Recent Trends in Management of Inguinal Hernia

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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 therefore carries significant socioeconomic impact on society ***(*Nixon & Kumar, *2005).***

The three types of surgical procedures are: conventional procedures (Shouldice, Bassini), open tension-free mesh procedures (Lichtenstein, Rutkow) and endoscopic procedures, predominantly transabdominal preperitoneal hernioplasty (TAPP) and total extra peritoneal hernioplasty (TEP) **(Wauschkuhn , *2011).***

Of all the factors used to compare the various methods of inguinal hernioplasty, the rate of recurrence is most often considered the measure of success. Without entering the peritoneal cavity, the totally extra peritoneal approach reduces the risk of visceral injury, adhesion formation, and the development of port-site hernias **(Cobb *et al.*, 2005).**

The endoscopic posterior approach also allows an excellent exposure of the anatomical defect, which is of particular use in the repair of recurrent hernias **(Chen *et al.*, 2010).**

Both the TAPP and TEP approaches ,the hernia sacs is reduced , and a large piece of mesh is placed to cover the indirect ,direct and femoral areas of the inguinal region. Another advantage of the TAPP and TEP approaches is that bilateral hernias may be repaired simultaneously with no apparent increase in morbidity ***(felix 2009).***

The TAPP requires access to the peritoneal cavity with placement of a mesh through a peritoneal incision. This mesh is placed in the preperitoneal space covering all potential hernia sites in the inguinal region. The peritoneum is then closed above the mesh, leaving it between the preperitoneal tissues and the abdominal wall where it becomes incorporated by fibrous tissue **(Macdonald &Ahmed, 2010).**

Aim of the work

This work aims at highlighting the literature regarding recent trends in surgical management of inguinal hernia.

Chapter one

Anatomy of the Inguinal Region

Successful repair of a groin hernia requires knowledge about the anatomy of the abdominal wall, inguinal canal, and femoral canal. The layers of the abdominal wall, from superficial to deep, include; skin, Camper's fascia, Scarpa's fascia, the external oblique aponeurosis and muscle, the internal oblique aponeurosis and muscle, the transverses

abdominis aponeurosis and muscle, the transversalis fascia, the preperitoneal fat, and the peritoneum. These layers continue in the region of the groin as they form their insertions in the inguinal canal ***(Scott and Jones, 2008).***

General Description of the Anterior Abdominal Wall

The anterior abdominal wall is bounded superiorly by the lower costal margin and inferiorly by the symphysis pubis, the pubic tubercle, the inguinal ligament, the anterior superior iliac spine and the iliac crest, from medial to lateral. The wall is composed of three flat sheets like muscles ***(Vestweber et al., 2011).***

They fuse medially to form a fibrous sheet for the vertically running rectus muscle lying on each side of the mid line. The sheath of the two sides meets in the mid line as a fibrous raphe known as the LineaAlba. The three transverse lines on the anterior surface of the rectus abdominis muscle can be seen above the umbilicus. They are termed tendinous intersections. The lateral line formation of the rectus sheath is known as the linea semilunaris ***(*Woods *&* Neumayer, 2008).***

The layers of the abdominal wall in the inguinal region consist of: skin, subcutaneous fascia (Camper and Scarpa) containing fat (superficial fascia), and the innominate fascia (Gallaudet). This may not always be recognized as a distinct entity, external oblique aponeurosis, which including (the inguinal, lacunar and reflected inguinal ligament), spermatic cord , internal oblique muscle (falx inguinalis (ligament of Henle), and the conjoint tendon when present), transversus abdominis muscle and aponeurosis , transversalis fascia (associated with the pectineal ligament (Cooper); the iliopubic tract, the trans-versalis fascia sling,and the deep inguinal ring), the preperitoneal connective tissue, the fat and the peritoneum. ***(Zollinger, 2011).***

I- Open view of the inguinal region:

Skin: skin of the anterior abdominal wall is thin.

