INTRODUCTION

Inguinal hernia is one of the commonest surgical pathologies requiring operation, a prevalence rate of 4.7% of inguinal hernia was found in men aged 25 years and older. Prevalence of inguinal hernia increased markedly with age. The estimated lifetime risk of inguinal hernia repair was 27% for men. Optimal management of inguinal hernia, (*the most frequent abdominal wall hernia*) therefore carries significant socio-economic impact on society **(Lau Hung, 2007).**

Inguinal hernia repair is one of the most common surgical procedures. Over the past 20 years, several hernia repair techniques have been introduced. The main course for the development of these new techniques was to reduce the recurrence rate. After the introduction of laparoscopic inguinal hernia repair, most of the discussions have focused on the choice between open or laparoscopic surgery **(Sabanci et al., 2007).**

Laparoscopic herniorrhaphy can be performed by using either transabdominal preperitoneal repair (TAPP) or total extraperitoneal repair (TEP). Surgeons generally prefer TEP procedure in terms of not destroying the virginity of the abdominal cavity and decreasing the complications (major vascular trauma, intestinal obstructions, and perforations) **(Sabanci et al., 2007).**

Ger R. reported the first laparoscopic repair of inguinal hernia in 1982. He closed the peritoneal opening of the sac

using clips. **(Lau Hung, 2007).** The indications for laparoscopic repair are the same as with open repair. Contraindications (relative and absolute) include previous lower abdominal surgery, pelvic radiation, previous extrperitoneal surgery (radical retropubic prostatectomy), and patients with impaired cardiac or pulmonary status who are not good candidates for general anesthesia **(Chad et al., 2007).**

Laparoscopic inguinal herniorrhaphy is associated with shorter recovery periods, earlier return to daily activities and work, and decreased postoperative pain. Some surgeons think that laparoscopic repair of recurrent hernia is easier because it is performed in a virgin tissue. Laparoscopic approach has also advantages over open techniques for bilateral hernias. On the other hand laparoscopic hernia repair has a significant learning curve **(Sabanci et al., 2007).**

Laparoscopic herniorrhaphy shares some complications with the open technique but also has its own set of complications. Some of these problems were encountered early on and were corrected as surgeons became more experienced with the technique. Thus, the incidence of complications has decreased with time **(Chad et al., 2007).**

Complications from laparoscopic herniorrhaphy can be categorized into those that occur intraoperatively and those postoperatively. Complications related to the laparoscopic technique itself, or to the hernia repair, include vascular injuries or injuries to bowel **(Chad et al., 2007).**

Complications in endoscopic inguinal hernia surgery are more dangerous and more frequent than those of open surgery, especially in inexperienced hands and hence are best avoided. It is possible to avoid most of these complications if one follows a set of well-defined steps and principles of endoscopic inguinal hernia surgery **(Mishra, 2004).**

Complications are known to occur at each and every step of hernia surgery. Applying caution while performing each step can save the patient from a lot of morbidity. One starts by applying strict patient selection criteria for endoscopic hernia repair, especially in the initial part of ones learning curve. A thorough knowledge of anatomy goes a long way in avoiding most of the complications seen in hernia repair. This anatomy needs to be relearned from what one is used to, as the approach is totally different from an open hernia repair. And finally, learning and mastering the right technique is an essential prerequisite before one ventures into inguinal hernia repair. Although there has been an increased incidence of complications reported in endoscopic repair in the earlier series, this can be explained partly by the fact that it was in the early part of the learning curve of most endoscopic surgeons. As the experience grew and the techniques were standardized, the incidences of complications have also reduced and have come to be on par with open hernia surgery **(Chowbey et al., 2006).**

LAPAROSCOPIC ANATOMY OF THE INGUINAL REGION

No disease of the human body belonging to the province of the surgeon requires in its treatment a greater combination of accurate anatomic knowledge with surgical skill than hernia in all its varieties (SIR ASTLEY COOPER) **(Anibbali et al., 1994)**.

The anatomy of the inguinal region is misunderstood by some surgeons at all levels of seniority (R.CONDON) **(Anibbali et al., 1994)**.

