A Comparative Study of cyanoacrylate glue versus sutured Mesh Fixation for Lichtenstein Inguinal Hernia repair

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This is to certify that the dissertation entitled **"A Comparative Study of cyanoacrylate glue versus sutured Mesh Fixation for Lichtenstein Inguinal Hernia repair"** is a bonafide record work done by **Dr.V. RADHA KRISHNA** under my direct supervision and guidance, submitted to the Tamil Nadu Dr. M.G.R. Medical University in partial fulfilment of University regulation for M.S. General Surgery, Branch I during the period of January 2017 to December 2017.

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I **Dr. V. RADHA KRISHNA** solemnly declare that the dissertation titled **"A Comparative Study of cyanoacrylate glue versus sutured Mesh Fixation for Lichtenstein Inguinal Hernia repair"** has been prepared by me. I also declare that this bonafide work or a part of this work was not submitted by me or any other for any award, degree, diploma to any other University board either in India or abroad. This is submitted to The Tamilnadu Dr. M. G. R. Medical University, Chennai in partial fulfillment of the rules and regulation for the award of M.S.(General Surgery) Branch – I to be held in April 2019.

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INTRODUCTION

In recent years, General surgeons performing inguinal hernia repair have paid attention to successful reduction of recurrence rates. The Lichtenstein technique is widely used because it is easy to learn and it is associated with a low rate of complications and recurrences. Meshoma, seroma and complications related to the migration of the plug and mesh are a problem, but their incidence is low. Today, the new objective in primary hernia surgery should be to reduce disabling complications such as chronic groin pain.

Chronic pain after hernia repair can be disabling, with considerable impact on quality of life and there is evidence to suggest increased use of health services by patients who have chronic pain.

Chronic pain or persistent neuralgia has been recognized as a complication after inguinal hernia repair but was reported in the 1980s as a rare and infrequent condition. Studies from the mid-1990s have reported a higher frequency of patients reporting pain after hernia repair more than 1 year after surgery. Estimates of chronic pain vary considerably from 0 to 53%. It can be mild to severe, even disabling and can adversely affect quality of life.

The ‘pain complex syndrome’ after hernia repair includes three different aspects: 1) numbness and burning sensation (hypoesthesia, hyperesthesia and paresthesia). Etiology of this problem includes non-neuropathic and neuropathic causes or a combination of both. Non-neuropathic causes include mechanical pressure of folded or wadded mesh, periosteal reaction and scar-tissue formation. Neuropathic pain can be caused by compression of one or more nerves by ‘perineural fibrosis,’ suture material, staples and tacks or by nerves injuries. So if it is possible to limit the use of suture and device fixation , chronic groin pain could be reduced. It also reduces the length of stay, shorter return to normal activity. The ideal adhesive material should be Biocompatible, Cheap, easy to store and use. long-lateral-chain cyanoacrylates represent the best choice for mesh fixation in open mesh repair of inguinal hernia.

AIM AND OBJECTIVES

AIM

The aim of this study is compare the efficacy of cyanoacrylate glue with that of sutures in mesh fixation for Lichtenstein Inguinal Hernia repair

OBJECTIVES

The objective is to investigate short-term outcomes like length of operation time and pain, post-operative analgesia requirement within 24 hours, hematoma, seroma, and long term outcomes like chronic pain, sensation of an extraneous body, recurrence, time taken to return to work/normal activity following inguinal hernioplasty performed by the Lichtenstein technique with mesh fixation by cyanoacrylate glue comparing with sutures

SURGICAL ANATOMY OF INGUINAL REGION

Hernia is derived from the Latin word for rupture. A hernia is defined as an abnormal protrusion of an organ or tissue through a defect in its surrounding walls. Although a hernia can occur at various sites of the body, these defects most commonly involve the abdominal wall, particularly the inguinal region. Abdominal wall hernias occur only at sites at which the aponeurosis and fascia are not covered by striated muscle.

These sites most commonly include the inguinal, femoral, and umbilical regions, linea alba, lower portion of the semilunar line, and sites of prior incisions. The so-called neck of a hernia is located at the innermost musculoaponeurotic layer, whereas the hernia sac is lined by peritoneum and protrudes from the neck. There is no consistent relationship between the area of a hernia defect and the size of a hernia sac.