The Superficial Fascia: this fascia (described here only for the male) is divided into a superficial part (Camper) and a deep part (Scarpa). The superficial part extends upward on the abdominal wall and downward over the penis, scrotum, perineum, thigh, and buttocks. The deep part extends from the abdominal wall to the penis (Buck fascia), the scrotum (dartos), and the perineum (Colles fascia) ***(Skandalakis, 2009).***

Innominate fascia: it is a thin tissue-like membrane that covers the external oblique muscle (fascia of Gallaudet) and follows the spermatic cord to form the external spermatic fascia ***(Gongke et al., 2011).***

The superficial inguinal ring: it is a triangular opening in the aponeurosis of the external oblique muscle ***(Chen et al., 2010).***

The Inguinal ligament (Poupart's ligament): this is the thickened lower part of the external oblique aponeurosis from the anterior superior iliac spine laterally to the superior ramus of the pubic tubercle ***(Acland, 2008).***

The Lacunar ligament (Gimbernat): this is the most inferior portion of the inguinal ligament and is formed from external oblique tendon fibers arising at the anterior superior iliac spine. Occasionally it forms the medial border of the femoral canal ***(Skandalakis, 2009).***

The Reflected part of the inguinal ligament (Colles' ligament): this is formed by aponeurotic fibers from the inferior crus of the external ring that extend to the Linea Alba ***(Acland, 2008).***

The pectineal ligament (Cooper's ligament): this is a thick, strong tendinous band formed principally by tendinous fibers of the lacunar ligament and aponeurotic fibers of the internal oblique, transverses abdominis, and pectineus muscles, and, with variation, of the inguinal falx. It is fixed to the periosteum of the superior pubic ramus and, laterally, with the periosteum of the ilium. The tendinous fibers are lined internally by transversalis fascia ***(Albrech & Bansagi 2010).***

The Ligament of Henle (FalxInguinalis): Henle ligament is the lateral, vertical expansion of the rectus sheath that inserts on the pecten of the pubis ***(Skandalakis, 2009).***

The Interfoveolar Ligament (Hesselbach's Ligament): this is not a true ligament. It is a thickening of the transversalis fascia at the medial side of the internal ring ***(Perko et al., 2011).***

The Internal oblique muscle: it is Fleshy fibers of muscle arise from the whole length of the lumbar fascia, from the intermediate area of the anterior two-thirds of the iliac crest and from the lateral two-thirds of the inguinal ligament. From the lumbar fascia the muscle fibers run upwards along the costal margin, to which they are attached, becoming aponeurotic at the tip of the ninth costal cartilage. Below the costal margin, the aponeurosis splits around the rectus muscle, as well the two layers rejoining at the Linea Alba. Halfway between the umbilicus and the pubic symphysis the posterior layer ends in a curved free margin, and the arcuate line. Below this point, the aponeurosis passes wholly in front of the rectus muscle, to the Linea Alba ***(Zollinger, 2011).***

The conjoint tendon: the conjoint tendon is classically described as a band formed by a conjoining of aponeurotic fibers from the internal oblique and transverses abdominis aponeuroses that turns sharply inferiorly along the border of the rectus muscle and sheath to insert into the pubic tubercle and adjacent superior pubic ramus ***(Albrecht, 2010).***

The Transversus abdominis muscle: the muscle arises in continuity from the lateral third of inguinal ligament, the anterior two-thirds of the inner lip of the iliac crest, the lumbar fascia, the twelfth rib, and from the inner aspects of the lower six costal cartilages where it interdigitates with the diaphragm. The muscle fibers become aponeurotic and pass behind the rectus to fuse with the internal oblique aponeurosis into the Linea Alba. Below the arcuate line the aponeurosis passes wholly in front of the rectus muscle. The lower fibers of the aponeurosis curve downwards and medially with those of the internal oblique as the conjoint tendon, to insert on the pubic crest and the pectineal line ***(Sinnatamby, 1999).***

The transversails fascia: it is a fascial layer covering muscles, aponeuroses, ligaments, and bones. In the inguinal area the transversalis fascia is bilaminar, enveloping the inferior epigastric vessels ***(Skandalakis, 2009).***

The Iliopubic Tract: it is an aponeurotic band forming the inferior margin of the transversalis fascia, which is mixed with stronger fibers from the transverses abdominis aponeurosis. This band of tissue is anchored superolaterally along the inner lip of the crest of the ilium and at the anterior superior iliac spine, and stretches medially to insert on the superior ramus of the pubis ***(Quinn, 2002).***