For a safe and successful approach to the laparoscopic herniorraphy, the anatomy should be visualized from inner layers, since laparoscopy provides an optimal panoramic view of the posterior surface of the abdominal wall **(Aniballi and Fitzgibbon, 1995, Kablin et al., 1998).** It also requires good viewing angle, proper direction of lighting and empty bladder **(Hughes, 1997).**

Laparoscopic view provides a well lightened view of posterior surface of the anterior abdominal wall**.** Initional inspection reveals five peritoneal folds or ligaments below the umbilicus. The median umbilical ligament (or median umbilical fold) represents the obliterated urachus, this midline structure extends from the fundus of the bladder to the umbilicus, laterally, on either side, are the medial umbilical ligaments (medial umbilical fold). The size of the medial umbilical ligament varies ranging from a minor fold in the peritoneum to

a fatty imposing structure that actually interferes with the visualization of other important landmarks **(Camps et al., 1995).** The medial umbilical ligament represents the obliterated portion of the umbilical artery **(Arregui et al., 1995).** The left and right deep inferior epigastric arteries and veins, with their peritoneal covering, form the lateral umbilical ligaments **(Anibbali et al., 1995).**

Peritoneal Fossae:

On either sides of midline, the medial and lateral umbilical ligaments delineate three shallow fossae, from lateral to medial they are as follow: (Fig 1)

The lateral fossa:

It lies lateral to the inferior epigastric vessles. It is the site where indirect inguinal hernia passes through internal inguinal ring **(Anibbali and Fitzgibbon, 1995).**

The medial fossa:

This is the space between the medial and the lateral umbilical ligaments and corresponds to the site of development of direct inguinal hernia (**Anibbali and Fitzgibbon, 1995).**

Supravesical Fossa:

It lies between the medial and median umbilical ligaments, and are the site of external supravesical hernias. As it is covered by the strong rectus muscle and its sheath, it offers greater strength to this area making supravesical hernia rare

(Anibbali and Fitzgibbon, 1995). Depending upon location, a direct hernia may be inguinal (in the medial fossae) or supravesical (in the supravesical fossae). The lateral border of the rectus sheath is preferred as a landmark for a supravesical hernia **(Skandalakis et al., 1993).**

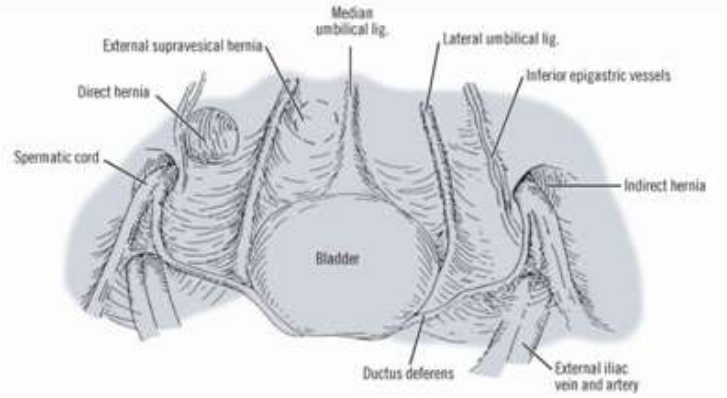

Fig. (1): Laparoscopic topographic anatomy of inguinal region. In men, spermatic vessels join vas deferens to form spermatic cord. Unlike direct hernia, indirect hernia presents fascial defect lateral or medial to inferior epigastric vessels (Modified from Peters JH, Ortega AE. Laparoscopic inguinal hernia repair. In: Hunter JG, Sackier JM, eds. Minimally invasive surgery. New York: McGraw-Hill, 1993, with permission).

Inguinal Canal:

The inguinal canal in adult, is an oblique rift measuring approximately 4cm in length, it is located 2-4cm above inguinal ligament between internal ring (deep inguinal) and the external ring (superficial inguinal).The superficial inguinal ring is an opening of the aponeurosis of external oblique muscle lateral to and above the pubic crest, the deep ring is an opening of transversalis fascia corresponding to the middle of inguinal area. The inguinal canal contains either the spermatic cord or round ligament of uterus. The anterior wall is formed by the

aponeurosis of the external oblique muscle and laterally by participation of internal oblique muscle, the superior wall (roof) is formed by internal oblique and transverses abdominis muscles and their aponeurosis, the inferior wall (floor) is formed by the inguinal ligament and lacunar ligament and the posterior wall is the fusion of the aponeurosis of transverses abdominis muscle and transversalis fascia **(Skandalakis et al., 2000)**.

