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An open access technique through the rectus fascia at its junction with umbilical cicatrix tube in laparoscopic surgery

SUBMITTED FOR PARTIAL FULFILLMENT OF MASTER DEGREE OF GENERAL SURGERY

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DEDICATION

TO THE SOUL OF MY FATHER

TO MY MOTHER

MAY SHE BE ALWAYS THE LIGHT OF MY LIFE

TO MY WIFE & SON

TO MY BROTHERS & SISTER

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to.

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Haitham R. ELmehdawi

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List of abbreviations

1	CBD	Common bile duct
2	LUQ	Left upper quadrant
3	BMI	Body mass index
4	VIP	Veress intraperitoneal pressure
5	HIP entry	High pressure entry
6	Lap. Chole.	Laparoscopic cholecystectomy

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INTRODUCTION

There is no debate that laparoscopic surgery has had tremendous positive impact on patients and the healthcare system.

Patients tend to return to their daily activities more quickly with less pain and less morbidity ,Thus the number of laparoscopic procedures done each year continues to rise substantially.

There are over 2 million laparoscopic cases performed annually in the U.S.[1]

Laparoscopic surgery, also known as minimal access surgery, is an approach to surgery whereby operations are performed with specialized instruments designed to be inserted through small incisions.

In order to perform minimal access surgery, you must have access to the peritoneal cavity to establish pneumoperitoneum.

The pneumoperitoneum is essential for improving visualization by moving the abdominal wall away from the viscera.

This initial step in establishing pneumoperitoneum is done blindly with either an open or closed methods .

There are multiple ways to gain access to the abdomen for laparoscopic surgery like; Veress needle , the open Hasson technique, the direct trocar insertion , radially expanding trocars and visual entry systems.

But there remains no clear consensus on an optimal method of entry into the peritoneal cavity.

The initial trocar insertion is the most dangerous aspect of trocar use and likely the most dangerous step in minimally invasive surgery.[2]

The risk associated with the blind initial access and establishing pneumoperitoneum is not found in open surgery.

Despite the many technical advances in laparoscopic surgery equipment and the extensive experience of many surgeons, there is still a number of injuries and deaths each year from insertion of trocars and Veress needles.

The creation of a pneumoperitoneum along with insertion of trocars remains the source of significant injuries to intraabdominal viscera and both intra and retroperitoneal vessels.[3]

The complications associated with trocars vary in severity and in the time of presentation.

It is well established that over 50% of the trocar-related injuries to the bowel and vasculature are during the initial entry.[4]

Unfortunately, 30-50% of the bowel injuries and 15-50% of the vascular injuries are not diagnosed at the time of injury.[4]

This delay has contributed to mortality rates of 3-30% for bowel and vascular injuries.[3,4]

Anatomy of anterior abdominal wall

Understanding of abdominal wall anatomy and its relationship with the viscera and vessels below is crucial for safe placement of trocars.

The abdominal wall extends from the xiphoid process of the sternum and the costal margins above to the iliac and pubic bones of the pelvis below.[5]

Integrity of the anterior abdominal wall is primarily dependent upon the abdominal muscles and their conjoined tendons.

These muscles assist with respiration and control the expulsive efforts during urination, defecation, coughing, and parturition.

They also work with the back muscles to flex and extend the trunk at the hips, rotate the trunk at the waist, and protect the viscera by becoming rigid.

The contour of the abdomen is dependent upon age, muscle mass, muscle tone, obesity, intra-abdominal pathology, parity, and posture.

These factors may significantly alter topography, and become a major obstacle to proper incision selection and placement of trocar .[6]

The principal structures from the most superficial layer to the peritoneum are:

skin, subcutaneous tissue, muscles with an aponeurosis, transversalis fascia, preperitoneal fat, and peritoneum. Nerves, blood vessels, and lymphatics are present throughout.

SKIN AND SUBCUTANEOUS TISSUE

The skin is the largest organ of the human body.
It has numerous functions, including protection against mechanical injury, prevention of bacterial invasion, and protection from the effects of ultraviolet light.
Skin is loosely attached to the underlying structures of the abdomen, with the exception of the umbilicus, where the skin is tethered firmly to underlying tissue.
Skin lines of approximately equal tension are known as Langer's lines. [7]
Across the abdomen, these lines are oriented predominately in a transverse direction with a gentle curvature.
Langer's lines are associated with the distribution of collagen and elastic fibers in the skin. [8]
Thus, transverse incisions heal with a narrower, more cosmetic scar, because they are parallel to Langer's lines and have less tension, while longitudinal or oblique incisions, which traverse these lines, may heal with a broader scar.
The subcutaneous tissue is comprised of deep and superficial adipose tissue layers separated by weak, poorly defined fibrous tissue matrices.
Camper's fascia is superficial and Scarpa's fascia is deep. [9]
Camper's fascia is the superficial fatty layer that is continuous with superficial adipose, and may vary in thickness, depending upon the patient's body habitus.
Scarpa's fascia is a more membranous layer that will eventually become continuous with the superficial fascia of the back and thorax.
Inferiorly, this membranous layer also fuses in the midline and forms a tubular sheath for the penis or clitoris.
This membranous deep fascia merges with the deep thigh fascia and superficial perineal fascia to contribute to the fascia lata and Colles' fascia, respectively. [9]

MUSCLES

The anterior abdominal wall consists primarily of the rectus muscles and associated fascia .
Posterolateral, lateral, and the remaining anterior portion of the abdominal wall are composed of three paired, broad, flat muscles, each with an aponeurosis or tendon including the external oblique, internal oblique and transversus abdominus muscles .
The rectus muscles are responsible for abdominal wall flexion, while the oblique muscles rotate the torso.
The internal oblique and transversus abdominis muscles support and compress the abdominal contents. [10]

Rectus abdominis

The rectus abdominis consists of a pair of strap muscles that extend the length of the anterior abdominal wall, and are separated by the linea alba .
These muscles arise from the symphysis pubis and the pubic crest with insertion into the fifth, sixth, and seventh costal cartilages and the xiphoid process.
The rectus sheath has variable contributions from the oblique and transversus muscles. [10]

External oblique

The external oblique muscle is a broad, thin muscle that arises from the surfaces of the lower eight ribs, fanning out downward to insert medially into the xiphoid process, the linea alba, and the anterior portion of the iliac crest .
Its aponeurotic sheet contributes to the anterior sheath of the rectus abdominis, then fuses at the linea alba in the midline with the contralateral counterpart.
The remainder of the aponeurosis extends from the iliac spine to the pubic tubercle where it becomes the inguinal ligament. [10]

Internal oblique

The internal oblique muscle is a broad, thin muscle that lies deep to the external oblique, with its origins from the thoracolumbar fascia, the anterior two-thirds of the iliac crest, and the lateral two-thirds of the inguinal ligament .
Its aponeurotic sheet contributes to the anterior sheath of the rectus abdominis, then fuses at the linea alba in the midline with the contralateral counterpart .
The muscle fibers travel upward and forward to insert into the lower borders of the lower three ribs and their costal cartilages, the xiphoid process, the linea alba, and the symphysis pubis. [10]

Transversus abdominis

The transversus abdominis muscle is a thin muscle sheet that lies deep to the internal oblique muscle. The fibers of this muscle sheet run horizontally and forward.
It arises from the deep surface of the lower six costal cartilages, the lumbar fascia, iliac crest, and the lateral third of the inguinal ligament, and inserts into the xiphoid process, linea alba, and the symphysis pubis .
Its aponeurotic sheet contributes to the posterior rectus sheath above the arcuate line and the anterior rectus sheath below the arcuate line .
It then fuses at the linea alba in the midline with the contralateral counterpart.

Pyramidalis

The pyramidalis muscle is a flat, triangular muscle at the inferior margin of the anterior abdominal wall.
It originates from the superior pubic ramus, between the symphysis pubis and the pubic tubercle, and runs superomedially inserting into the linea alba. [11]

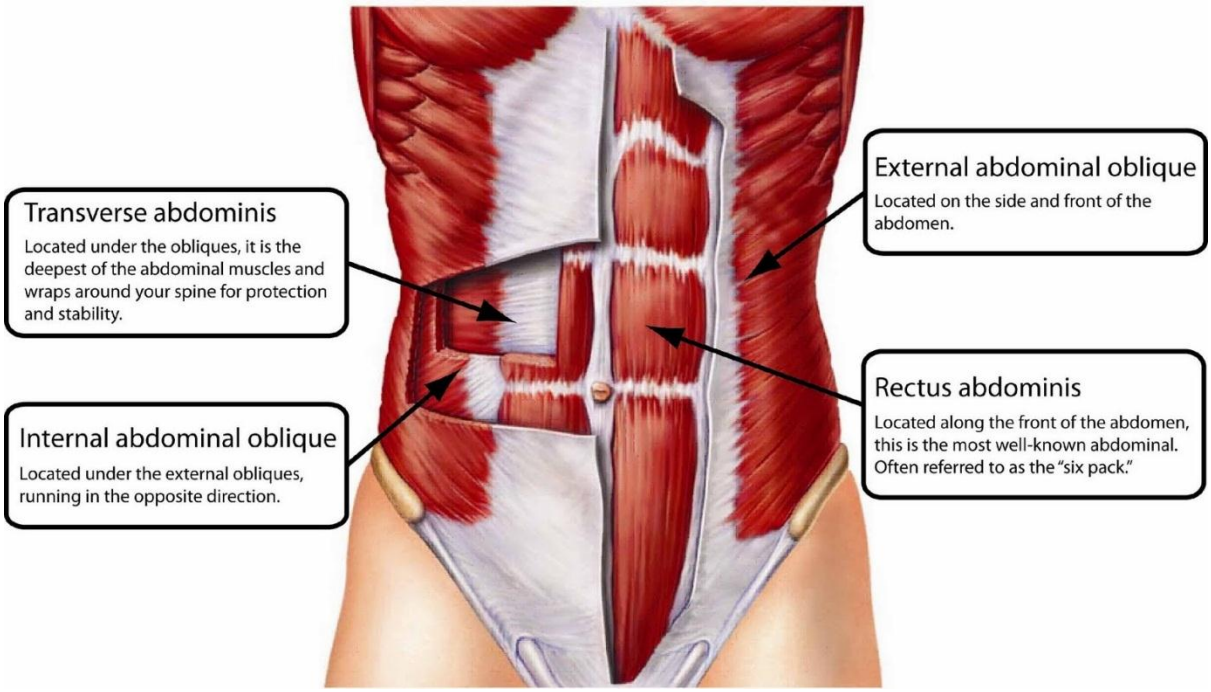


Fig (1) Muscles of anterior abdominal wall [12]

FASCIA

Rectus sheath

The rectus sheath is composed of the broad sheet-like aponeuroses of the flank muscles which enclose the rectus abdominis (and pyramidalis muscle, if present). Lateral to the rectus abdominis, the aponeuroses can be separated, but they fuse as they reach the midline .

The external oblique muscle, the most superficial of the flank muscles, has a broad aponeurosis that passes anteriorly over the rectus abdominis.

Beneath the external oblique, the internal oblique has a bilaminar aponeurosis that passes posterior to the rectus abdominis above the arcuate line, and anterior to the rectus below the arcuate line.

The innermost abdominal muscle is the transversus abdominis.

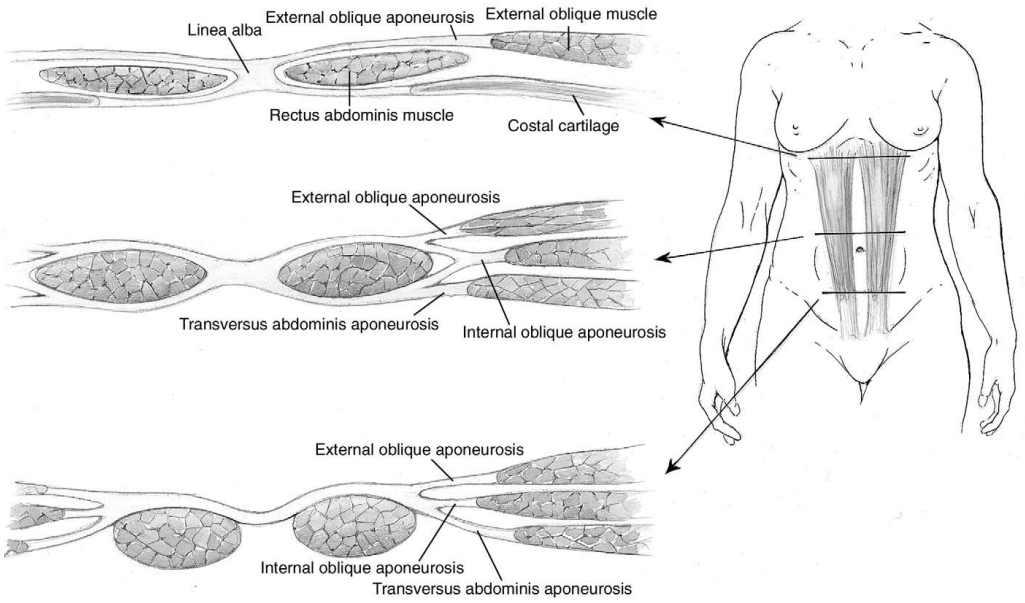
Its aponeurosis is posterior to the rectus abdominis above the arcuate line, and anterior to the rectus abdominis below the arcuate line where it fuses with the aponeurosis of the internal oblique.