A hernia is reducible when its contents can be replaced back within the surrounding musculature, and it is irreducible or incarcerated when it cannot be reduced. A strangulated hernia has compromised blood supply

to its contents, which is a serious and potentially dreaded complication. Strangulation occurs more often in large hernias that have small orifices. In this situation, the small neck of the hernia obstructs arterial blood flow,

venous drainage, or both to the contents of the hernia sac. Adhesions between the contents of the hernia and peritoneal lining of the sac can provide a tethering point that entraps the hernia contents and predisposes to intestinal obstruction and strangulation.

A more unusual type of strangulation is a Richter's hernia. In Richter's hernia, a small portion of the antimesenteric wall of the intestine is trapped within the hernia, and strangulation can occur without the presence of intestinal obstruction. An external hernia protrudes through all layers of the abdominal wall, whereas an internal hernia is a protrusion of intestine through a defect in the peritoneal cavity. An interparietal hernia occurs when the hernia sac is contained within a musculo -aponeurotic layer of the abdominal wall. In broad terms, most abdominal wall hernias can be separated into inguinal and ventral hernias.

INGUINAL HERNIAS

Inguinal hernias are classified as direct or indirect. The sac of an indirect inguinal hernia passes from the internal inguinal ring obliquely toward the external inguinal ring and ultimately into the scrotum. In contrast, the sac of a direct inguinal hernia protrudes outward and forward and is medial to the internal inguinal ring and inferior epigastric vessels. As indirect hernias

enlarge, it sometimes can be difficult to distinguish between indirect and direct inguinal hernias. A pantaloon-type hernia occurs when there is an indirect and direct hernia component.[1]

Incidence

Hernias are a common problem; however, their true incidence is unknown. It is estimated that 5% of the population will develop an abdominal wall hernia, but the prevalence may be even higher. About 75% of all hernias occur in the inguinal region. Two thirds of these are indirect and the remainder are direct inguinal hernias. Femoral hernias comprise only 3% of all groin hernias.

Men are 25 times more likely to have a groin hernia than women, because of the descent of the testis through the inguinal canal & patent processus vaginalis. An indirect inguinal hernia is the most common hernia, regardless of gender. In men, indirect hernias predominate over direct hernias at a ratio of 2 : 1. Direct hernias are uncommon in women. Although femoral hernias occur more frequently in women than in men,