Laparoscopic anatomy of the deep inguinal ring:

The deep inguinal ring is one of the transversalis analogues and forms the internal opening of the inguinal canal and is located in the lateral fossa about 1.25cm above and slightly lateral to the middle of the inguinal ligament. It allows passage of the vas deferens, the round ligament, the testicular vessels and the genital branch of the genitofemoral nerve. The ring appears nearly closed when viewed laparoscopically **(Anibbali and Fitzgibbons, 1995).**

Inguinal ligament: Poupart' s ligament

This is thickened lower part of the external oblique muscle aponeurosis that extends from anterior superior iliac spine laterally to the superior ramus of pubic bone, the middle 1/3 has a free edge the lateral 2/3 is attached strongly to the underlying iliopsoas fascia **(Skandalakis et al., 2000).**

Lacuner ligament: Gimbernat' s ligament

This is the most inferior portion of the inguinal ligament and is formed from the external oblique tendon fibers arising at the anterior superior iliac spine. Its fibers recurve through an angle of less than 45^{o} before attaching to the pectineal ligament occasionally it forms the medial border of the femoral canal **(Skandalakis et al., 2000).**

Iliopubic tract:

This is an aponeurotic band extending from the iliopectneal arch to the superior ramus of the pubis. It forms part of the deep musculoaponeurotic layer together with the transverses abdominis muscle and aponeurosis and transversalis fascia**.**

The tract passes medially, contributing to the inferior border of the internal ring. It crosses the femoral vessels to form the anterior margin of the femoral sheath together with the transversalis fascia. The tract curves around the medial surface of the femoral sheath to attach to the pectineal ligament. It can be confused with the inguinal ligament **(Skandalakis et al., 2000).**

Pectineal ligament: Cooper's ligament

This is a thick tendinous band formed principally by tendinous fibers of the lacunar ligament and the aponeurotic fibers of the internal oblique, transverses abdominis and with variation the inguinal falx. It is fixed to the periosteum of the

superior pubic ramus and laterally the periosteum of the ilium. The tendinous fibers are lined internally by transversalis fascia **(Skandalakis et al., 2000).**

Ilio pectineal arch:

This is the medial thickening of the iliopsoas deep to the inguinal ligament.The surgeon does not directly use this arch, but it is important as the junction of a number of structure of the groin. These are insertion of fibers of external oblique aponeurosis and fibers of the inguinal ligament and origin of part of internal oblique muscle and a part of transverses abdominis muscle and lateral attachment of iliopubic tract **(Skandalakis et al., 2000).**

Hesselebach triangle:

As described by Hesselebach (1814); the base of the triangle was formed by pubic pectin and pectineal ligament. The boundaries of triangle as usually described today: superior laterally: inferior epigastric vessels, medially: rectus sheath lateral border, inferiorly: inguinal ligament this is smaller than described by Hesselebach most direct inguinal hernias occure in this area **(Skandalakis et al., 2000).**

Conjoined area:

By definition, this is fusion of fibers of the internal oblique aponeurosis with similar fibers from the aponeurosis of transverses abdominis muscle just as they insert in the pubic

tubercle, the pectineal ligament and the superior ramus of the pubis **(Skandalakis et al., 2000).**

Reflected inguinal ligament: (Coll' s)

This is formed by aponeurotic fibers from the inferior crus of the external ring which pass superomedially to the linea alba **(Skandalakis et al., 2000).**

Myopectineal orifice:

This represents the entire inguinal area bounded by transverses abdominis muscle anteriorly and iliacus, psoas muscle and superior pubic ramus posteriorly. It is the region of inguino-femoral herniation. The prominence of the myopectineal orifice depends on one main and variable dimention and that is the distance between the iliopubic tract and the counter point of transverses abdominis arch **(Desmond, 1997).**

Transversalis fascia:

The named transversalis fascia is restricted to the internal fascial lining of the transversus abdominis muscle. It is often applied to the entire connective tissue sheath lining the abdominal cavity, in the latter sense; it is the fascial layer covering muscles aponeurosis, ligaments and bones. In inguinal area the transversalis fascia is bilaminar enveloping the inferior epigastric vessels **(Skandalakis et al., 2000).**

Preperitoneal space:

