgesia use More pulmonary compromise

Paramedian incision: A paramedian incision is made 2 to 5 cm to the left or right of the midline.

Advantage : Less chances of dehiscence or hernia and extensibility.

Disadvantages:

- Longer time to perform
- Restrict access to the contralateral pelvis
- More injury to the epigastric vessels
- Nerve injury may result in rectus paralysis and rectal atrophy
- More difficult closure than midline

Transverse Incisions : Commonly used Transverse incisions in gynaecology are:

[1] Pfannenstiel's incision : It is most commonly used in gynaecology. It is a muscle-separating operation.

Indication : When pathology is strictly confined to pelvis only.

Technique : It is placed 2 to 5 cm above the pubic symphysis and usually is 10 to 15 cm in length. After the skin is entered, the incision is carried up to the anterior rectus sheath, which is incised transversely. The upper and lower fascial edges are grasped and elevated with a heavy toothed clamp and dissected bluntly and sharply off the underlying rectus muscle from the umbilicus to the symphysis. The rectus muscle is separated along the midline raphe, exposing the transversalis fascia. Posterior rectus sheath is separated above the arcuate line. Peritoneum is incised vertically taking care of underlying structures. In this incision sheath is closed with continuous suture. Skin is approximated with a subcuticular (SC) suture. Fascia is closed with continuous delayed- absorbable suture. Subcutanous tissue has to be closed if > 2 cm depth. Skin is approximated with subcuticular, absorbable monofilament suture

Advantages : It provides excellent strength and cosmesis, and exposure is adequate for procedures limited to the pelvis.

Disadvantages:[8]

- Speed of entry is restricted and the risk of seroma, hematoma, and wound infection may be increased.
- If the incision is extended beyond the rectus muscle, the iliohypogastric and ilioinguinal

nerves may be traumatized, and some patients will experience chronic pain due nerve entrapment and neuroma formation.

- In men, risk of inguinal hernia is more when the incision is close to the external inguinal ring.

[2] Cherney's incision :

Technique: Cherney's incision is similar to the Pfannenstiel incision except it is placed is placed slightly lower on the abdomen and involves incising the rectus tendons leaving only half centimetre of it for reattachment. The muscles and tendons are retracted. and the peritoneum is incised longitudinally. Closure of incision requires reattachment of the muscle tendons to their insertions. This is usually done by using permanent horizontal mattress sutures. Alternatively, the tendons of rectus muscle may be attached to the lower rectus sheath.

Advantage: Cherney's incision provides excellent exposure to the retropubic space of Retzius. It is preferred for retropubic urethropexy. Sometimes a pfannenstiel incision may be converted to a Cherney incision to enhance exposure during surgery. Risk of hernia is also less.

[3] Maylard's incision [Mackenrodt incision]:[9] It is a transverse incision at the level of the anterior iliac spine.

Technique : Before transection of the muscles, the deep inferior epigastric vessels are identified on their lateral undersurface. The vessels are isolated, clamped, transected, and ligated. During transection of the rectus muscles, dissection from the anterior rectus sheath should be avoided in order to limit retraction of the muscles. In addition, the cut edge of the muscle may be secured to the anterior sheath with 0-caliber absorbable mattress sutures to further prevent retraction.

Advantage : Adequate abdominal and pelvic exposure for complex gynaecologic surgery.

Disadvantage :

- Access to upper abdomen is limited.
- Delayed bleeding from the cut edge of the rectus muscle or deep epigastric vessels can occur.
- In patients with significant aortoiliac occlusion, blood supply to lower limbs is dependent on collateral flow from the epigastric vessels. Maylard incision may result in leg claudication and even acute leg ischemia.

[4] Kustner's incision: Kustner's incision is a transverse skin incision approximately 5 cm above the symphysis and just below the anterior iliac spine.

Technique: After skin subcutaneous tissue is separated from the rectus sheath in a vertical plane to reveal the linea alba. Numerous small branches of the superficial epigastric plexus of vessels may be encountered and must be ligated to prevent excess oozing. Care must be taken to dissect only enough to expose the linea alba and not to separate the subcutaneous tissue too far laterally. A vertical midline incision is then made in the linea alba.

Advantage: It was developed to reduce the risk of evisceration and for good exposure. Risk of hernia and wound dehiscence is less.

Disadvantage :

- Very time consuming because of the need for extensive hemostasis.
- It has disadvantages of both midline and transverse incisions and therefore has limited utility and no extensibility.
- Collection of blood and serum increases the risk of infection and may necessitate drainage. Risk of hernia is equal to midline incision.

Turner-Warwick's incision: Turner-Warwick's incision is centered 2 to 3 cm above the symphysis and placed within the lateral borders of the rectus muscles.

Trocar placement in laparoscopy: During trocar placement Ilioinguinal and iliohypogastric nerves, superficial and inferior epigastric arteries to be taken care to avoid injury. The lower quadrant ports are placed approximately 2 cm medial and at or superior to the anterior superior iliac spine, lateral to the border of the rectus muscle.[10]

Conclusion

All gynaecologist should be well versed with anatomy of anterior abdominal wall. As the famous saying goes "Pray before surgery, but remember : God will not alter a faulty incision.

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Ethical Clearance : none

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