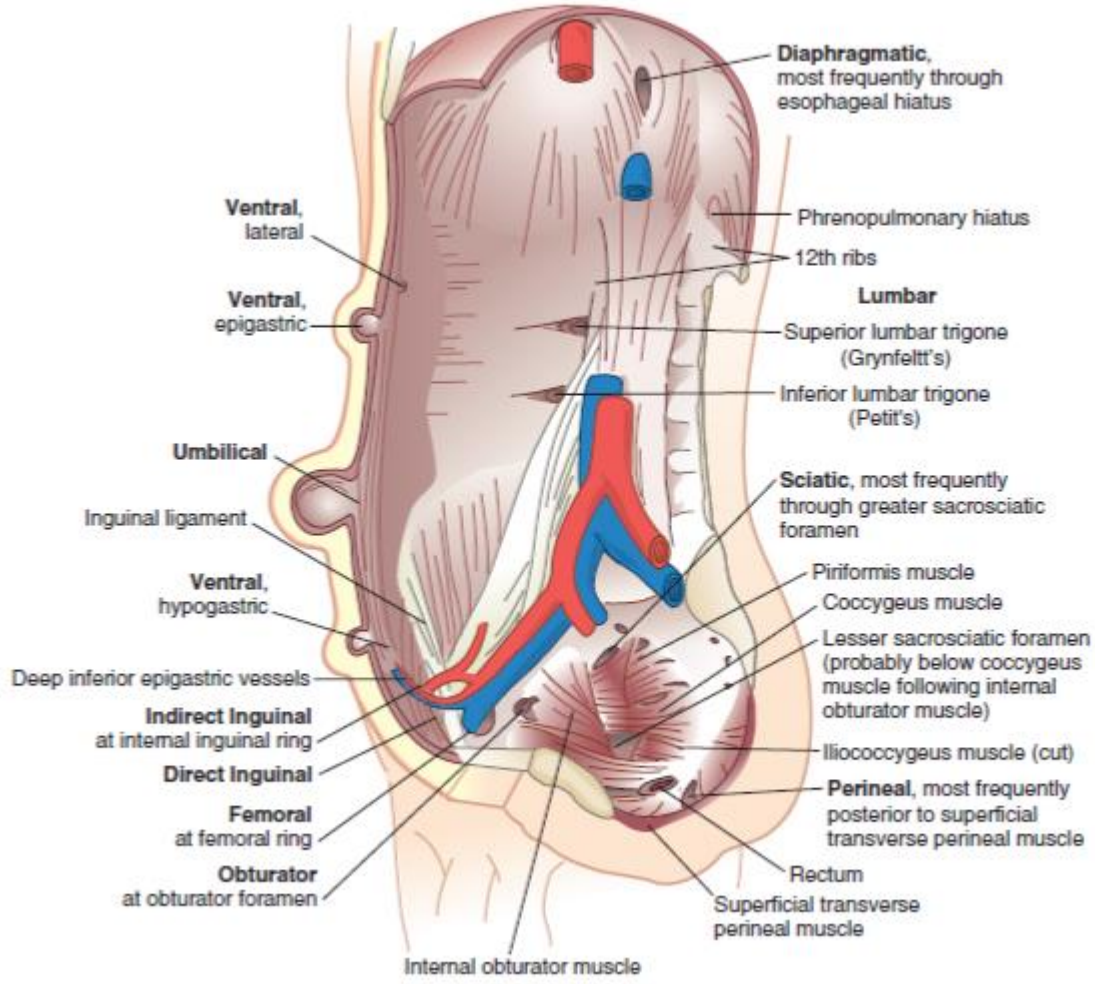
Femoral hernias are rare in men. Ten percent of women and 50% of men who have a femoral hernia have or will develop an inguinal hernia.

Indirect inguinal and femoral hernias occur more commonly on the right side. This is attributed to a delay in atrophy of the processus vaginalis after the normal slower descent of the right testis to the scrotum during fetal development. The predominance of right-sided femoral hernias is thought to be caused by the tamponading effect of the sigmoid colon on the left femoral canal.

The prevalence of hernias increases with age, particularly for inguinal, umbilical, and femoral hernias. The likelihood of strangulation and need for hospitalization also increase with aging. Strangulation, the most common serious complication of a hernia, occurs in only 1% to 3% of groin hernias and is more common at the extremes of life. Most strangulated hernias are indirect inguinal hernias; however, femoral hernias have the highest rate of strangulation (15% to 20%) of all hernias.

ANATOMY

From anterior to posterior, the groin anatomy includes the skin and subcutaneous tissues, below which are the superficial circumflex iliac, superficial epigastric, and external pudendal arteries and accompanying veins.



External Oblique Muscle and Aponeurosis

The external oblique muscle is the most superficial of the lateral abdominal wall muscles; its fibers are directed inferiorly and medially and lie deep to the subcutaneous tissues. The aponeurosis of the external oblique muscle is formed by a superficial and deep layer. This aponeurosis, along with the bilaminar aponeuroses of the internal oblique and transversus abdominis, forms the anterior rectus sheath and, finally, the linea alba by linear decussation. The external oblique aponeurosis serves as the superficial boundary of the inguinal canal. The inguinal ligament (Poupart ligament) is

the inferior edge of the external oblique aponeurosis and extends from the anterior superior iliac spine to the pubic tubercle, turning posteriorly to form a shelving edge. The lacunar ligament is the fan-shaped medial expansion of the inguinal ligament, which inserts into the pubis and forms the medial border of the femoral space. The external (superficial) inguinal ring is an ovoid opening of the external oblique aponeurosis that is positioned superiorly and slightly laterally to the pubic tubercle. The spermatic cord exits the inguinal canal through the external inguinal ring.