The deep inguinal ring: the internal or deep inguinal ring is a normal defect in the transversalis fascia shaped like an inverted V or U. Its arms anterior and posterior are a special thickening of the transversalis fascia, and forming a sling. Its inferior border is formed by another thickening of the transversalis fascia—the iliopubic tract—which is not always very aponeurotic **(Avisse et al., 2000).**

The Inguinal (Hesselbach's) Triangle: the inguinal triangle is the weak area through which direct inguinal hernias pass. Hesselbach's triangle is defined today as having the inferior (deep) epigastric vessels as its superior border, the rectus sheath as its medial border, and the inguinal ligament as its latero-inferior border**(Skandalakis et al., 2009).**

The Preperitoneal fat and space: it lies within a space between the peritoneum and the transversalis fascia. The reflection of parietal peritoneum toward the iliac fossa before it reaches the pubic bone exposes the preperitoneal space ***(Skandalakis et al, 2010).***

The Peritoneum: it is connected loosely with the transversalis fascia in most areas except at the internal ring, where the connection is stronger **(Surgit, 2010).**

II- Laparoscopic view of the inguinal region

Many of the complications seen with the early laparoscopic repairs of inguinal hernias were directly related to a lack of the appreciation of the anatomy of inguinal region from a laparoscopic perspective. If space in the abdominal wall is created by distending with gas, an excellent view of the deep aspect of the anterior abdominal wall, peritoneal folds, and associated structures will be seen ***(Richard et al., 2006).***

Peritoneal folds: the median umbilical fold extends from the umbilicus to the urinary bladder and covers the urachus. The medial umbilical fold is formed due to the presence of the underlying obliterated portion of the fetal umbilical artery. This cord-like structure, similar to the urachus may be patent for a portion of its length. Indeed the proximal portion of the artery normally supplies the superior vesicular arteries to the bladder. The lateral umbilical fold covers the inferior epigastric artery ***(Fitzgibbon et al., 2005).***

Fossae of the anterior abdominal wall: the inner (posterior) surface of the anterior body wall above the inguinal ligament and below the umbilicus is divided into three shallow fossae on either side of a low ridge formed in the midline by the median umbilical ligament, the obliterated urachus. Each of these fossae is a potential site for a hernia. ***(Skandalakis, 2009).***

The preperitoneal space at the inguinal area: or properitoneal space is the space between the peritoneum internally and the transversalis fascia externally. Accepting the bilaminar formation of the transversalis fascia into anterior and posterior laminae 2 spaces are formed; between the peritoneum and the posterior lamina of the transversalis fascia and another between the Laminae of the transversalis fascia. Occasionally, the posterior lamina is not well developed. In such cases, the space is limited by the peritoneum internally and the anterior lamina of the transversalis fascia externally that is the "old" transversalis fascia **(Chung and Odwey, 2007).**

The understanding and recognition of the anatomy of the preperitoneal space is essential to the performance of a safe and effective laparoscopic hernia repair. The five important landmarks are: Pubic tubercle and Cooper’s ligament, External iliac vein, Medial umbilical ligament and the inferior epigastric vessels as they come off the external iliac vessels, Vas deferens and Cord vessels. Along with the iliopubic tract, these landmarks define the three spaces associated with groin hernias, all three spaces should be covered by an appropriate size mesh: **Indirect inguinal hernia (**lateral to the inferior epigastric vessels), **Direct inguinal hernia (**medial to the inferior epigastric vessels and lateral to the border of the rectus abdominus muscle within the triangle of Hesselbach) and **Femoral hernia (**under the iliopubic tract, medial to the iliac vein, and lateral to Cooper’s ligament). **(Katkhouda, 2011).**

The Circle of Death: the arterial network of the Circle of Death is formed by the common iliac artery, internal and external iliac arteries, obturator artery, aberrant obturator artery, and inferior epigastric artery. The venous counterparts are similar in name, course, and position ***(Fitzgibbon et al., 2005).***

Chapter 2

Pathophysiology of Inguinal Hernia

Incidence:

Inguinal hernias represent about 73% of all hernias. Indirect inguinal hernia is the most common type of hernia appearing at any age, but is more common in young whereas a direct hernia is more common in the old. In the first decade of life, inguinal hernia is more common on the right side in the male. After the second decade left inguinal hernias are as frequent. The majority of inguinal hernia occurs in male subjects with a male-to-female ratio of 20:1 ***(Richard et al., 2006).***