Inferior to the arcuate ligament, the aponeuroses of all three muscles form the anterior sheath.

The posterior sheath is absent and the rectus lies directly on top of the transversalis fascia .

The arcuate line is the site where the inferior epigastric vessels enter the rectus sheath, travel superiorly, and converge with the superior epigastric vessels .

The arcuate line is absent in as many as 30 percent of individuals. [13]



Fig(2) The **rectus sheath at various levels** [13]

Transversalis fascia

The transversalis fascia is a weak fibrous layer covering the inner surface of the transversus abdominis muscles and is separated from the peritoneum by a layer of fat, commonly known as the preperitoneal fat layer.

It is frequently incised off the bladder when the peritoneal cavity is opened. This layer of connective tissue forms a continuous lining for the abdominal and pelvic cavities and is continuous with the diaphragmatic fascia, the iliacus fascia, and the pelvic fascia . [10]

Linea alba

The linea alba stretches from the xiphoid process to the pubic symphysis.

It is defined as the fusion of the aponeuroses of the external oblique, internal oblique, and the transversus abdominis muscles .

It maintains the abdominal musculature at a certain proximity to each other.

The linea tends to have its widest margin approximately 3 cm superior to the umbilicus, and has varying distances depending upon the point of reference along the abdominal wall. [14]

PERITONEUM

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); and the lateral umbilical ligaments associated with the deep inferior epigastric vessels. [10]

VASCULATURE

The blood supply of the abdominal wall is comprised of superficial and deep vascular supplies.
These named vessels run primarily longitudinally and may provide collateral flow channels between the subclavian artery and femoral artery when significant aortic or bilateral iliac artery obstruction is present.
The superficial vasculature is located in the subcutaneous tissues and supplies the tissues superficial to the external oblique aponeurosis and the anterior rectus sheath. [15]
The muscles and tissues below these layers are supplied by the deep vessels which are located in the musculofascial layers.

Deep arteries

Inferior deep epigastric arteries

The inferior deep epigastric artery is thought to be the dominant vascular supply to the anterior abdominal wall .
It branches from the external iliac artery passing medially adjacent the inguinal ligament.
It ascends medial to the external inguinal ring and superficial to the transversalis fascia.
It then proceeds toward the umbilicus and crosses the lateral border of the rectus muscle at the arcuate line where it enters the posterior rectus sheath .
Once the artery enters the sheath, it branches extensively. It ascends within the rectus sheath to communicate with the superior deep epigastric artery.
The angle between the vessels and lateral border of the rectus forms the apex of the inguinal (Hesselbach's) triangle, the base of which is the inguinal ligament.
The musculocutaneous perforating vessels of the inferior deep epigastric artery reach and supply deeper tissue as well as the integument of the anterior abdominal wall. These perforators are particularly relevant in reconstructive surgery as an important supply for abdominal tissue flaps used . [15]
The number, location, and course of these perforators are highly variable.
The inferior deep epigastric vessels are bounded only by loose areolar tissue below the arcuate line.
Trauma to this portion of the inferior deep epigastric artery may result in considerable hemorrhage.
Because hematomas commonly dissect into the retroperitoneal space, large quantities of blood may be lost before outward evidence of hematoma is detectable. [10]

Superior deep epigastric arteries

The superior deep epigastric artery is a terminal branch of the internal thoracic artery .

It enters the rectus sheath at the seventh costal cartilage and descends on the posterior surface of the rectus muscle .

The superior and inferior deep epigastric arteries freely anastomose with one another at the level of the umbilicus to provide a generous collateral circulation between the subclavian and external iliac arteries.

These vessels communicate laterally with the intercostals, subcostal, and lumbar arteries, as well as the ascending branch of the deep circumflex iliac artery . [15]

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.

Deep circumflex iliac arteries

The deep circumflex iliac artery also branches from the external iliac artery or, less frequently, from a common origin that includes the inferior epigastric artery.

Its course is lateral and vertical behind the inguinal ligament.

It then turns medially at the iliac crest, where it pierces the transversus abdominis muscle.

Between the transversus abdominis and internal oblique muscles, numerous connecting branches supply the lower and lateral abdominal wall.

Anastomoses with the intercostal and lumbar vessels supply branches to all the flank muscles. [12]

Musculophrenic arteries

The musculophrenic artery is also a branch of the internal thoracic artery.

It lies behind the costal cartilage to supply the intercostal spaces and upper abdominal wall.

Anastomoses from intercostal and subcostal vessels to the deep circumflex iliac vessels occur in the deep layer. [12]

Superficial arteries

The superficial vasculature of the abdominal wall is located in the subcutaneous tissues and consists of branches of the femoral artery, including the superficial inferior epigastric, superficial external pudendal, and superficial circumflex arteries.

The superficial inferior epigastric vessels run diagonally in the subcutaneous tissues from the femoral artery toward the umbilicus .

They can be identified on a line between the palpable femoral pulse and umbilicus just superficial to Scarpa's fascia. As they approach the umbilicus, the arteries branch extensively.
The external pudendal arteries have a medial and diagonal course from the femoral artery, and supply the region of the mons pubis.
These vessels branch extensively as they approach the midline. Following incision, bleeding is typically heavier here than in other subcutaneous areas of the abdomen.
The superficial circumflex iliac vessels proceed from the femoral vessels to the flank. The superficial vessels follow the general pattern of the deep vessels and arise from the iliac or femoral vessels.
The exception is that the superficial inferior epigastric vessels have no superior counterparts. [12]

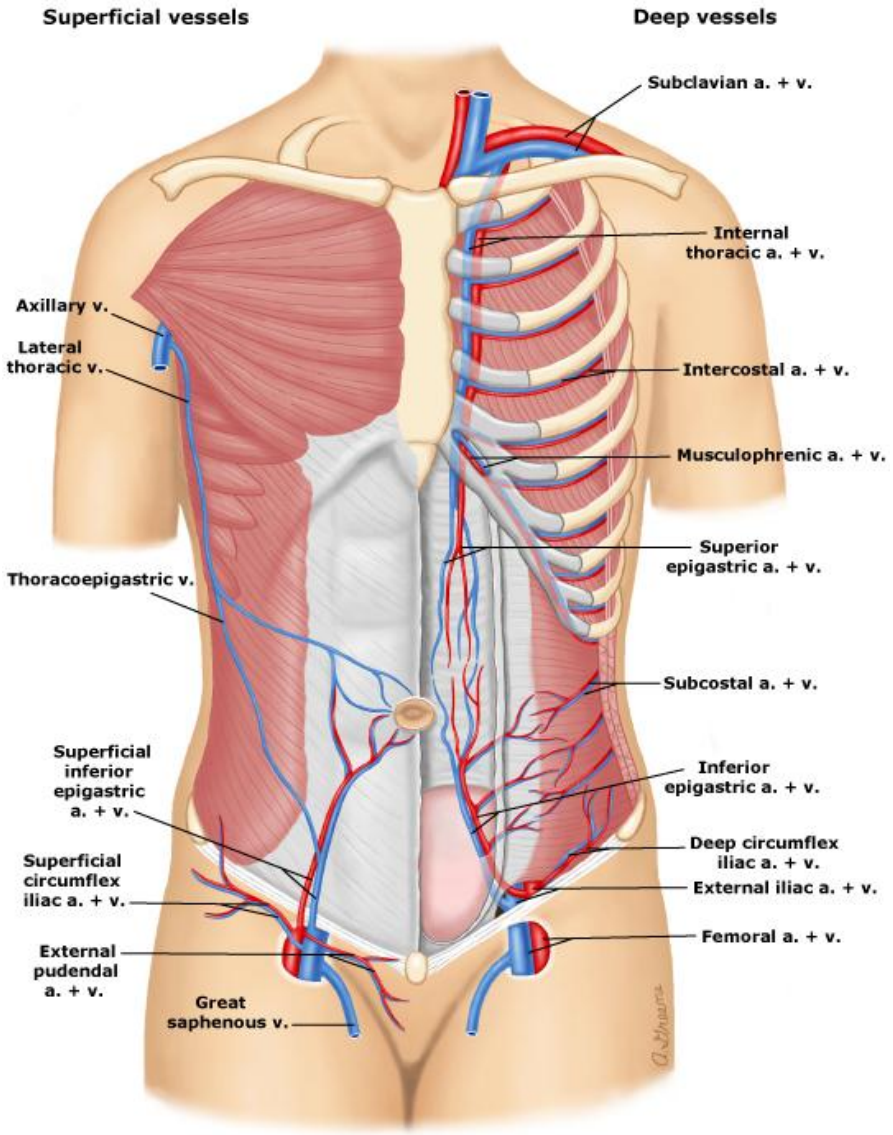


Fig (3) Blood supply of anterior abdominal wall [12]

Veins

Venous drainage of the anterior abdominal wall tends to be more variable than arterial pathways; however, veins typically follow the course of arteries .
Above the umbilicus, they drain to the subclavian vessels, and below the umbilicus, they drain to the external iliac vessels.
Veins may be dilated in patients with obstructed blood-flow through the liver and porta hepatis.
They may also be engorged in patients with large pelvic masses. [12]

Collateral flow channels

Several patterns of collateral flow exist in the abdominal wall due to the extensive network of vessels supplying it.
The principle blood vessels involved in this collateral circulation are the internal mammary, superior epigastric, intercostals, inferior epigastric, and external iliac.
This network allows blood to bypass the occlusion of the aorta or iliac vessels, and thus, restore blood flow to the lower extremities.
Case reports have described worsening of lower extremity ischemia when transverse incisions of the abdomen disrupt the abdominal wall vessels . [16]

LYMPHATIC CHANNELS

Abdominal lymphatics generally follow the course of the abdominal veins.
As a general rule, the channels of the upper abdominal wall, above the level of the umbilicus, drain primarily to the anterior axillary (ie, pectoral) lymph nodes, and to a lesser extent, to the internal mammary chain .
Those of the lower abdomen, below the level of the umbilicus, drain to the inguinal nodes and then to the iliac chain of nodes.
Lymphatics adjacent the umbilicus drain towards the liver through the falciform ligament.
Transverse incisions are likely to disrupt lymphatic drainage to some degree.
This disruption may lead to tissue swelling in the abdominal wall until collateral lymphatic drainage can be established. [12]

NERVES

The intercostal and lumbar nerves enter the abdominal wall between the transversus abdominis and internal oblique muscles, and run in a generally caudal and medial direction.
Each nerve innervates a dermatome, but some overlapping innervation occurs. Longitudinal incisions (except at the midline) can be expected to lead to sensory impairment inferior and medial to the level of the transected nerves.
Although technically not nerves of the abdominal wall, the femoral nerve, the lateral femoral cutaneous nerve, and the genitofemoral nerve can also be damaged during abdominal surgery, especially with inguinal and femoral hernia repair . [12]

Intercostal nerves

The 7th to 12th intercostal nerves innervate the abdominal wall .
Because of overlapping dermatomes, the fifth and sixth intercostal nerves can also contribute.
The intercostal nerves divide into lateral cutaneous branches and anterior and posterior branches.
The 10th nerve supplies the region of the umbilicus.
Postoperative bulge is related to intercostal nerve injury with subsequent paralysis of abdominal wall musculature.
Intercostal nerve injury can be reduced by avoiding extension of the incision into the 11th intercostal space . [17]

Iliohypogastric nerves

The 12th intercostal and the first lumbar nerves form the iliohypogastric nerve, which passes medial to the anterior superior iliac spine .
The iliohypogastric nerve enters the abdominal wall at the transversus abdominis muscle and courses, on average, 2.1 cm medial and 0.9 cm inferior to the anterior superior iliac spine, following a linear course to terminate 3.7 cm lateral to the midline and 5.2 cm superior to pubic symphysis . [18]
The terminal branch courses medial and parallel to the inguinal ligament. It provides motor fibers to external oblique, internal oblique, and transversus abdominis muscles, and provides sensory fibers to the skin of the mons pubis.
The anterior cutaneous branch of the iliohypogastric nerve provides sensory innervation to the skin of the upper and lateral thigh . [19]
It communicates with the ilioinguinal nerve, and provides sensory fibers to the skin overlying the external inguinal ring and symphysis.

Ilioinguinal nerve

The ilioinguinal nerve is formed by the combination of the first and second lumbar nerves, and passes medial to the superior anterior iliac spine to supply the lower abdominal wall .

On average, the proximal end of the ilioinguinal nerve enters the abdominal wall 3.1 cm medial and 3.7 cm inferior to the anterior superior iliac spine, then follows a linear course to terminate 2.7 cm lateral to the midline and 1.7 cm superior to pubic symphysis . [17]

The ilioinguinal nerve generally follows a course with the iliohypogastric nerve, running medially at the inguinal ligament between the transversus abdominis and internal oblique muscles.

A branch of the ilioinguinal nerve accompanies the round ligament as it passes through the inguinal canal.

It exits the canal at the external inguinal ring, and provides sensory fibers to the labia majora and the upper aspect of the medial thigh . [18]

Genitofemoral nerve

The genitofemoral nerve has fibers from the first and second lumbar nerves, and rests on the psoas muscle lateral to the external iliac artery.

The genital branch provides sensation to the mons pubis and labia majora.

The femoral branch provides sensation to the femoral triangle .