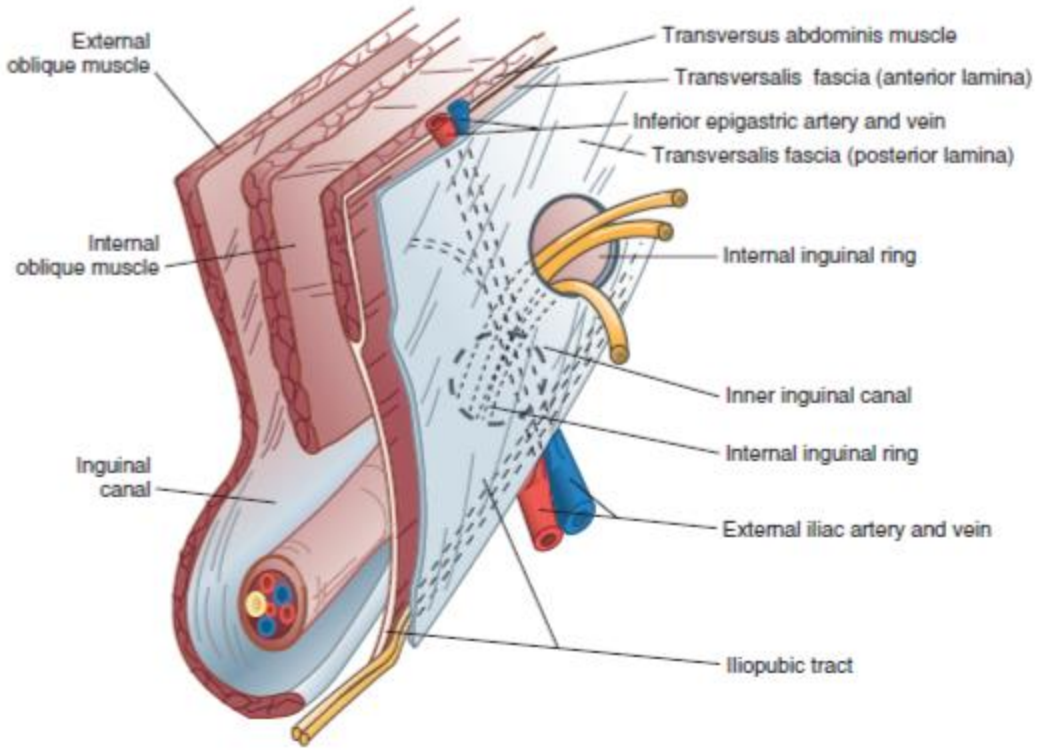
Internal Oblique Muscle and Aponeurosis

The internal oblique muscle forms the middle layer of the lateral abdominal musculoaponeurotic complex. The fibers of the internal oblique are directed superiorly and laterally in the upper abdomen; however, they run in a slightly inferior direction in the inguinal region. The internal oblique muscle serves as the cephalad (or superior) border of the inguinal canal. The medial aspect of the internal oblique aponeurosis fuses with fibers from the transversus abdominis aponeurosis to form a conjoined tendon The cremaster muscle fibers arise from the internal oblique, encompass the

spermatic cord, and attach to the tunica vaginalis of the testis. These muscle fibers are essential to maintain the cremasteric reflex.

Transversus Abdominis Muscle and Aponeurosis and Transversalis Fascia The transversus abdominis muscle layer is oriented horizontally throughout most of its area; in the inguinal region, these fibers course in a slightly oblique downward direction. The strength and continuity of this muscle and aponeurosis are important for the prevention and treatment of inguinal hernia.

The aponeurosis of the transversus abdominis covers anterior and posterior surfaces. The lower margin of the transversus abdominis arches along with the internal oblique muscle over the internal inguinal ring to form the transversus abdominis aponeurotic arch. The transversalis fascia is the connective tissue layer that underlies the abdominal wall musculature. The transversalis fascia, sometimes referred to as the endoabdominal fascia, is a component of the inguinal canal floor.



Inguinal Canal

The inguinal canal is about 4 cm in length and is located just cephalad to the inguinal ligament. The canal extends between the internal (deep) inguinal and external (superficial) inguinal rings. The inguinal canal contains the spermatic cord in men and the round ligament of the uterus in women.