In adult male 65% of inguinal hernias are indirect and 55% are right sided. The inguinal hernia is bilateral in 12% cases. If both sides are explored in infants presenting with one hernia, the incidence of a patent processus vaginalis on the other side is 60% ***(Russel et al., 2004).***

Definitions:

Inguinal hernia (Greek hernios: offshoot or bud), presenting as a bulge in the groin. A hernia is an abnormal protrusion of a viscus or part of a viscus through a defect either in the containing wall of that viscus or within the cavity in which the viscus normally is situated **(Francis, 2006).**

A sliding hernia exists when a retroperitoneal organ, usually the sigmoid colon, cecum, bladder, or ureter, forms part of the wall of the sac. A Richter's hernia exists when the antimesenteric portion of intestine (not the complete circumference of bowel) protrudes into the hernia sac.A Littre's hernia exists when the sac contains a Meckel's diverticulum **(Scott and Jones, 2008).**

If the sac and its contents can be returned to the abdominal cavity, a hernia is termed reducible. If it cannot be returned to the abdominal cavity, as is sometime the case with a small fascial defect and a large hernia, the hernia is termed irreducible or incarcerated. If an irreducible hernia contains intestine or other viscera with blood supply that is compromised, the hernia is strangulated **(Lau, 2002)**. As a rule, a hernia consists of three parts: the sac, the coverings of the sac and the contents of the sac. ***(Kingsnorth et al., 2008).***

Etiology of inguinal hernia:

I -Patent processus vaginalis: the prime cause of an indirect inguinal hernia is a patent processus vaginalis. Normally the processus becomes obliterated in the first few months of life. If all or part of the processus remains patent, the defect can give rise to an indirect inguinal hernia, a scrotal hydrocele, or an encysted hydrocele of the cord or hydrocele of the canal of Nuck in a female patient **(Skandalakis et al., 2004).**

II - The Shutter Mechanisms: Coughing, straining, and lifting of heavy weights and other normal daily activities generate extremely high intra-abdominal pressures, the accepted explanation for this is the physiologic "shutter mechanism", which is activated when the abdominal muscles contract and cause the intra-abdominal pressure to increase when performing these functions, which causes hernia emerges through a weak point of the abdominal wall. **(Katkhouda, 2011).**

III -Loss of the integrity of fascia transversalis: the fascia transversalis, like other fascial tissues, derives its strength from collagen fibers that are continually being produced and reabsorbed. A disturbance of this balance results in attenuation of the fascia. Congenital defects, such as occur in Marfan and Ehler-Danlos, can predispose to hernia formation. ***(Read, 2002).***

IV-Trauma: Spontaneous or iatrogenic: it is remarkable how strong the abdominal wall is. It takes massive trauma to cause inguinal herniation. Aponeuroses are then detached from their insertions into the pubis. A similar result can follow fractures or osteotomies. Previous appendectomy may be followed by right inguinal herniation. ***(Fitzgibbon et al., 2005).***

Classification of Inguinal Hernia

Inguinal hernias are further divided by anatomical location into direct and indirect types. This differentiation is based on the location of the actual hernia defect in relation to the inferior epigastric vessels. Hernias that develop lateral to the inferior epigastric vessels are termed indirect inguinal hernias, and those that develop medial to the vessels are direct inguinal hernias **(Bhattacharjee,2006).** Over the next few years, three new major classifications were proposed, and they have become widely used ***(Zollinger, 2009).***

Gilbert classification: Gilbert in 1989 based on anatomic and functional defects established intra operatively namely the presence or absence of a peritoneal sac, the size of the internal ring, and the integrity of the posterior wall. Applying these three factors, he categorized groin hernias into five classes. Types 1, 2, 3 were indirect, while types 4, 5 were direct. ***(Mariano et al., 2010).***

Nyhus classification: in his classification, Nyhus used location, the sizes of the defect and the sac, and the integrity or function of the internal ring and direct floor, along with combinations of inguinal hernias and recurrences. ***(Nyhus, 1993).***