The genital branch passes within the cremasteric muscle fibers in men and in the round ligament in women, and may be encountered during open hernia surgery. [19]

Lateral femoral cutaneous nerve

The second and third lumbar roots give rise to this nerve ,which crosses the psoas muscle slightly above the femoral nerve and provides sensory innervation to the anterior and lateral thigh .

It runs inferiorly and laterally toward the anterior superior iliac spine, exiting the pelvis through the lateral lacuna musculorum.

It pierces the fascia approximately 2 to 3 cm below the anterior superior iliac spine. Entrapment of the lateral femoral cutaneous nerve can occur, leading to numbness; paresthesias; and pain in the anterolateral thigh . [20]

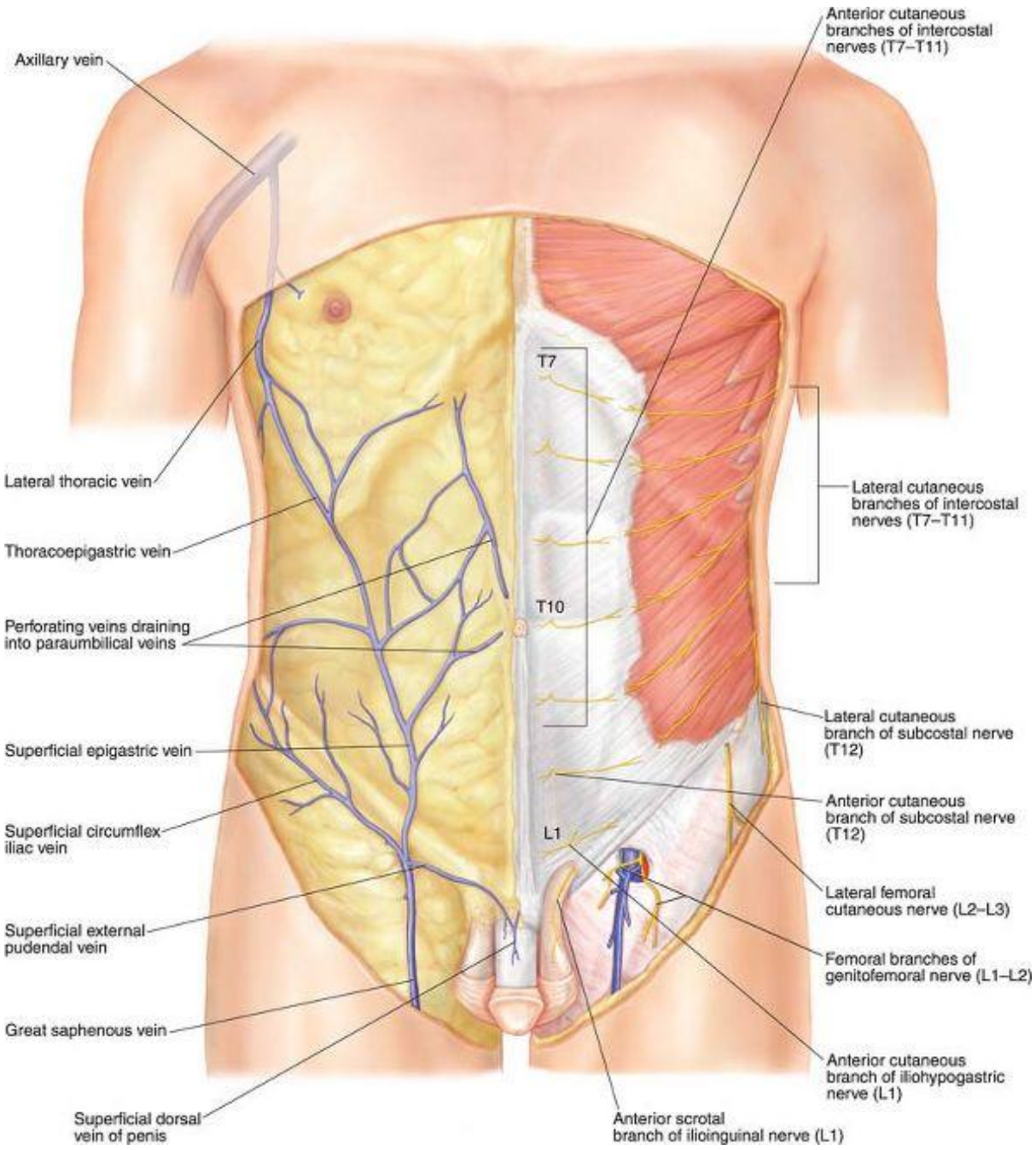


Fig (4) Nerve supply of anterior abdominal wall [12]

Clinical Anatomy of the Umbilicus

'Every time an abdomen is examined the eyes of the clinician, almost instinctively, rest momentarily on the umbilicus.'
(Hamilton Bailey) [22]

Position and appearance

Typically the umbilicus is at the same level as the highest point of the iliac crest, i.e. at the 3rd - 4th lumbar disc.
This point is almost equidistant along the line joining the tip of the xiphoid process and the top of the symphysis pubis.
The position is, however, variable and unreliable as a landmark.
The umbilicus is normally above the midpoint between the top of the head and the soles of the feet; in achondroplasia it is below this point.
If the abdomen is distended as a result of a pregnant uterus, the umbilicus is displaced up wards ; ascites will cause downwards displacement (Tanyol's sign). [22]

The skin in the umbilical area drains upwards to the lymph nodes in both axillae, and downwards to bothgroins.
The prominence of the umbilicus and the depth of the umbilical pit (cicatrix) are extremely variable.
A bluish tinge may be noticeable at the umbilicus and the surrounding skin in cases of ruptured ectopic pregnancy (Cullen's sign, umbilical 'black eye'), while a yellow tinge is sometimes observed in acute pancreatitis.

Intraperitoneal rupture of a hydatid cyst may result in a dirty greenish stain of the umbilicus.
Visible veins are often seen, arranged radially from the umbilicus.
Normally the blood flow is upwards in the veins above the umbilicus, downwards in those below.
In portal vein obstruction this direction of flow is unchanged, but in obstruction of the inferior vena cava the flow in veins below the umbilicus is reversed (i.e. up wards) to shunt blood to the superior vena cava. [22]

METHODS OF ENTRY

Access into the abdomen is the one challenge of laparoscopy that is particular to insertion of surgical instruments through small incisions.
Access is therefore associated with injuries to the gastrointestinal tract and major blood vessels, and at least 50% of these major complications of trocar insertion occur prior to commencement of the intended surgery. [22]

This complication rate has remained the same during the last 25 years. [23]
The majority of injuries are due to the insertion of the primary umbilical trocar.
Increased morbidity and mortality result when surgeon do not recognize injuries early or do not address them quickly. [24]

To minimize entry-related injuries, several techniques, instruments, and approaches have been introduced during the last century.

These include the

- Veress pneumoperitoneum “classic” or closed entry
- The open (Hasson) technique
- Direct trocar insertion without prior pneumoperitoneum
- Use of shielded disposable trocars
- Optical Veress needle,optical trocars
- Radially expanding trocars
- Visual access cannula. [25]

Each of these methods of entry enjoys a certain degree of popularity according to the surgeon’s training, experience, and bias, and according to regional and interdisciplinary variability , but there remains no clear consensus on an optimal method of entry into the peritoneal cavity.

CLOSED ENTRY (CLASSIC) LAPAROSCOPY

The classic, or closed entry, laparoscopic technique requires cutting of the abdominal skin with a scalpel, insufflation of air or gas into the abdomen (establishment of pneumoperitoneum), and insertion of a sharp trocar/cannula system into the abdomen.
Following removal of the sharp trocar, the abdominal cavity is examined by an illuminated telescope through the cannula.

THE VERESS NEEDLE

The Veress needle consists of a sharp needle with an internal, spring loaded trocar.
The trocar is blunt ended with a lumen and side hole.
Disposable and non-disposable metal Veress needles are available commercial in different lengths i.e. long for obese patients, short for thin or pediatric patients. .
Before using the needle every time it should be checked for its patancy and spring action . [26]

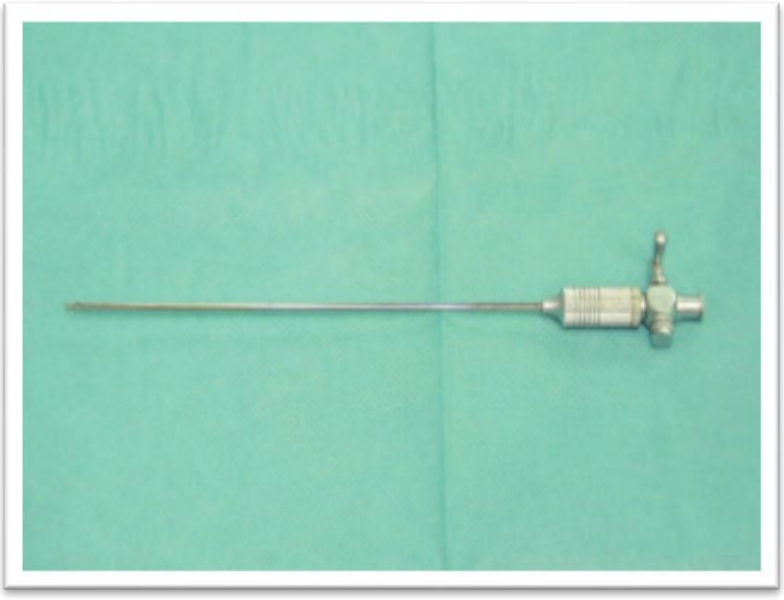


Fig (5) The Veress needle [27]

In 1947, Raoul Palmer of France popularized the use of the Veress needle using CO2 to induce pneumoperitoneum for laparoscopy, and he subsequently published on its safety in the first 250 patients. [28]
Palmer emphasized that the creation of pneumoperitoneum remains a vital first step, and it is one still associated with recognized complications.
Several surveys indicate that most gynaecologists practising laparoscopy worldwide use the Veress needle pneumoperitoneum- primary trocar technique to access the abdomen. [25]
In a Canadian survey of 407 (51% responding) obstetricians and gynaecologists, 96.3% reported always inducing pneumoperitoneum prior to insertion of the primary trocar, 1.2% sometimes, and 2% never (0.5% made no response). [25]
Furthermore, 26.4% of respondents had experienced vessel or organ injury attributable to the Veress needle, and 25.6% and 15.0% experienced vessel or organ injury from the primary and secondary trocars, respectively. [25]

Veress Needle Insertion Sites

Under usual circumstances, the Veress needle is inserted in the umbilical area, in the midsagittal plane, with or without stabilizing or lifting the anterior abdominal wall.
In patients known or suspected to have periumbilical adhesions, or after failure to establish pneumoperitoneum after three attempts, alternative sites for Veress needle insertion may be used . [29]

Is umbilicus safe for access?

Umbilical is good site for access because it is:

1. thinnest abdominal wall (easy access)
2. cosmetically better
3. no significant blood vessels
4. Ergonomically better (centre point of abdomen)

Initially there was controversy regarding use of umbilicus for first port access. There were two fear regarding use of umbilicus

- First concern was regarding infection.
  Umbilicus is a naturally dirty area and many surgeons were having this impression that it may cause infection of port site.
  The umbilical skin cannot be cleaned of all bacteria even with modern iodophor solution.
  Carson and associates (1997) demonstrated that the bacteria introduced inside the abdominal cavity through this dirty skin but these bacteria do not have many dead cells to act as culture medium to grow and the normal defence mechanism of body destroys these bacteria rapidly. [26]
- Second fear of using umbilicus was ventral hernia. Umbilicus is the weakest abdominal wall so the chances are more that ventral hernia may develop if umbilicus is used for access.

A survey of American Association of Gynecological Laparoscopists members reported in 1994 (Montz et al).
The study was of 3127 surgeons and there were 840 hernia reported.
86% of cases of incisional hernia after laparoscopy were due to unrepaired 10 mm or larger port wound. . [26]
Due to these two possible complications of using umbilicus for access, many surgeons started using supra-umbilical or infra-umbilical region of abdominal wall for access.
Even the port wound of 10 mm away from the umbilical site was also reported higher incidence of incisional hernia.

Recent study has proved that umbilicus does not have increased incidence of infection or ventral hernia compared to other site if few precautions are taken.