The spermatic cord is composed of the cremaster muscle fibers, testicular artery and accompanying veins, genital branch of the genitofemoral nerve, vas deferens, cremasteric vessels, lymphatics, and processus vaginalis. These structures enter the cord at the internal inguinal ring, and vessels and vas deferens exit the external inguinal ring. The cremaster muscle arises from the lowermost fibers of the internal oblique muscle and encompasses

the spermatic cord in the inguinal canal. The cremasteric vessels are branches of the inferior epigastric vessels and pass through the posterior wall of the inguinal canal through their own foramen.

These vessels supply the cremaster muscle and can be divided to expose the floor of the inguinal canal during hernia repair without damaging the testis. The inguinal canal is bounded superficially by the external oblique aponeurosis. The internal oblique and transversus abdominis musculoaponeuroses form the cephalad wall of the inguinal canal. The inferior wall of the inguinal canal is formed by the inguinal ligament and lacunar ligament. The posterior wall, or floor of the inguinal canal, is formed by the aponeurosis of the transversus abdominis muscle and transversalis fascia.

Hesselbach triangle refers to the margins of the floor of the inguinal canal. The inferior epigastric vessels serve as its superolateral border, the rectus sheath as the medial border, and the inguinal ligament and pectineal ligament as the inferior border. Direct hernias occur within Hesselbach triangle, whereas indirect inguinal hernias arise lateral to the triangle. It is not uncommon, however, for medium and large indirect inguinal hernias to involve the floor of the inguinal canal as they enlarge.

The iliohypogastric and ilioinguinal nerves and genital branch of the genitofemoral nerve are the important sensory nerves in the groin area. The iliohypogastric and ilioinguinal nerves provide sensation to the skin of the groin, base of the penis, and ipsilateral upper medial thigh. The iliohypogastric and ilioinguinal nerves lie beneath the internal oblique muscle to a point just medial and superior to the anterior superior iliac spine, where they penetrate the internal oblique muscle and course beneath the external oblique aponeurosis. The main trunk of the iliohypogastric nerve runs on the anterior surface of the internal oblique

muscle and aponeurosis medial and superior to the internal ring. The iliohypogastric nerve may provide an inguinal branch that joins the ilioinguinal nerve. The ilioinguinal nerve runs anterior to the spermatic cord in the inguinal canal and branches at the superficial inguinal ring. The genital branch of the genitofemoral nerve innervates the cremaster muscle and skin on the lateral side of the scrotum and labia. This nerve lies on the iliopubic tract and accompanies the cremaster vessels to form a neurovascular bundle.

The integrity of the inguinal canal depends upon the strength of the anterior wall in the lateral part and of the posterior wall in the medial part, provided the abdominal muscles are of good tone and their aponeuroses unyielding.

The deep and superficial inguinal rings lie at opposite ends of the inguinal canal and the intervening part of the canal is pressed flat when the aponeuroses are under tension and the intra-abdominal pressure raised. The conjoint tendon lies posterior to the superficial inguinal ring and helps to reinforce this area. Laterally the transversalis fascia in the posterior wall is strengthened by the presence of tendinous in front of it, and sometimes muscular, fibres derived from the transversus abdominis muscle. These fibres constitute the inter foveolar ligament. They arch down from the lower border of transversus around the vas to the inguinal ligament, and constitute the functional medial edge of the deep ring.

Spermatic cord

The spermatic cord has three coverings and six constituents. Of the three coverings of the spermatic cord , the internal spermatic fascia is derived from the transversalis fascia at the deep inguinal ring. As the cord passes through the ring into the inguinal canal, it picks up a second covering, the cremaster muscle and cremasteric fascia. This loosely arranged layer consists of striated muscle bundles united by areolar tissue. The muscle arises laterally from the inguinal ligament, the internal oblique and transversus abdominis muscles. The fibres spiral down the cord and loop back to become attached to the pubic tubercle. The third covering,

the external spermatic fascia, is acquired from the external oblique aponeurosis as the cord passes between the crura of the superficial ring.