Schumpelick classification: the third major classification was created in 1995 by Schumpelick. He used **''L''** for the lateral indirect site, **''M''** for the medial direct one, and **''F''** for femoral. The defect sizes were graded as I being <1.5 cm in diameter; II being 1.5–3.0 cm; and III being >3 cm. lastly, he classified the **pantaloon** (direct+indirect) inguinal hernias as **''Mc.''** The Schumpelick classification system is used principally in Europe, as it has not been widely published in American surgical journals ***(Kraft et al., 2003).***

Chapter 3

Diagnosis of Inguinal Hernia

The preoperative diagnosis of inguinal hernias is one of the surgeon's most commonplace duties yet one of the least valued aspects in the treatment of this pathology. Preoperative clinical examination should never be overlooked, as it may be very useful for classifying hernias with great accuracy, for designing programmes of apprenticeship in laparoscopic surgery, for increasing the yield of outpatient surgery departments and for deciding on the best therapeutic option **(Egea et al., 2000).**

History: the gold standard for hernia diagnosis is a history and physical exam. Patients will usually complain of a persistent or intermittent bulge in the groin associated with some degree of discomfort, aggravated by physical exertion ***(Scott and Jones, 2008).***

Physical examination: including general examination and local examination; General examination involves looking for the common causes of a raised intra- abdominal pressure such as a large bladder due to enlarged prostate, ascites, intra-abdominal masses and chronic intestinal obstruction,

chronic bronchitis and coughing .Also, any signs of intestinal obstruction are looked for such as distension, increased bowel sounds, and visible peristalsis. ***(Fitzgibbon et al., 2005).***Local Examination the clinician examines the patient from the front with the patient standing with legs apart. The patient is instructed to look at the ceiling and cough. If the hernia will come down, it usually does. The examiner looks for the impulse and feels for the impulse and then addresses the following questions: is the hernia right, left or bilateral? inguinal or femoral hernia?direct or an indirect hernia? reducible or irreducib? ***(Russel et al., 2004).***

Clinical Presentations of Inguinal Hernia: patients with a groin hernia could present in a variety of ways, from the asymptomatic hernia (about 30% of patients) to a painful lump (the commonest presentation accounting for 66% of patients), Overwhelming or focal pain from a groin hernia is unusual and should raise the suspicion of hernia incarceration or strangulation ***(*****Francis ,*****2006).***

Investigations: most clinically significant hernias can be diagnosed on clinical examination and managed without the use of diagnostic imaging. However, there are recognized limitations to clinical assessment, and a significant proportion of patients with symptoms suggestive of a hernia are found to have normal or equivocal clinical examination findings ***(*****Chen *****et al., 2010).***

I. Herniography: Herniography has been evaluated in patients with equivocal clinical features and has been shown to be a very sensitive, but potentially nonspecific, technique, for depiction of asymptomatic hernias. Herniography has a low complication rate, but the procedure is still relatively invasive and requires ionizing radiation **(Macdonald & Ahmed 2010).**

II. Sonography: Sonography has been shown to be an accurate preoperative technique in adults for confirming hernias evident on clinical examination. Sonography has been evaluated in infants for confirming clinically evident inguinal hernias, but a varied accuracy is reported for the assessment of the contralateral inguinal canal ***(*****Perko *****et al., 2011).***

III. CT and MRI: Reviews of abdominal CT series have shown CT to be an effective technique for detecting and classifying abdominal hernias predominantly in patients with diffuse symptoms and a palpable abnormality ***(Milanchi and Allins, 2008).***

Chapter 4

Management of Inguinal Hernia

Inguinal hernioplasty has undergone a gradual evolution over the last 100 years. In the beginning, surgeons like Edoardo Bassini, William Halsted, and Chester McVay championed new understandings of hernia anatomy and fresh approaches to dissection and repair of the inguinal floor ***(Felix, 2009)***.