1. Umbilicus should be cleaned meticulously before incision
2. Rectus sheath of all the 10 mm port should be repaired.
3. If umbilical route is used for tissue retrieval, infected tissue should be removed after putting in endobag , It should not contaminate the port wound.
4. Any haematoma formation at the port wound site should be discouraged by maintaining proper haemostasis. [26]

Contraindications of Umbilical Entry

1. Previous midline incision
2. Portal hypertension with recanalyzed umbilical artery with advanced cirrhosis of the liver
3. Umbilical abnormalities viz. urachal cyst, sinus, hernia . [26]

Challenge with anterior abdominal wall adhesions

Adhesions at the umbilical area are found in approximately 10% of all laparoscopies. [30]
One series of 4532 laparoscopies reported an incidence of only 0.2 per1000. [25]
In women with no previous abdominal surgery, umbilical adhesions are found in 0% to 0.68% of laparoscopies.
Rates of umbilical adhesions range from 0% to 15% in women with prior laparoscopic surgery, from 20% to 28% in those who have had previous laparotomy with horizontal suprapubic incision, and from 50% to 60% in those who have had previous laparotomy with longitudinal incision. [25]
Patients with midline incisions performed for gynaecologic indications had significantly more adhesions than those with all types of incisions performed for obstetric indications. [31]
In some research protocols, preoperative ultrasonography to detect anterior wall adhesions has been found to be useful, but it needs further evaluation, and there is insufficient evidence to recommend routine preoperative ultrasound. [32]
In 58 of 69 subjects, laparoscopic or laparotomy findings confirmed the ultrasound findings of “restricted visceral slide” in the presence of visceral adhesions. [32]

Left upper quadrant (LUQ, Palmer’s point) CO2 insufflation

In patients with previous laparotomy, Palmer advocated insertion of the Veress needle 3 cm below the left subcostal border in the midclavicular line. [28]
This technique should be considered in the obese as well as the very thin patient.
In very thin patients, especially those with a prominent sacral promontory and android pelvis, the great vessels lie 1 cm to 2 cm underneath the umbilicus, and in obese women, the umbilicus is shifted caudally to the aortic bifurcation. [25]
LUQ insufflation requires emptying of the stomach by nasogastric suction and introduction of the Veress needle perpendicularly to the skin.
Patients with previous splenic or gastric surgery, significant hepatosplenomegaly, portal hypertension, or gastropancreatic masses should be excluded. [33]
After establishment of the pneumoperitoneum, trocars of various diameters and shapes may be introduced at the same site as the Veress, followed by additional trocar/cannula systems inserted under direct vision, as required. [34]

Veress needle safety tests or checks

1. **Needle movement test (Very gentle movement)**

Once the veress needle is inside the abdominal cavity the tip of veress needle should be free and if surgeon will gently move the tip of needle there should not be feel of any resistance.

It is very important to remember that veress needle should not be moved inside the abdominal cavity much, otherwise there may be risk of laceration of bowel if it is punctured. . [26]

2. **Irrigation test**

A 10 ml syringe should be taken in one hand and surgeon should try to inject at least 5 ml of normal saline through veress needle.

If tip of veress needle is inside the abdominal cavity then there will be free flow of saline otherwise some resistance is felt in injecting saline. . [26]

3. **Aspiration test**

After injecting saline surgeon should try to aspirate that saline back through veress needle.

If the tip of veress needle is in abdominal cavity the irrigated water can not be sucked but if it is in pre-peritoneal space on in muscle fibre of above the rectus the injected water can be aspirated back.

At the time of aspiration test if more fluid then irrigated fluid is coming then surgeon should suspect either ascitis or he has perforated urinary bladder or some cyst.

If faecal mater is seen then perforation of colon may be the reason and if blood is coming then the vessel injury is the cause.

If any fresh blood or fecal fluid is aspirated in the syringe surgeon should not remove the veress needle and urgent laparotomy is required.

Leaving veress needle in position is helpful in two ways first it is easy to localize the punctured area in laparotomy and secondly the further bleeding will be prevented .[26]

4. Hanging drop test

Few drops of saline should be pored over the veress needle and abdominal wall should be lifted slightly if tip of the veress needle is inside the abdominal cavity the hanging drop should be sucked inside because inside the abdomen there is negative pressure.

If tip of the veress needle is anywhere else the hanging drop test will be negative. . [26]

5. Insufflation of gas test, Quadro-manometric test

For safe access surgeon should always see carefully all these four indicators of insufflator at the time of creation of pneumoperitoneum.
If the gas is flowing inside the abdominal cavity there should be proportionate rise in actual pressure with total gas used. . [26]
Suppose only with the entry of 400 to 500 ml of gas, if actual pressure is equal to preset pressure of 12 mm of Hg, that means gas is not going in free abdominal cavity, it may be in pre-peritoneal space or inside omentum or may be in bowel.
If gas is flown more than 5 liter without any distension of abdomen that may be due to leakage or gas may be going inside the vessel.
With increasing experience, surgeon will immediately realize where he is by seeing these four setting of his insufflator. [26]
Several studies have described tests and techniques for determining the correct placement of the Veress needle.
Although all these tests and techniques may be helpful in accessing the peritoneal cavity, the fact that visceral and vascular injuries occur shows that they are not fool proof.
In fact, a recent prospective study reported that the double click, aspiration, and hanging drop tests provided very little useful information on the placement of the Veress needle. [35]
In view of recent evidence, failure to perform these tests should no longer be considered as substandard care or negligence. [35]
Some surgeons waggle the Veress needle from side to side, believing that this shakes an attached organ from the tip of the needle and confirms correct intra-abdominal placement.
However, this manoeuvre can enlarge a 1.6 mm puncture injury to an injury of up to 1 cm in viscera or blood vessels. [36]

Veress Needle Modifications

1. Pressure-sensor-equipped Veress needle

A modified pressure-sensor-equipped Veress needle to provide the surgeon immediate feedback the moment the tip enters the peritoneal cavity has been described. [37]

2. Optical Veress needle (minilaparoscopy)

The Veress needle has been modified to a 2.1 mm diameter and cannula 10.5 cm long to allow insertion of a thin (1.2 mm diameter), zero degree, semirigid fiberoptic minilaparoscope.

This system may be inserted in the umbilicus or the left upper quadrant, and subsequent ancillary ports are inserted under direct vision.

During insertion of the assembled unit (Veress cannula and telescope) the surgeon observes a cascade of monitor colour sequences that represent different abdominal wall layers: subcutaneous fat appears yellow, fascia white, anterior rectus muscle red, and peritoneum translucent or shiny bright.

When the Veress needle enters the peritoneum, CO2 gas can be seen bubbling forwards, and the intra-abdominal structures soon come into view. Alternatively, some surgeons insert the optical Veress needle first, secure insufflation, and then introduce the minilaparoscope. [25]
In patients with longitudinal abdominal wall incisions, utilization of the optical Veress system through the LUQ and insertion of the ancillary ports under direct vision may present a safer alternative.
However, in a prospective study of 184 cases, two bowel injury occurred. [38]

Therefore, the relative predictive risks of the optical Veress needle remain uncertain in the absence of randomized studies.

3. Veress intraperitoneal pressure (VIP pressure)

Several investigators have reported initial intraperitoneal insufflation pressures 10 mm Hg indicating correct Veress needle placement.

Prospective studies have concluded that initial intra-abdominal pressures of 10 mm Hg or below indicate correct placement of the Veress needle, regardless of the women's body habitus, parity, and age.

In fact, another study concluded that the initial gas pressure (9 mm Hg) is the only accurate measure of correct intraperitoneal Veress needle placement. [35]

Finally, a recent study has confirmed that the initial intraperitoneal insufflation pressure(10 mmHg) correlates positively with the patient's weight and BMI and negatively with parity. [39]

Elevation of the anterior abdominal wall

Many surgeons advocate elevating the lower anterior abdominal wall by hand or using towel clips at the time of Veress or primary trocar insertion.

One study used a suprapubic port to compare the efficacy of manual elevation below the umbilicus and of towel clips placed within and 2 cm from the umbilicus.

They reported that only towel clips provided significant elevation of peritoneum (6.8 cm above the viscera) that was maintained during the force of the primary trocar insertion. [40]

Using this technique, however, one surgeon caused aortic injury to two patients in one month. [41]

Hill and Maher reported 26 (4.8%) omental perforations as the omentum was elevated (lifted by hand), together with the anterior wall, during 542 direct trocar insertions for laparoscopic access. [42]

Adequate Pneumoperitoneum

Controversy exists as to what defines an “adequate,” “appropriate,” or “sufficient” pneumoperitoneum prior to insertion of the primary trocar.

Traditionally, it has been defined by an arbitrary volume of 1 L to 4 L of CO2 or an arbitrary intraperitoneal pressure of 10 to 15 mm Hg. [42]

Richardson and Sutton undertook a prospective study of 836 patients undergoing laparoscopy to determine the complications associated with the first entry, using the volume technique (n = 291) and the pressure technique (n= 335, median pressure 14 mm Hg) as the end points. [42]

The average volume of CO2 used in the pressure technique group was significantly greater than that used with the volume technique group , and the complication rate in the pressure technique group was significantly lower than that in the volume technique group , at all levels of operator experience.

The authors suggested that the pressure technique should be universally adopted. [42]

High Pressure Entry (The HIP Entry)

The pressure technique has been adopted by many surgeons worldwide, but the appropriate volume to establish an appropriate intra-abdominal pressure remains controversial.
The rationale for the higher pressure entry technique is that it produces greater splinting of the anterior abdominal wall and a deeper intra-abdominal CO2 bubble than the traditional
volume-limited pneumoperitoneum of 2 L to 4 L.
One study determined that 3 L and 4 L of insufflated CO2 volume established intraperitoneal pressures of 10 and 15 mm Hg, respectively. [43]
The same study demonstrated that when a downward force of 3 kg was applied to an umbilical trocar, the intra-abdominal CO2 bubble was reduced to zero at 15 mm Hg, and the tip of the trocar touched abdominal contents; when the same force was applied at 25 mm Hg pressure, a CO2 gas bubble at least 4 cm deep was maintained in all cases, and the tip of the trocar never touched abdominal contents. [43]
It has been determined that trocar insertion requires 4 to 6 kg of force, and shielded disposable trocars require half the force of reusable trocars. [25]
The combined results of three series involving 8997 laparoscopies using entry pressures of 25 to 30 mm Hg included reports of four (0.04%) bowel injuries and one (0.01%) major vessel injury. [25]
In all cases of bowel injuries, the bowel was adhered at the entry site of the anterior abdominal wall, and the vascular injury occurred because of inadvertent loss of pneumoperitoneum during trocar insertion.
Although the high-pressure entry technique is easier for the surgeon and safer for the patient, surgeons may be reluctant to accept it for fear of compromising the patient's cardiopulmonary function.
It has been demonstrated that the use of transient high-pressure pneumoperitoneum causes minor hemodynamic alterations of no clinical significance. [43]
However, although there is a significant decrease in pulmonary compliance (approximately 20%) from 15 to 30mmHg, the maximum respiratory effects at 25 to 30mmHg have not been shown to differ from the effect of Trendelenburg position with intra-abdominal pressure at 15 mm Hg. [43]

OPEN LAPAROSCOPIC ENTRY OR HASSON TECHNIQUE

Hasson first described the open entry technique in 1971. [44]
The suggested benefits are prevention of gas embolism, during preperitoneal insufflation, and possibly of visceral and major vascular injury.
The technique involves using a cannula fitted with a cone-shaped sleeve, a blunt obturator, and possibly a second sleeve to which stay sutures can be attached.

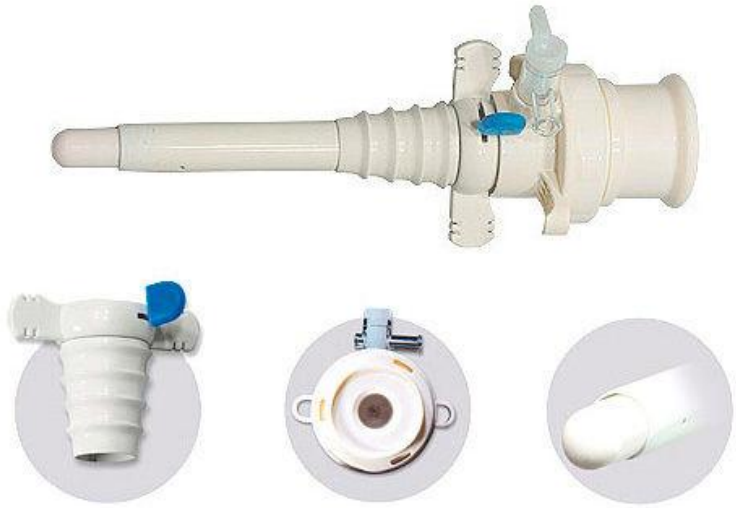


Fig (6) Disposable Hasson's cannula [45]

Fig (7) Disposable Hasson's cannula [45]

The entry is essentially a mini-laparotomy.

- A small incision is made transversely or longitudinally at the umbilicus.
- This incision is long enough to dissect down to the fascia, incise it, and enter the peritoneal cavity under direct vision.
- The cannula is inserted into the peritoneal cavity with the blunt obturator in place.
- Sutures are placed on either side of the cannula in the fascia and attached to the cannula or purse-stringed around the cannula to seal the abdominal wall incision to the cone-shaped sleeve.
- The trocar is then introduced and insufflation is commenced.
- At the end of the procedure the fascial defect is closed and the skin is approximated.

The open technique is favoured by general surgeons and considered by some to be indicated in patients with previous abdominal surgery, especially those with longitudinal abdominal wall incisions.
Several studies on the benefits and complications of the various laparoscopic entry techniques have been published.
there is not convincing evidence that the open entry technique is superior to or inferior to the other entry techniques currently available.
The open entry technique does have a lower incidence of vascular injuries, but this is balanced by a potentially higher incidence of bowel injury, although this can be mitigated if alternative entry sites are chosen in high-risk patients.
Instead of dissecting down at the umbilicus on suspected bowel adhesions, an alternative site of entry may be more appropriate, such as the left upper quadrant or the ninth/tenth intercostal spaces.
This could possibly decrease the rate of bowel injury, as these sites are rarely affected by adhesions and have been shown to be safe in small studies when hepatosplenomegaly and stomach distension have been excluded. [25]

DIRECT TROCAR ENTRY

Dingfelder was the first to publish (in 1978) on direct entry into the abdomen with a trocar. [46]

The suggested advantages of this method of entry are the avoidance of complications related to the use of the Veress needle: failed pneumoperitoneum, preperitoneal insufflation, intestinal insufflation, or the more serious CO2 embolism. [47]

Laparoscopic entry is initiated with only one blind step (trocar) instead of three steps (Veress needle, insufflation, trocar).