The constituents of the cord consist of:

• The vas deferens, which usually lies in the lower and posterior part of the cord.

• Arteries, the largest of which is the testicular artery (see below), with the artery to the vas (from the superior or inferior vesical), and the cremasteric artery to the coverings.

• Veins—the pampiniform plexus.

• Lymphatics, essentially those from the testis draining to para-aortic nodes, but including some from the coverings which drain to external iliac nodes.

• Nerves, in particular the genital branch of the genitofemoral nerve which supplies the cremaster muscle. Other nerves are sympathetic twigs which accompany the arteries.

• The processus vaginalis, the obliterated remains of the peritoneal connection with the tunica vaginalis of the testis. When patent it forms the sac of an indirect inguinal hernia.

Preperitoneal Space

The preperitoneal space contains adipose tissue, lymphatics, blood vessels, and nerves. The nerves of the preperitoneal space of specific concern to the surgeon include the lateral femoral cutaneous nerve and genitofemoral nerve. The lateral femoral cutaneous nerve originates as a root of L2 and L3 and is occasionally a direct branch of the femoral nerve. This nerve courses along the anterior surface of the iliac muscle beneath the iliac fascia and passes under or through the lateral attachment of the inguinal ligament at the anterior superior iliac spine. This nerve runs beneath or occasionally through the iliopubic tract, lateral to the internal inguinal ring.

The genitofemoral nerve usually arises from the L2 or L1-L2 nerve roots. It divides into genital and femoral branches on the anterior surface of the psoas muscle. The genital branch enters the inguinal canal through the deep ring, whereas the femoral branch enters the femoral sheath lateral to the artery. The inferior epigastric artery and vein are branches of the

external iliac vessels. These vessels course medial to the internal inguinal ring and eventually lie beneath the rectus abdominis muscle, immediately superficial to the transversalis fascia. The inferior epigastric vessels serve to define the types of inguinal hernia. Indirect inguinal hernias occur lateral

to the inferior epigastric vessels, whereas direct hernias occur medial to these vessels. The deep circumflex iliac artery and vein are located below the lateral portion of the iliopubic tract in the preperitoneal space. These vessels are branches of the inferior epigastric or external iliac artery and vein. It is important to dissect only above the iliopubic tract during a laparoscopic hernia repair to avoid injury to these vessels.

The vas deferens courses through the preperitoneal space from caudad to cephalad and medial to lateral to join the spermatic cord at the deep inguinal ring.

Defence mechanism of inguinal canal

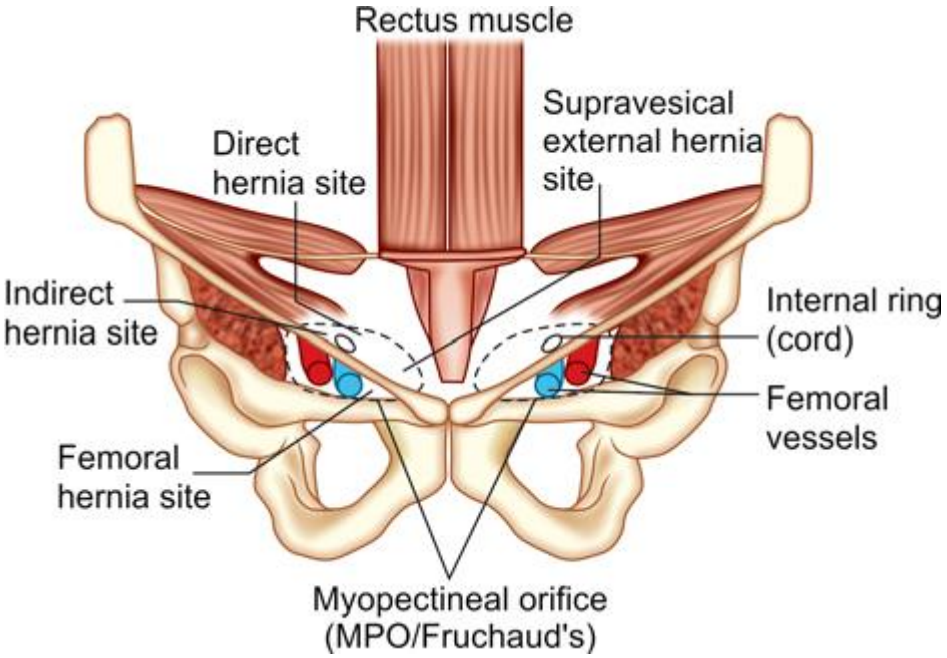
- Obliquity of inguinal canal
- Arching of conjoint tendon
- 'Shutter mechanism' of internal oblique muscle
- 'Ball valve mechanism' due to contraction of cremaster muscle which plugs to superficial ring
- When external oblique muscle contracts, intercrural fibres of superficial ring appose causing 'slit valve mechanism'
- Hormones