The preperitoneal (also called extra-peritoneal or properitoneal) space lies in the abdominal cavity between the peritoneum internally and the transversalis fascia externally. Although the more inclusive term, extraperitoneal, is probably preferable because it more clearly includes all the potential space just external to the peritoneum, including the retroperitoneal area, whereas preperitoneal implies the ventral portion of the extraperitoneal space **(Eubanks, 1997).**

Preperitoneal fascia:

At the internal ring, just superficial to the peritoneum, is a thin but clearly discrete fascia called the preperitoneal fascia. This structure is also identified as the posterior layer of the transversalis fascia by other authors, it is not always easily identified during anatomical dissections on an embalmed cadaver, but is readily apparent during laparoscopic preperitoneal dissection. The preperitoneal fascia forms a conical sheath around the cord structures and indirect hernia, if present, this continues as the internal spermatic fascia as the cord structure enters the inguinal canal **(Arregui et al., 1995).**

The peritoneum can be easily distinguished from the preperitoneal fascia in the lower anterior abdominal wall where these fascial planes can be recognized by relatively generous fatty tissue separating them **(Anniballi et al., 1995).**

The space of Retzius:

The space of Retzius is thought of only as the potential space between the bladder posteriorly and the pubic bones anteriorly, but as originally described, the space of Retzius extends from the muscular floor of the pelvis to the level of the umbilicus. Anteriorly, it is bounded by the bodies of the pubic bones; medial portion of the pubic rami; and the lamina of rectus sheath. **(Kingsnorth et al., 2000).**

In the pelvis, the space of Retzius is bounded posteriorly by the prevesical fascia and the lateral pillars of the urinary bladder and the covering of pelvic peritoneum. More superiorly, the vesicoumbilical fascia and peritoneum provide a posterior wall for the space. The ductus deference and the round ligament of the uterus traverse the umbilicovesical fascia en route to the deep inguinal ring. The space of Retzius is closed laterally along the line of fusion provided by the inferior epigastric vessels and the tissue that encloses them (whether that be the posterior lamina of transversalis fascia, extra-peritoneal connective tissue or a fascial fusion between transversalis and extra-peritoneal membranous fascia). **(Kingsnorth et al., 2000).**

Bogros' space:

In the thesis presented in Paris in 1823, Bogros describe a triangular space between the abdominal wall and the peritoneum that could be entered by means of an incision through the roof and floor of the inguinal canal. In this way,

aneurysms of the iliac or inferior epigastric vessels could be secured and treated without the considerable surgical risk of entering the peritoneal cavity (Fig 2) **(Kingsnorth et al., 2000).** Although Bogros described the space at the termination of the external iliac artery as being only approximately 13 mm to 15 mm wide and 4 mm to 6 mm deep, modern interpretation seems to be extending this space upward into the retroperitoneal area, and some workers state that it is continuous medially with the space of Retzius, but the Kingsnorth et al., believe that communication between two spaces is an artifact of dissection or a result of disease processes; they are normally separated from one another by the plane of fusion between extraperitoneal connective tissue and transversalis fascia that occurs along the path of the inferior epigastric vessels **(Kingsnorth et al., 2000).**