The direct entry method is faster than any other method of entry [48]

however, it is the least performed laparoscopic technique in clinical practice today. [49]

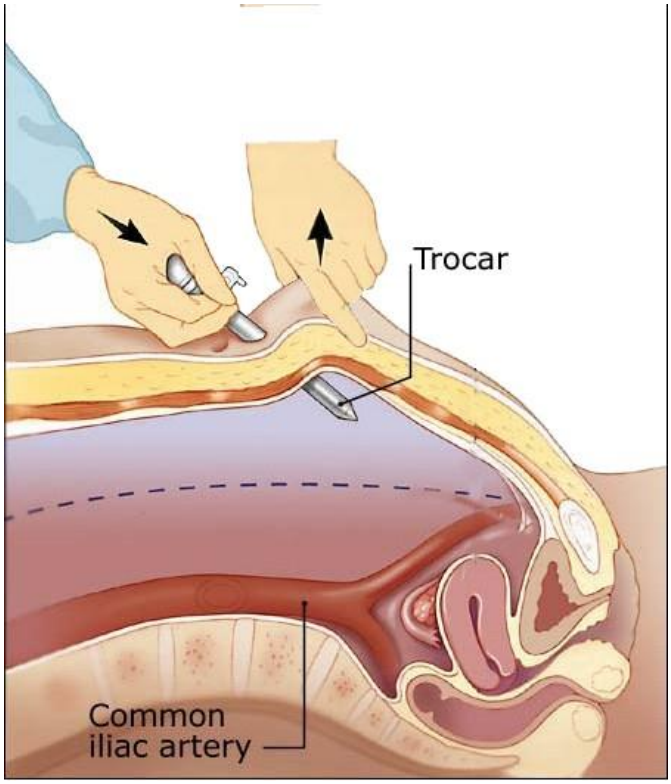


Fig (8) Direct trocar entry [50]

The technique begins with an infra-umbilical skin incision wide enough to accommodate the diameter of a sharp trocar/cannual system.
The anterior abdominal wall must be adequately elevated by hand, and the trocar is inserted directly into the cavity, aiming towards the pelvic hollow.

Alternatively, the abdominal wall is elevated by pulling on two towel clips placed 3 cm on either side of the umbilicus, and the trocar is inserted at a 90 angle. [51]
On removal of the sharp trocar, the laparoscope is inserted to confirm the presence of omentom or bowel in the visual field. [52]

DISPOSABLE SHIELDED TROCARS

Disposable shielded “safety” trocars were introduced in 1984. [53]
These trocars are designed with a shield that partially retracts and exposes the sharp tip as it encounters resistance through the abdominal wall.
As the shield enters the abdominal cavity, it springs forward and covers the sharp tip of the trocar.

Fig (9) Disposable shielded trocar [45]

These trocars were intended to prevent the sharp tip from injuring intra-abdominal contents. However, it must be pointed out that even when a shielded trocar functions properly and is used according to the specifications, there is a brief moment when the sharp trocar tip is exposed and unprotected as it enters the abdominal cavity. [54]
In the presence of pneumoperitoneum, disposable shielded trocars have been shown to require half the force needed for a reusable trocar.
The force required to enter the abdomen with various disposable trocars in the pig model was 4 to 6 kg. [55]
Increased entry force frequently results in loss of operator control and over thrusting of the trocar, which is a potential cause of serious vascular and visceral injuries. [55]

RADIALLY EXPANDING ACCESS SYSTEM

The radially expanding access system (Step, InnerDyne, Sunnyvale, CA) was introduced in 1994.
It consists of a 1.9 mm Veress surrounded by an expanding polymeric sleeve.
The abdomen may first be insufflated using the Veress needle.
The needle is removed, and the sleeve acts as a tract through the abdominal wall that can be dilated up to 12 mm by inserting a blunt obturator with a twisting motion. [56]

Fig (10) The radially expanding access system [45]

Advantages of this system include elimination of sharp trocars, application of radial force, stabilization of the cannula's position (cannula does not slide in and out), avoidance of injury to abdominal wall vessels, and elimination of the need for suturing of fascial defects.

VISUAL ENTRY SYSTEMS

Disposable Optical Trocars

Optical/access trocars were introduced in 1949 and are popular among urologists.
Two disposable visual entry systems are available that retain the conventional trocar and cannula push-through design: the Endopath Optiview optical trocar and The Visiport optical trocar. [57]
These single-use visual trocars trade blind sharp trocars for a hollow trocar, in which a zero degree laparoscope is loaded for the distal crystal tip to transmit real-time monitor images while transecting abdominal wall tissue layers.
Their application recruits significant axial thrust through the surgeon's dominant upper
body muscles to transect abdominal myofascial layers. [58]

Fig (11) Disposable optical trocar [45]

COMPLICATIONS AND TREATMENT OF TROCAR INJURIES

As previously stated, there are various complications that can occur as a result of trocar and/or Veress needle use.
Those are divided into immediate and delayed complications.
The immediate complications occur at the time of placement but may not be recognized at the time of the injury.
As stated before, this can lead to increased morbidity and mortality.
Immediate complications include vascular injury, bowel/visceral injury, subcutaneous emphysema, air embolus and inability to gain access to the peritoneal cavity.
The bowel and vascular injuries are often due to placement of the primary trocar or Veress needle because they are done blindly.
However, injuries can occur with secondary trocar insertion if the trocars are not properly visualized throughout their insertion.
Vascular injuries may involve retroperitoneal, intraperitoneal or abdominal wall vessels.
Rates of major vascular injury during initial entry are between 0.05% and 0.5%.[59]
The sites of injury from most common to least common are iliac vein, greater omental vessels, inferior vena cava, aorta, pelvic and superior mesenteric veins and lumbar veins. [60]
Injury to a major vessel is usually signified by visible bleeding and hemodynamic instability.
If an injury is confirmed or highly suspected especially in the retroperitoneum, convert to an open procedure and explore the area in question.
Depending upon the situation, consider calling for help from another surgeon and notify anesthesia for potential instability.

Any surgeon performing laparoscopy needs to keep in mind a few basic principles of repair of a vascular injury according to Suarez. [61]

- Once a potentially serious vascular injury is suspected, immediate conversion to an open procedure must be considered.
- Direct compression of the bleeding site is the quickest and safest way to gain initial control of blood loss, especially with a venous injury.

- If the patient exhibits unstable vital signs, adequate volume replacement, while controlling the blood loss, must take place prior to attempting repair of the injury.
- If the bleeding site is difficult to see, early and wide exposure of the site and the surrounding structures must be obtained.
- The vessel wall must be repaired with precise intima to intima apposition without tension.
- Venous injuries may be best handled by ligation rather than suture repair if the patient is unstable.
- If ligation of a vessel does not lead to ischemia, definitive repair may be postponed until the patient is stable and/or when the appropriate vascular surgeon is available.

In some circumstances of minor venous bleeding occur, hemostasis can be done by applying pressure, increasing the insufflation pressure, and suture closure. [60]

If there is any suspicion of a puncture of a major retroperitoneal vessel, including finding a retroperitoneal hematoma, it should be explored and the injury repaired.

If not treated, these vessels will continue to bleed unnoticed until life-threatening changes have occurred. [61]

Abdominal wall vessels are much smaller and signified by bleeding along the trocar intra abdominally or externally alongside the skin incision.

These can be controlled using multiple options.

Routine injection of lidocaine with epinephrine may decrease skin edge bleeding.

According to Vasquez-Frias, options for control of bleeding include using the trocar that the bleeding is coming through for direct pressure by rotating the tip against the bleeding site.

A foley catheter can be passed into the port site, and after inflating the balloon, outward traction is applied to put pressure on the abdominal wall. Both intramural, such as with a Carter Thomason needle, and transmural suturing has been done.

If transmural suturing is done, the sutures need to be removed early (around 24 hours) to prevent full thickness abdominal wall necrosis.

One should also visualize all ports after trocar removal to ensure that there is no bleeding that was tamponaded by the trocar itself.

This bleeding can often be stopped by cautery or pressure.

Any significant bleeding that continues with these means requires enlarging the incision around the port site and direct ligation. [62]

Most bleeding will present during the procedure, but there can be delayed bleeding from the abdominal wall that presents in the post-operative period.

In this circumstance, there is bruising and swelling of the abdominal wall and a drop in hemoglobin.
These can usually be managed conservatively with observation.
If the patient is unstable, exploration of the port site in question should be done. Bleeding from the smaller abdominal wall vessels can usually be avoided by not placing trocars or the Veress needle into the location of the epigastric vessels and by transilluminating the abdominal wall prior to inserting secondary trocars.
Bowel and visceral injuries by Veress needle insertion or trocar placement may or may not be seen at the time of the injury.
The delayed presentation contributes to the morbidity and mortality of bowel injuries. The incidence of bowel injury is between 0.04% and 0.5%.[63]
More importantly, 30-50% of the bowel injuries are not diagnosed intraoperatively when they occur.
This leads to a mortality rate of up to 30% for unrecognized bowel injury. [64]

Bowel and visceral injuries occur by two mechanisms according to Bhoyrul.
The injuries happen if the viscera is unusually close to the point of insertion and when the trocar penetrates too far into the abdominal cavity. [65]

If a bowel injury is recognized at the time of the injury, it needs to be repaired at that time.
Careful visualization is necessary to delineate the extent of the injury.
The surgeon has to then decide if he has the ability to repair the damage laparoscopically or convert to open.
It varies depending on each individual surgeon's skill set, equipment, and injury.
One should always err on the side of conversion to an open procedure it there is any question.
For visceral injuries, liver and spleen, management includes applying pressure, increasing the insufflation pressure and consideration of suturing and thrombin sealants for ongoing bleeding. [60]
Small bowel injuries are usually able to be controlled by laparoscopic suture repair or stapling.
Colon injuries are somewhat more complicated. Injuries that are low risk complications, such as those recognized right away, are best repaired by suturing with intravenous antibiotics and drainage.
Injuries that are at higher risk complications, such as those found in a delayed fashion, are best handled by open repair, washout, and proximal diversion.

One must have a high level of suspicion for bowel injury in anyone who is not recovering in the usual time from his or her laparoscopic procedure.
If a bowel injury is confirmed or strongly suspected, surgical intervention is necessary after initial resuscitation.
The procedure to be done is dictated by the structure that is injured, associated intraabdominal findings and associated patient factors.
Another immediate problem is subcutaneous emphysema.
This usually presents as subcutaneous crepitance around the trocar site.
However, it can be severe involving severe swelling of the head and neck area.
This is due to malposition of the insufflation port allowing CO_2 to track into the preperitoneal, retroperitoneal, or subcutaneous space.
This can cause increased CO_2 absorption leading to respiratory acidosis and hypercapnia.
This is best prevented by keeping insufflation pressures around 12 mmHg and accurate port placement prior to insufflation.
If the hypercapnea is severe, mechanical hyperventilation and possible cardiovascular support may be necessary. [60]
Air embolus is another immediate complication of trocar placement.
This is summarized well by Suarez as follows. Air embolus may occur when the intra-abdominal pressure exceeds intravenous pressure and there is a communication with the venous system through a large vein.
A large bolus of gas can cause cardiovascular collapse by interfering with right ventricular outflow.
The physical findings are a machinery type heart murmur along with significant drops in blood pressure and oxygen saturation.
If gas embolism is suspected, insufflation should be stopped and the peritoneal cavity vented.
The patient should be placed in the left lateral decubitus position and Trendelenburg (head down).
In addition, a central line can be inserted into the right ventricle and gas bubbles may be aspirated. [61]
Another immediate complication is preperitoneal placement of the Veress needle or trocar, which causes an increase in the distance between the skin and peritoneum.
This can make percutaneous insertion of a trocar quite difficult.
This can also cause subcutaneous emphysema.
This is best avoided by properly confirming intraperitoneal placement prior to insufflation.
There are times when satisfactory placement of a percutaneous trocar cannot be safely done.