In the 1970s surgeons began to incorporate prosthetic materials into their repairs to eliminate tension and to decrease recurrence. Later Nyhus, Stoppa, and Wantz further changed the direction of inguinal hernioplasty by applying prostheses to the posterior wall of the groin. The evolution reached its current level in 1990 shortly after the introduction of laparoscopic cholecystectomy, when the laparoscopic approach to inguinal hernia repair was introduced ***(*****Vestweber *****et al., 2011).***

I. Open Repair of Inguinal Hernia:

A. Open non-mesh techniques (Open suture repair):

Bassini repair: the posterior wall of the inguinal canal can be reconstructed on

one side by the three fold layer formed by the internal oblique muscle, the transverses abdominus muscle, the transversalis fascia, and the external border of the rectus muscle and its aponeurosis, in the lower part and on the other side by the strong Poupart's ligament. In order to include the stitches of the whole three fold layers, it is necessary to open the transversalis fascia, through this opening, the index finger of the left hand was passed, allowing the needle to pass through the three fold layer and avoiding injuries to other underlying organs ***(Katkhouda, 2011).***

The McVay repair (Cooper's ligament repair): the McVay repair addresses both inguinal and femoral hernias. The central attenuated portion of the inguinal floor is excised. Cooper's ligament must be clearly identified. The inguinal floor is then repaired by approximating the transverses abdominis aponeurosis and transversalis fascia to Cooper's ligament between the pubic tubercle and the femoral vein. More laterally, the transversus abdominis muscle and transversalis fascia are approximated to the iliopubic tract and femoral sheath up to the internal ring **(Richard et al., 2006).**

The Shouldice operation (The Canadian repair): the Canadian hernioplasty is the modern equivalent of the original Bassini operation. this hernioplasty consisted of preservation of the cremasteric muscle and its anatomic relationship to an intact posterior inguinal canal In the Shouldice repair, the transversalis fascia is divided from the internal ring to the pubic tubercle and lifted from the peritoneum. The fascia is then overlapped with two rows of running sutures. Two further rows of sutures are applied to bring the transversus abdominis muscle to the shelving edge of the inguinal ligament. ***(*Woods *& Neumayer, 2008).***

B. **Mesh repairs:**

Lichtenstein repair: A prosthesis measuring approximately 8 - 16 cm is used. The lower edge of the prosthesis is fixed using a continuous suture to Poupart‟s ligament beginning medially and overlapping 2 cm onto the pubic tubercle and proceeding laterally along the ligament beyond the internal ring, ending just lateral to the internal ring ***(Amid, 2011).***

Plug and patch repair: A preformed plug of polypropylene mesh is placed within the internal ring (for indirect hernia) or into the direct hernial defect and sutured to the ring of the fascial opening ***(Bhattacharjee, 2006).***

Repair with the Prolene Hernia System (PHS): The use of the bilayer Prolene Hernia System (PHS), which combines the anterior approach and posterior mesh augmentation with minimal fixation, is becoming an accepted technique ***(Faraj et al., 2010).***

II. Laparoscopic Inguinal Hernia Repair in Adult Patients (>18 Years)

Laparoscopy was first described in the beginning of the 20th century. It was promoted as a valuable adjunct to the diagnosis of diseases of the abdominal cavity ***(Amid, 2011).***In Minnesota, **Schultz** conducted the first large series of laparoscopic herniorrhaphy. Prior to the introduction of the hernia staplers, he incised the peritoneum adjacent to the indirect hernia defect, filled the inguinal canal with a mesh plug, and closed the sac with suture. **(Nixon, 2005).**

The transabdominal preperitoneal (TAPP) approach with full exposure of the inguinal floor and placement of a large preperitoneal prosthesis. The transabdominalpreperitoneal (TAPP) repair involves standard laparoscopy with access into the peritoneal cavity and placement of a large mesh along the anterior abdominal wall, thereby repairing the hernia posterior to the defect. This technique was the first

laparoscopic hernia repair to be performed ***(Zollinger, 2004)***

The intraperitoneal onlay mesh technique (IPOM) was developed as a simplified version of the TAPP repair. In this technique, laparoscopic exposure is obtained directly into the peritoneal cavity as in the TAPP **(Bhattacharjee, 2006)**

The total extraperitoneal repair (TEP) avoids insertion of trocars into the abdominal cavity and confines dissection to the peritoneum. This technique gained favor because of less complication from trocar insertion, however the above procedures require general anesthesia. Recently, preliminary reports are appearing describing techniques of repair under local anesthesia, or using standard instruments without trocars by the "gasless" technique, which may solve some issues of safety and cost effectiveness of laparoscopic hernia repair ***(Tran H, 2011).***