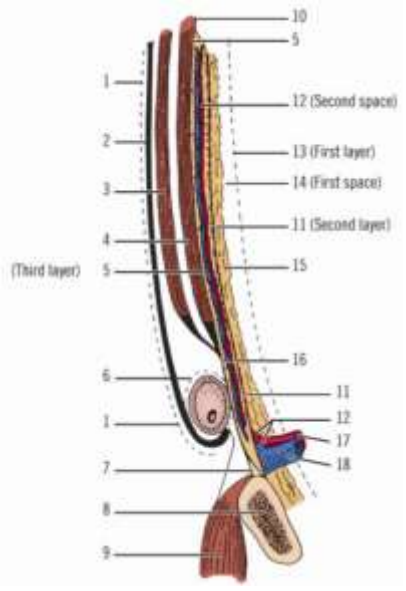

Fig. (2): Highly diagrammatic representation of the layers of the abdominal wall and inguinal area. 1, external oblique fascia (fascia of Gallaudet), 2, external oblique aponeurosis, 3, internal oblique muscle, 4, transverses abdominis muscle and its aponeurosis, 5, transversalis fascia anterior lamina (third layer), 6, external spermatic fascia, 7, Cooper's ligament, 8, pubic bone, 9, pectineus muscle, 10, possible union of transversalis fascia laminae, 11, transveralis fascia posterior lamina (second layer), 12, vessels (second space), 13, peritoneum (first layer), 14, space of bogros (first space), 15, preperitoneal fat; 16, transversus abdominis aponeurosis and anterior lamina of transversalis fascia, 17, femoral artery, 18, femoral vein (Modified from Skandalakis JE, Colborn GL, Androulakis JA, Skandalakis LJ, Pemberton LB. Embryologic and anatomic basis of inguinal herniorrhaphy. Surg. Clin North Am 1993, 73: 799-836. Drawn with R.C. Read, with permission).

Triangle of doom: This triangle is bounded by the spermatic vessels laterally, the vas deferens medially, and the inferior flap of the peritoneal dissection inferiorly. This area has been referred to as the triangle of doom in that the external iliac vessels lie beneath. It has been advised that stapling be done only medial to the vas deferens (Fig 3) **(Fitzgibbon et al., 2001).**

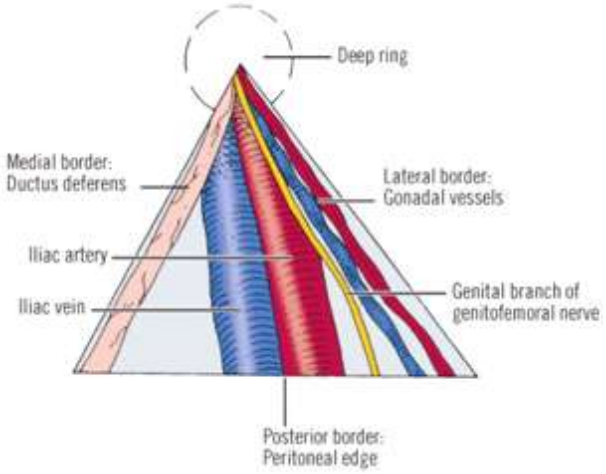

Fig. (3): Triangle of Doom. (Modified from Colborn GL, Skandalakis JE, Laparoscopic cadaveric anatomy of the inguinal area. Probl Gen Surg. 1995, 12-13-20; with permission).

Square of doom:

Kathouda and Mouiel (1993), stated that ; the triangle of doom should be extended laterally to the psoas muscle where two nerves of great importance are found: the lateral femorocutaneous and the genitofemoral; these two nerves should be kept in mind when placing sutures or staples laterally on the psoas in order to avoid neuromas or hypothesia of the groin. This area described as the square of doom is located between the vas medially and the iliopubic tract superiorly.

The second triangle is lateral to the spermatic vessels and is bounded by these structures medially, the iliopubic tract superiorly, and the lateral pelvic wall. In this triangle lie the genital and femoral branches of the genitofemoral nerve, the femoral nerve, and the lateral femoral cutaneous nerve of the thigh. Therefore, staples or tacks placed caudal to the iliopubic tract and lateral to the internal spermatic vessels can result in neuralgias (Fig 4) **(Fitzgibbon et al., 2001).**

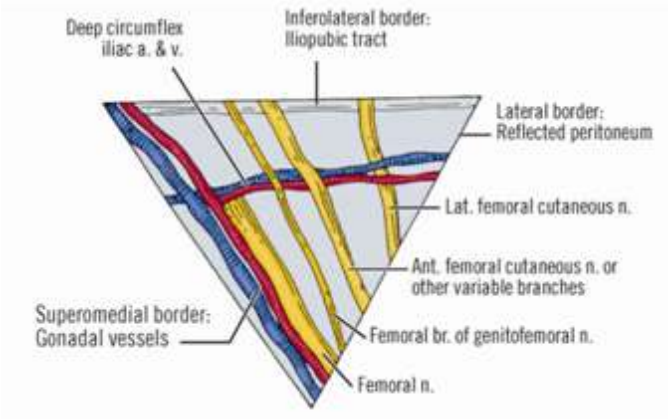

Fig. (4): Triangle of Pain (Modified from Colborn GL, Skandalakis JE Laparoscopic cadaveric anatomy of the inguinal area. Probl GenSurg 1995, 12-13-20, with permission).