If unable to safely pass the trocar or Veress needle after three attempts in the periumbilical site, consider using Palmer's point, which was previously described.
One must convert to open technique if safe percutaneous access to the peritoneal cavity cannot be obtained.
There are also delayed complications regarding trocar insertion.
These include trocar site infection, tumor implantation, endometriosis implantation and incisional hernia.
It has been accepted that the risk of postoperative wound infection in minimally invasive surgery is quite low and related to the case being performed and not necessarily the port insertion.
The wound infection is signified by the usual findings of pain, erythema, and occasional wound drainage.
The principles for treatment are antibiotics, local wound and drainage of pus if abscess is found.
The ways to attempt to prevent these wound infections are prophylactic antibiotics for the specific procedure that is being done, placing any contaminated specimen inside a protective pouch prior to removing it from the skin and irrigation of the port sites prior to closure.
Implantation of tumor cells in port sites has been reported for all types of malignancy that are treated by minimally invasive surgery.
The incidence is quite low, about 1% for colorectal and 2.3 % for gynecologic malignancies. [66]
Poor surgical technique such as improper handling of the tissue is the most likely cause.
There are other mechanisms investigated including hematogenous spread, aerosolization, and direct wound implantation.
The timing of presentation is variable.
Various preventative strategies including retrieval bags for specimens, wound protectors, intraperitoneal agents, port site excision, alternative insufflations strategies, and peritoneal wound closures have been tried.
Endometriosis in port sites is quite rare.
This can be found in patients with known endometriosis and those undergoing laparoscopic hysterectomy without evidence of endometriosis.
The treatment is excision of the implant.
Preventative measures include avoidance of implantation of fragments during morcellization. [67]
Incisional hernia is a problem that can be seen anytime in the post-operative period but usually delayed several months or years.
The incidence of incision hernias in a trocar site is 21/100,000. [68]
The most prevalent feelings are that all fascial puncture sites that are 10 mm or more should undergo fascial closure. [68]

This is still controversial.
There are multiple reports in the literature of 5 mm trocar sites that develop incisional hernias. [68]
Various other risk factors other than trocar size such as BMI, age, and duration of surgery have been found to contribute to the risk of incisional hernia.
Usla et al found that age greater that 60year, BMI greater than 25, and duration of procedure greater that 90 min increased the risk in laparoscopic cholecystectomy patients. [69]
There is no consensus on closure of port sites and the means to do this. Many feel that the new dilating trocars allow the fascia to be left alone.
There are various devices being proposed for closure but none that have gained widespread acceptance.

Extraperitoneal insufflation is one of the most common complications of laparoscopy, which is may lead to conversion to open surgery because further attempts to achieve pneumoperitoneum are usually unsuccessful.
In one study, preperitoneal insufflation occurred in 2.7%, 15%, 44.4%, and 100% of cases at one, two, three, and more than three attempts, respectively. [35]
Kabukoba and Skillern described a technique to deal with extraperitoneal insufflation that requires the laparoscope to be left in the preperitoneal space and the gas not evacuated.
The Veress needle is then reintroduced into the preperitoneal space in front of the telescope and visually guided into the peritoneal cavity. [70]

AIM AND OBJECTIVES

In this study we introduce a new method of open access to enter the peritoneal cavity for laparoscopic surgery through the fascia at its junction with umbilical cicatrix tube .

The technique is described and then evaluated with respect to the simplicity, the effect of previous abdominal surgery , the effect of body mass index , time for entrance, surgeons experience and the possible complications .

PATIENT AND METHODS

PATIENTS

A 400 operations enrolled in this study.
The operations were mainly laparoscopic cholecystectomies.
The surgeon's status, as consultant , specialist or resident, and complications associated with the open technique were registered.
Age, sex , time and body mass index (BMI) registered.
Obesity defined as BMI > 30.

OPERATIVE TECHNIQUE

The technique can be applied supra or infra umbilically .
A step-by-step entrance though all layers is used as follows:

1. A transverse or longitudinal skin incision of a length corresponding to the diameter of the trocar is made in the umbilical fold.

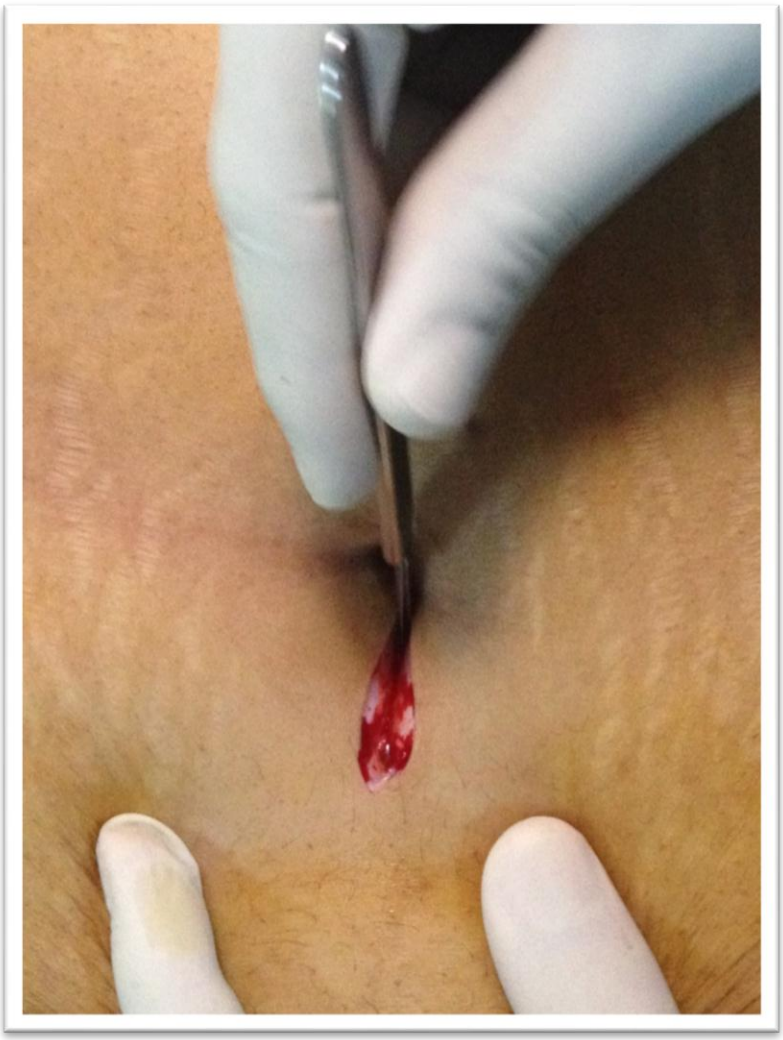


Fig (12)

2. The umbilical cicatrix tube is dissected with artery forceps down to the linea alba.

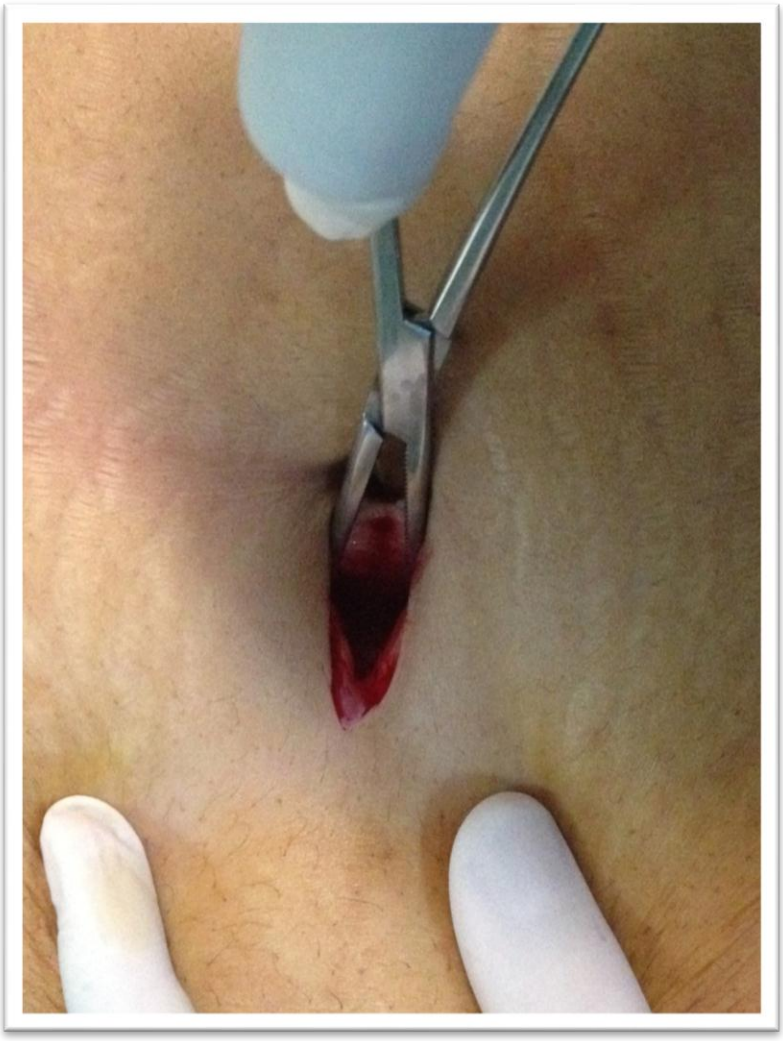


Fig (13)

3. A towel clip is applied in the cicatrix tube of the umbilicus, which is then upward traction applied .

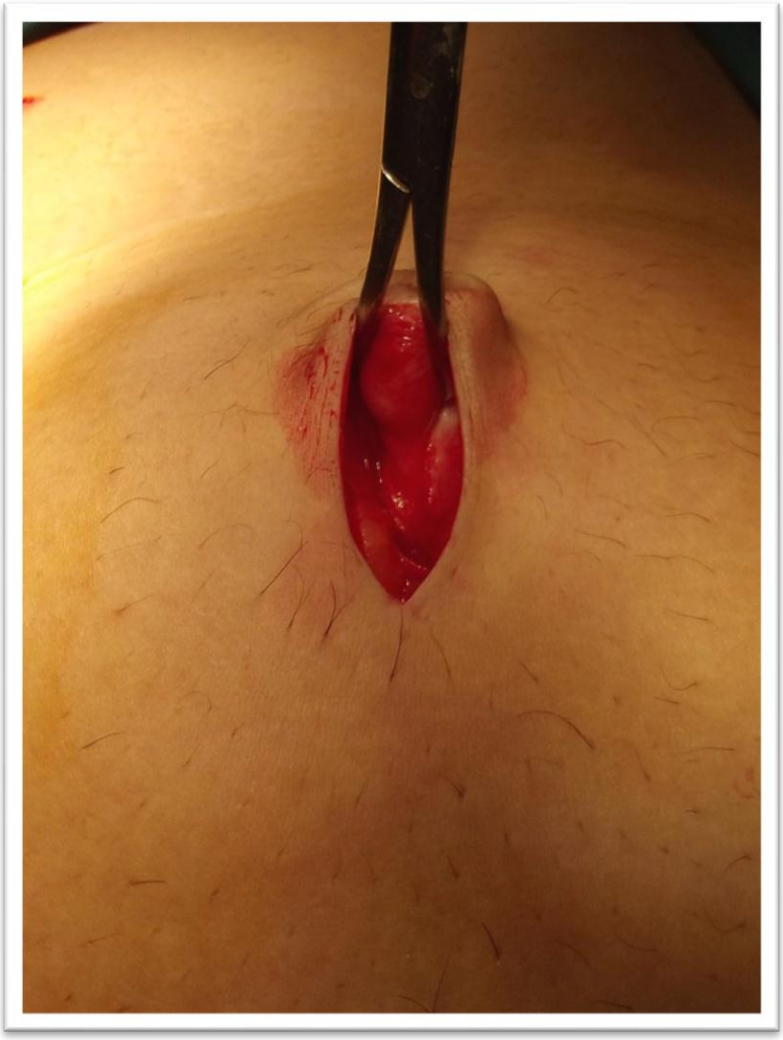


Fig (14)

4. A midline incision of appropriate length is made in the linea alba at site of its junction with the umbilical cicatrix tube with care taken only to incise the fascia layer .

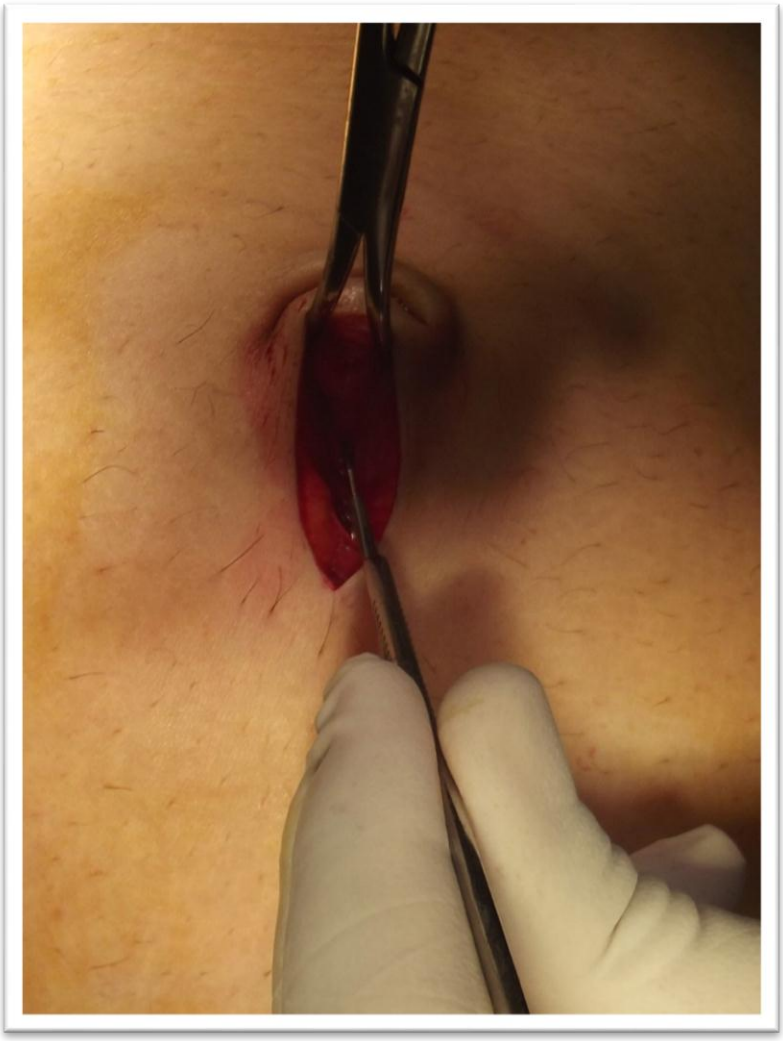


Fig (15)

5. In obese patients, two retractors can be used to facilitate this approach.

6. The peritoneum is opened bluntly with artery forceps and the negative pressure allows air to flow into the abdominal cavity creating a distance between the peritoneum and the intestines by upward traction with the towel clip .