Contraindication for laparoscopic inguinal hernia repair: because general anesthesia is necessary for the laparoscopic approach, an open approach should be performed when the patient‟s medical condition makes general anesthesia more risky. These cases include elderly patients and anyone who has significant cardiac or pulmonary co-morbidities. In addition patients who have had prior or who have planned pelvic or extraperitoneal operations (e.g. radical prostatectomy) or who have had a recurrence from a prior laparoscopic repair, should have an open inguinal hernia repair ***(Takata and Duh, 2008).***

Choice of approach: the choice of laparoscopic approach depends on the surgeon's level of experience, the type of hernia present, and the patient's history**.** The TEP approach avoids entering the peritoneal cavity. It is therefore less likely to have intra operative complications and is often performed more quickly than the TAPP approach because it does not require peritoneal closure after mesh placement **(Felix, 2009).**

A. Laparoscopic Transabdominal Preperitoneal (TAPP) Approach

Surgical technique: ***(Zollinger, 2011).***

- Step 1: Pneumoperitoneum& Peritoneal Access
- Step 2: Trocar placement & Inspection of the Groin Anatomy
- Step 3: Dissection of the Preperitoneal Space
- Step 4: Preparation and placement of the Mesh
- Step 5: Closure of the Peritoneum

B. Laparoscopic Total Extra-PeritonealHernia Repair (TEP):

A totally extraperitoneal approach potentially offers several advantages. It might eliminate complications related to violating the peritoneal cavity to reach the extraperitoneal space, and it might reduce operative time, especially for bilateral hernia repairs. At first, the dissection of the extraperitoneal space was difficult and sometimes confusing, but with the advent of balloon dissectors, this exposure has become quite routine ***(Nixon & Kumar 2005).***

TEP techniques:

- **Phillip's technique:** after induction of general anesthesia, pneumoperitoneum is established using a veress needle technique through a subumbilical incision. A 10/ll mm laparoscopic trocar is often inserted into the peritoneal cavity while being directed toward the pelvis. Through this trocar, a 30-degree laparoscope is introduced

and a general inspection of the abdomen and pelvic floor is made. A 10-mm scope is sturdier when used to bluntly develop the preperitoneal space, and it provides better illumination during the procedure ***(*Tran, *2011).***

- **Mckerman technique of TEP:** A 20 mm peri-umbilical or vertical skin incision is made to gain access to the preperitoneal space. The fascia is identified and elevated with clamps, and a 12 mm vertical midline incision is performed. The 'S' retractors are placed beneath the fascia for exposure. The rectus muscle is identified and separated bluntly, retractors are placed beneath the musculature and a small tunnel in the midline is begun in the direction of the pubis, between the rectus muscle and the preperitoneal fat, Stay sutures of 0 polyglycolic acid are placed in the fascia. ***(Amid, 2011).***

III. Single port laparoscopic surgery

It is the surgery in which the surgeon operates through a single access point, usually the patient‟s umbilicus ***(Bucher , 2010)***. Single port laparoscopic surgery has potential advantages for e.g. postoperative pain, wound infections and cosmesis. The SILS port introduced via a single incision allows the deployment of 3 ports with blunt introducers, hence negating the risks of potential catastrophic bowel or vascular punctures ***(Surgit et.al, 2010).***

To perform single port procedures successfully many surgeons use special devices which is instruments including access platforms (which involves; Tri Port and Quad port, X-cone, Endocone for Single portal laparoscopic surgery, Gel point, Spider, Uni-X, OCTO Port, Air Seal) angled and articulating instruments and Optical devices. (**Avisse, 2000)**

The patient is placed supine with both hands restrained by his sides. The table is given a 20° Trendelenberg tilt and the side on which the surgery is to be performed is tilted up by about 20°. This helps in reducing the contents of the sac and displaces the intraabdominal viscera away from the operating site. The first assistant handling the camera stands beside the patient‟s opposite shoulder and the surgeon stands just caudad ***(Scott & Jons 2008).***