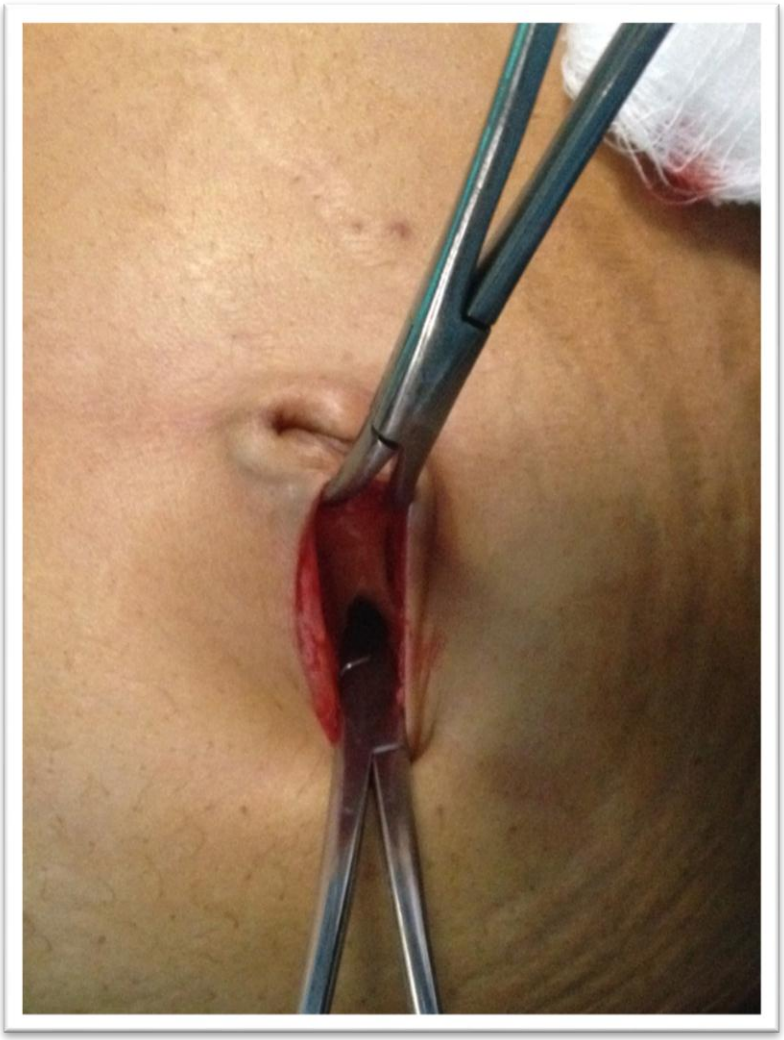


Fig (16)

7. Finally a blunt, 10 mm, trocar is placed through the incision into the abdominal cavity followed by insertion of the camera.

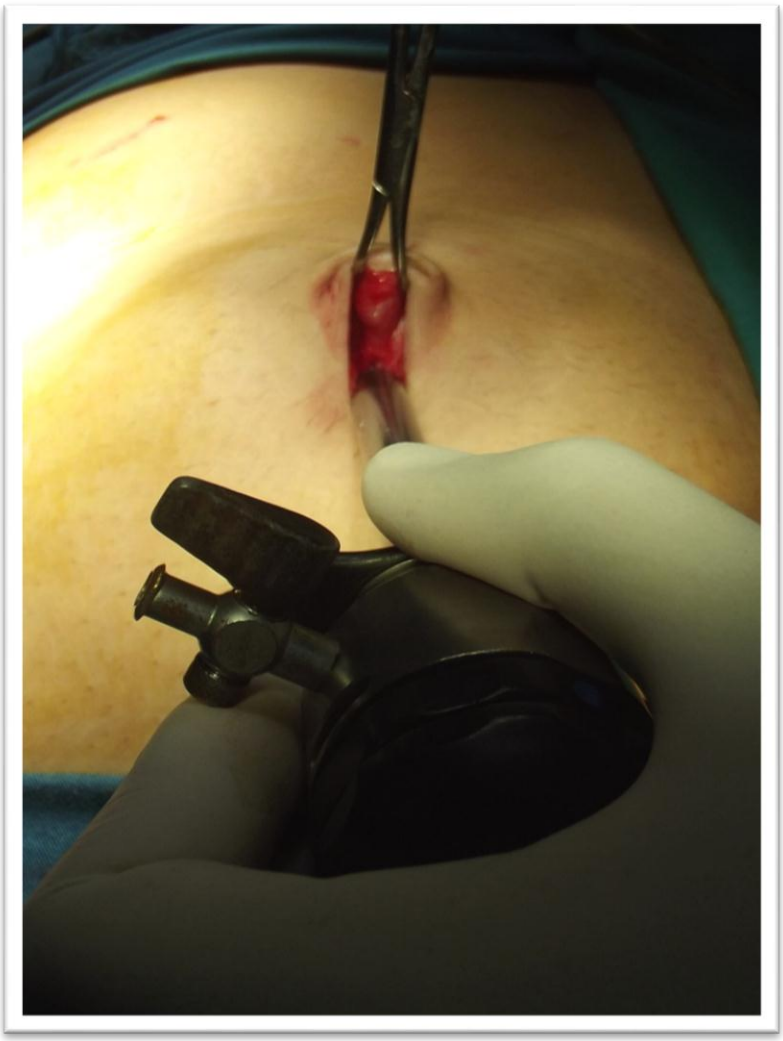


Fig (17)

8. Insufflation is then initiated for the creation of pneumoperitoneum.

9. At the end of the procedure, the fascia is exposed and closed with suture .

RESULTES

In 400 patients the mean age group was (31- 50) years and 85% were females.
Three levels of surgeons participated.
The consultant performed 50.25 % of the operations, the specialist performed 19.75% and the resident performed 30% of the operations .
BMI was calculated in only 100 patient
16 patients were obese with BMI more than 30.
Most of the operations was laparoscopic cholecystectomy
In 64% of patient had no previous abdominal surgery , the other had history of abdominal surgery.
In 100 patients time duration of entry was less than 120 second in 78%
Gas leakage did not occur in any case.
No conversion due to entry failure
No injuries to intra-abdominal organs and vascular injuries were seen.
No wound infection .
Only one patient presented after about one year with port site umbilical hernia.

Distributions of age

Table (1)

Age	No.	%
0 – 20	7	1.75
21 – 30	54	13.5
31 - 40	118	29.5
41 – 50	96	24
51 – 60	54	13.5
61 -70	36	9
71 -80	22	5.5
81 – 90	13	3.25

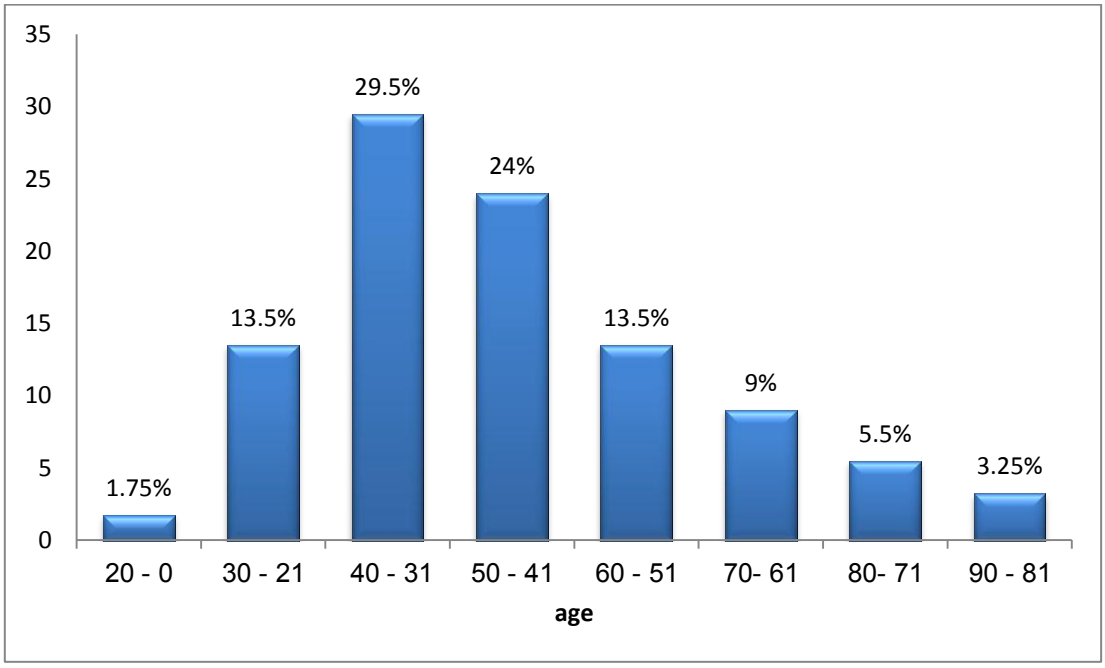


Fig (18)

Gender distribution

Table (2)

Gender	No.	%
Male	60	15
Female	340	85

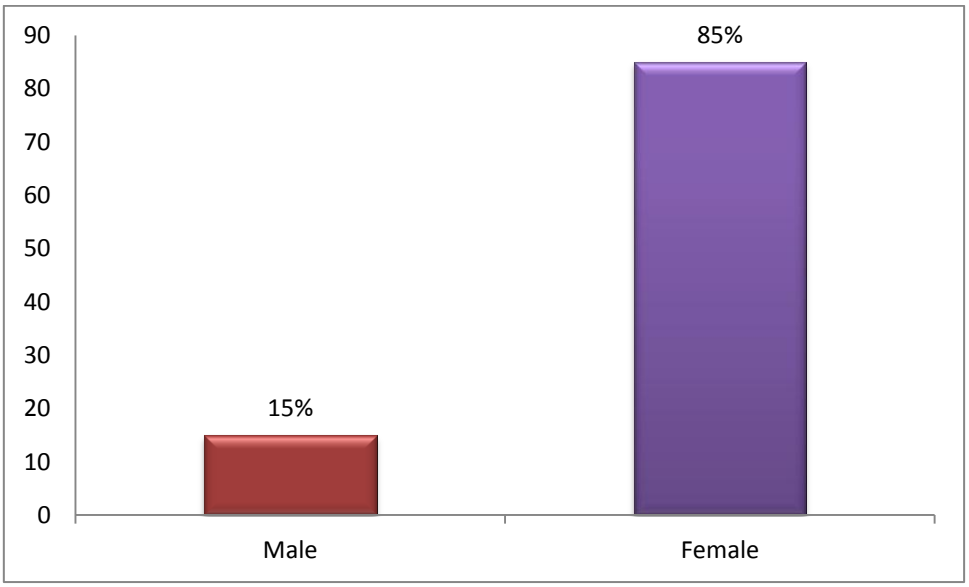


Fig (19)

Types of operations

Table (3)

Operation	No.	%
Lap. chole.	385	96.25
Others	15	3.75

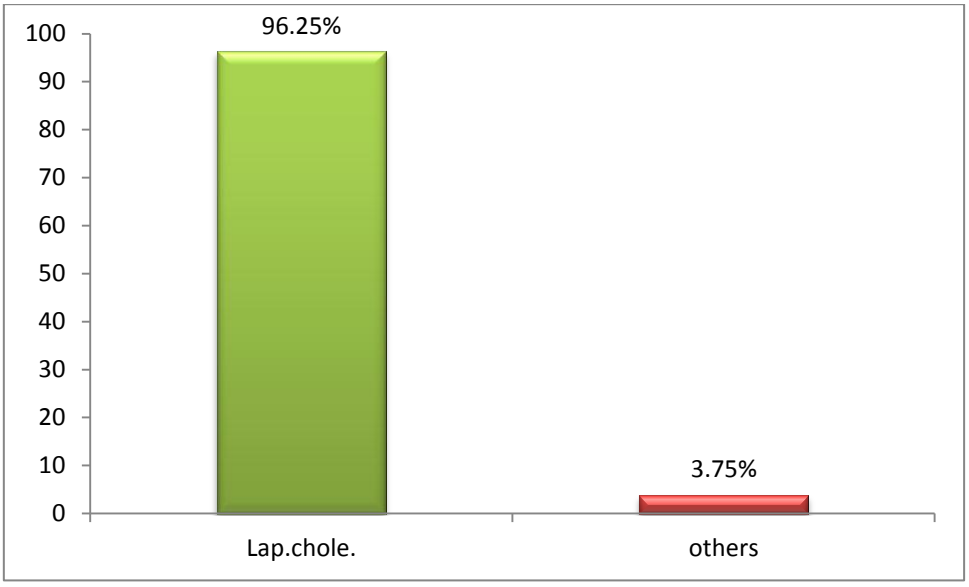


Fig (20)

Levels of surgeon

Table (4)

Surgeon	No.	%
consultant	201	50.25
specialist	79	19.75
Resident	120	30

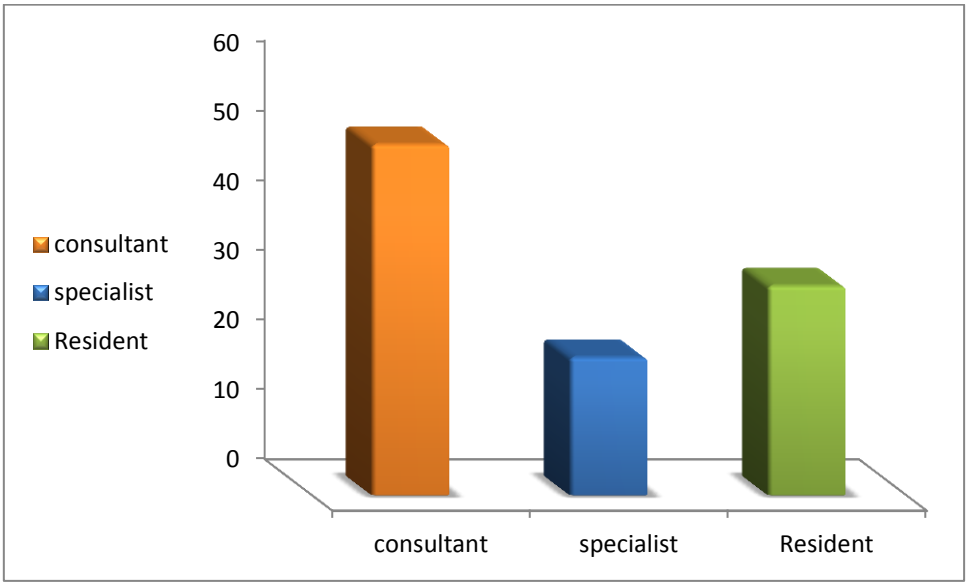


Fig (21)

Body Mass Index

Table (5)

BMI	NO	%
Underweight (BMI < 18.5)	0	0 %
Healthy weight (BMI 18.5 - 24.9)	38	38%
Over weight (BMI 25-29.9)	46	46%
Obese (BMI > 30)	16	16%

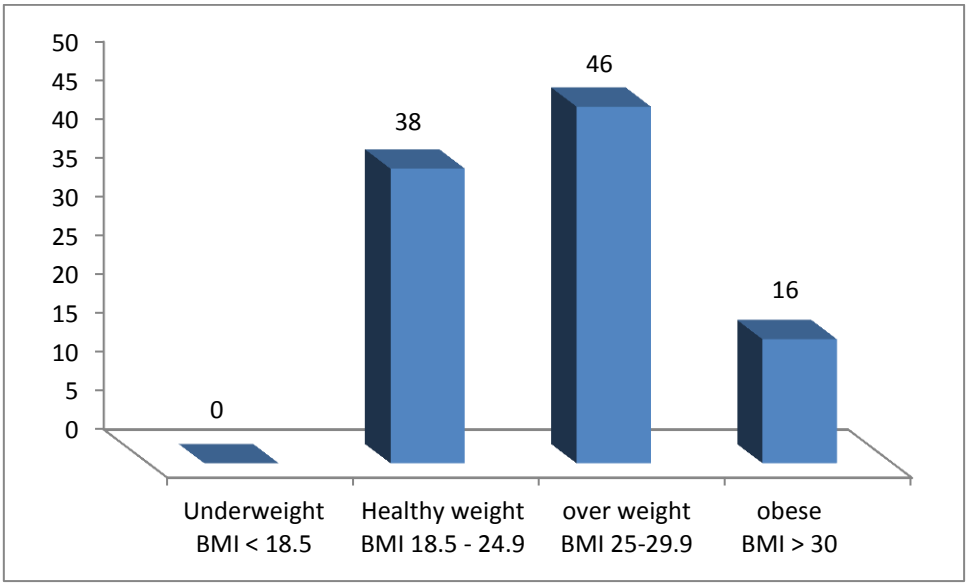


Fig (22)

Time of entrance

Table (6)

Time of entrance	NO	%
< 90 seconds	32	32%
90 - 120 seconds	46	46%
121 - 140 seconds	18	18%
> 140 seconds	4	4%

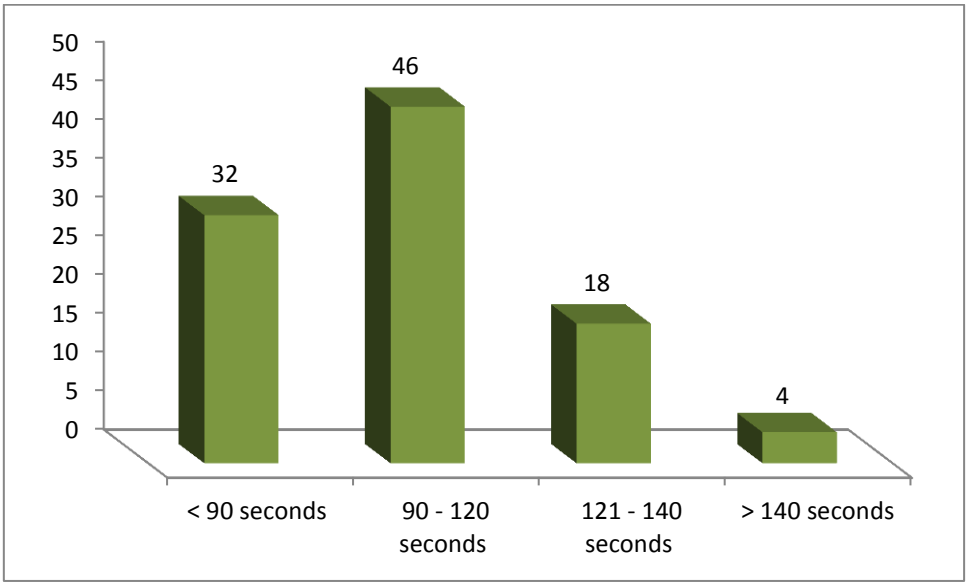


Fig (23)

DISCUSSION

The Veress needle followed by blind trocar placement or direct trocar insertion without creating pneumoperitoneum are the most common approaches to access the abdominal cavity in laparoscopic surgery. [51,71]

Laparoscopic surgery developed rapidly in the early 1990ies among general surgeons, pediatric surgeons, gynecologists and urologist's.
The learning curve had to be passed simultaneously by many surgeons resulting in an increase in major complications including both vascular and visceral injuries .

Champault et al described an incidence of vascular injuries of 0,04% and visceral injuries of 0,06% in more than 100000 patients using the Veress technique. [72]
The open access technique was first described by Hasson in 1971
The benefits are prevention of gas embolism, pre peritoneal insufflation, and possibly of visceral and major vascular injury.
Several studies on the benefits and complications of the various laparoscopic entry techniques have been published.

Hasson reviewed 17 publications of open laparoscopy technique by general surgeons (9 publications, 7205 patients) and (8 publications, 13486 patients) by gynecologists and compared them with closed laparoscopy performed by general surgeons (7 publications, 90152 patients) and gynecologists (12 publications, 579510 patients). [73]

Hasson reported that for open laparoscopy the rate of umbilical infection was 0.4%, bowel injury 0.1%, and vascular injury 0%.

The corresponding rates were seen for closed laparoscopy were 1% umbilical infection, 0.2% bowel injury, and vascular injury 0.2%.

In a published record of his own 29-year experience with laparoscopy in 5284 patients, Hasson reports only one bowel injury within the first 50 cases.

Hasson advocated the open technique as the preferred method of access for laparoscopic surgery. [73]

A meta-analysis by Merlin et al found vascular injuries in 0.003–1.33% using a close technique and 0– 0.03% using an open technique, whereas visceral injuries were found in 0.04% using the close technique and in 0–1.3% using the open technique. [74]

Vascular injuries can possibly be avoided with an open technique and the meta-analysis indicates a trend towards a reduced risk of major complications for the open access technique. [74]

Bowel injuries are reported in some studies more frequently with open laparoscopy than with other techniques .
This may be influenced by patient selection bias, as open procedures may be more likely to be chosen for patients who have had previous abdominal surgery.

Guidelines from The European Association for Endoscopic Surgery conclude that available data does not favor the use of either technique . [75]
However, they agree that major vascular injuries most often occur with the Veress approach.

Hasson's method is a mini-laparotomy with a midline incision of up to 3–4 centimeters.
It required a special cannula fitted with a cone-shaped sleeve used in order to minimize gas leakage , blunt trocar , and possibly a second sleeve to which stay sutures can be attached

This method did not gain wide acceptance due to its complexity and needs a special instruments .

There are many trails of modification of the Hasson's technique without using special instruments .

Hurd et al demonstrated a modification of the Hasson's technique without using special instruments, but reported problems with gas leakage in 14%of cases. [76]

Pawanindra et and A.-c. moberg, u. petersson, A. Montgomery also had a trails of modifications of open access technique . [77]

In this study we demonstrate a modification of open access technique without using any special instrument .

Through umbilical cicatrix tube we elevate the anterior abdominal wall by a towel clamp holding the tube , to give a good space to enter the first blunt

trocar through a small incision in the fascia at its junction with the umbilical cicatrix tube .
We use a blunt artery forceps to open the peritoneum thus avoid any visceral injury .

When the potential space of the peritoneum is opened with the artery forceps the air is enter inside it causing a good real space creating a distance between the peritoneum and intestines by upward traction of anterior abdominal wall with the towel clamp.

We enter the abdominal cavity with blunt trocar in horizontal direction , i.e. parallel to abdominal wall to avoid visceral and vascular injury .

The opining which we made in the fascia is very small just to allow the tip of the trocar to enter through it , to avoid the gas leakage and in stability of the trocar .

In this study a 400 laparoscopic operations were done with our entry technique .
We found that there is no any vascular injures in all cases , which is the same result in comparison with other studies of the open technique .

The good thing we found in this study is that there is no visceral injury with our technique while in a meta-analysis by Merlin et al found 1.3% visceral injures in operation using open technique, and also Hasson reported 0.1% visceral injures in his review of 17 publications of open laparoscopy technique. [73,74]

Even in 144 cases who had previous abdominal surgery there was no vascular or visceral injures .
This means that our technique is safe and applicable in patient with previous abdominal surgery .

Two of the drawbacks of open laparoscopy are potential for leakage of CO_2 gas and difficulty in achieving pneumoperitoneum.
Various modifications of Hasson trocars have been designed to provide an ideal seal for escaping gas.
Nevertheless the rate of gas leakage in literature ranges from 4.2 to 14.2%. [76]
In our study there was no gas leakage in any case of the study.

Extra peritoneal insufflation is one of the most common complications of laparoscopy, frequently leading to abandonment of the procedure because further attempts to achieve pneumoperitoneum are usually unsuccessful. [25]

In one study, pre peritoneal insufflation occurred in 2.7%, 15%, 44.4%, and 100% of cases at one, two, three, and more than three attempts, respectively. [35]

The advantage of our technique is before CO2 insufflation , examining the trocar position with a camera will decrease the risk of extra peritoneal insufflation , this explain why in our technique there is no case with extra peritoneal insufflation reported.

Besides there is no complication seen in this technique , it is also possible to achieve a suitable insufflation speed .

Maximal flow through a Veress needle is only about 2.5 L/min, regardless of the insufflator setting, because it is only 14 gauge.
A trocar has a much larger internal diameter (10- 12 mm) and can immediately accommodate the flow rate more than 6 L/min . [25]

Also the technique is not complicated and did not take a long time to access the abdominal cavity .
We checked the time of entrance in 100 operations , the entrance time was mostly requires 90 - 120 seconds .
In comparison with other technique in other studies we found that the time is considerably shorter in our study , the veress technique requires 214-300 seconds for abdominal cavity access. [78,77]
While it taks from 240 to 300 seconds when open access technique has been used . [77]

Although time is not a primary objective but it indicates the simplicity of the technique .

This open access technique seems to be well adopted among different level of surgeons participating in this study.
A 30% of operation are done by a residents which indicates the simplicity of the technique and it is easy to learn .

One of the common challenge for the surgeon to gain access to abdominal cavity is the obesity .
Which is cause a difficulty in all techniques leading to change the site of entrance in some cases to another places rather than the umbilical site , like Left upper quadrant (Palmer's point) .

In our study among 100 cases there were a 46 cases over weight (BMI 25-29.9) and 16 cases obese (BMI > 30) .
That means that the technique can be used for obese patient .

In general we found that the open access technique used in this study is safe without complications like visceral or vascular injury .
The technique is easy to learn , faster than the other technique , and applicable in obese patient , and in patient with previous abdominal surgery .

Also this technique does not needs any special instrument or equipment like a cone shaped cannula in hasson's technique , or expanding polymeric sleeve in radially expanding access system , or Endopath Optiview optical trocar in visual entry system which are expensive and not available in all hospitals and countries .

With a towel clamp , blunt artery forceps and blunt trocar we can achieve safe easy entry without gas leakage and without using of stay suture to fix the trocar .

CONCLUSION

In conclusion, the open access technique used in this study is safe , fast, easy to learn and applicable even in obese patients and in patient with previous abdominal surgery .
We strongly recommend this technique for laparoscopic procedures.

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