Single port access starts with a 15 – 20 mm skin incision in the umbilicus or at the lower circumference of the umbilicus.After dissecting the subcutaneous tissue and opening the ventral fascia, the rectus muscles are pulled to both sides with Langenbeck hooks. The posterior sheath and the peritoneum are pulled upwards and opened by scissors. The Langenbeck hooks are placed under the peritoneum. If there are local adhesions, they can be dissected by finger or sharply under direct visual control ***(Vestweber et.al, 2011).***

IV. Robotic Surgery:

A Robotic device is a powered, computer controlled manipulator with artificial sensing that can be reprogrammed to move and position tools to carry out a wide range of tasks. The original goal of developing these telemanipulators was to enable telesurgery. This would allow surgeons to operate on patients from a remote location thus avoiding hazardous environments, such as a battlefield, or inaccessible places, such as outer space. It would also allow them to perform surgery on patients who carry life-threatening infections **(Talamini *et.al*, 2009).**

One major obstacle to the telerobotic surgery is the "Latent time", which is the time taken to send an electrical signal from a hand motion to actual visualization of the hand motion on a remote screen. Humans can compensate for delays of less than 200 msec. longer delays compromise surgical accuracy

and safety. Incompatibility with imaging equipments is an area that needs attention **(Skandalakis, 2009).**

Current Robotic Surgical Systems: *(*Richard *et al., 2006)*

A. **Supervisory-controlled Robotic Surgery Systems** (e. g. the ROBODOC system from CUREXO Technology Corporation): It is the most automated surgical robots available till date. Surgeons can plan their surgery preoperatively in a 3-D virtual space and then execute the surgery exactly as planned in the operating theatre.

B. **Shared-control Robotic Surgery Systems:** These robots aid surgeons during surgery, but the human does most of the work.

C. **Telesurgical devices:** Here, the surgeon directs the motions of the robot, e. g. the da Vinci Robotic system, the ZEUS Surgical System:

a. **The da Vinci Surgical System:** there are essentially 3 components: a vision cart that holds a dual light source and dual 3-chip cameras, a master console where the operating surgeon sits, and a moveable cart, where 2 instrument arms and the camera arm are mounted. The camera arm contains dual cameras and the image generated is 3-dimensional. The master console consists of an image processing computer that generates a true 3-dimensional image with depth of field; the view port where the surgeon views the image; foot pedals to control electrocautery, camera focus, instrument/camera arm clutches, and master control grips that drive the servant robotic arms at the patient‟s side ***(Tran , 2011).***

b. **The ZEUS surgical system**: is made up of a surgeon control console and three Table-mounted robotic arms, which perform surgical tasks and provide steady visualization using AESOP technology The right and left robotic arms replicate the arms of the surgeon, and the third arm is an AESOP voice-controlled robotic endoscope for visualization. In the Zeus system, the surgeon is seated comfortably upright with the video monitor and instrument handles positioned ergonomically to maximize dexterity and allow complete visualization of the OR environment. ***(Amid,2011)***

Robotic Single-Port Inguinal Hernia Repair surgical technique:

Patient setup for single-port robotic Freehand TEP inguinal hernia repair is as for conventional single-port repair, except with the placement of the robotic arm positioned over the Tri-port after its placement. This usually requires some adjustments to ensure maximal range of movements with minimal clashing with dissecting instruments ***(Zollinger, 2011).***

Once the laparoscope has been inserted into the camera holder and secured, the movements of the robotic arm are then precisely controlled by the surgeon's head movements with the sensor being worn on his forehead. Once the direction of movement is achieved, the precise and incremental movement of the robotic arm is controlled with the foot pedal. The basic movements of the robotic arm are Pan=left/right, Tilt=up/down, and Zoom=in/out. In this way, any combination of robotic arm movements can be achieved, allowing for precise dissection and a rock steady image ***(Tran , 2011).***

The principles of dissection for TEP inguinal hernia repair are the same whether it is the traditional 3 ports, single-port, or robotic single port repair; namely, identification and dissection of the supra-pubic space (for orientation and to avoid bladder injury), dissection of the lateral

space, and then complete reduction of any indirect sac together with any associated lipoma of the cord and adequate proximal dissection of the peritoneum for placement of a 12-cm to 15-cm light weight mesh. This is fixed with 2 Protack staples in the midline and 1 laterally ***(Katkhouda, 2011)***

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