Fruchaud's Myopectineal Orifice

It is an osseo-myo-aponeurotic tunnel. It is through this tunnel all groin hernias occur.

It is bounded:

- Medially by lateral border of rectus sheath.
- Above by the arched fibres of internal oblique and transversus abdominis muscle.
- Laterally by the iliopsoas muscle.
- Below by the pectin pubis and fascia covering it



CLASSIFICATION OF INGUINAL HERNIA

Classification I - Anatomical Classification (in Inguinal Hernia)

Indirect hernia : It comes out through internal ring along with the cord. It is lateral to the inferior epigastric artery.

Direct hernia: It occurs through the posterior wall of the inguinal canal through 'Hesselbach's triangle' (bounded medially by lateral border of rectus muscle, laterally by inferior epigastric artery, below by inguinal ligament). Sac is medial to the inferior epigastric artery.

Classification II - According to the Extent

Incomplete:

Bubonocele: Here sac is confined to the inguinal canal.

Funicular: Here sac crosses the superfi cial inguinal ring, but does not reach the bottom of the scrotum.

Complete: Here sac descends to the bottom of the scrotum. Saddle-bag or pantaloon hernial sac has got both medial and lateral component

NYHUS CLASSIFICATION OF GROIN HERNIA

Type I - Indirect inguinal hernia: internal inguinal ring normal

Type II - Indirect inguinal hernia: internal inguinal ring dilated but posterior inguinal wall intact; inferior deep epigastric vessels not displaced

Type III - Posterior wall defect

A. Direct inguinal hernia

B. Indirect inguinal hernia: internal inguinal ring dilated, medially encroaching on or destroying the transversalis fascia of Hesselbach triangle (e.g., scrotal, sliding, or pantaloon hernia)

C. Femoral hernia

Type IV - Recurrent hernia

A. Direct

B. Indirect

C. Femoral

D. Combined

GILBERT CLASSIFICATION

Type I: Hernia has got snug internal ring through which a peritoneal sac Passes out as indirect sac.

Type II: Hernia has a moderately enlarged internal ring which admits one finger but lesser than two finger breadth. Once reduced it protrude during coughing or straining.

Type III: Hernia has got large internal ring with defect more than two finger breadth. Hernia descends into the scrotum or with sliding hernia. Once reduced it immediately protrudes out without any straining.

Type IV: It is direct hernia with large full blow out of the posterior wall of the inguinal canal. The internal ring is intact.

Type V: It is a direct hernia protruding out through punched out hole/defect in the transversalis fascia. The internal ring is intact.

Type VI: Pantaloon/double hernia.

Type VII: Femoral hernia.

Type VI and VII are Robbin's modifications

Precipitating causes for inguinal hernia

- Smoking
- Obesity
- Respiratory causes like bronchial asthma, tuberculosis, bronchitis, Ascites
- Previous surgery like appendicectomy which can cause direct inguinal hernia
- Chronic constipation due to anorectal strictures. Rectal stricture may be due to chronic proctitis (amoebic), tuberculosis of anorectum, previous anorectal surgery, rectal carcinoma or stricture
- Urinary problems like benign prostatic hyperplasia , urethral stricture
- Straining
- Multiple pregnancies

CLINICAL FEATURES

Swelling in the inguinal region either pyriform or spherical shaped , with cough impulse, reduces on lying down posture or by manual reduction

Skin over the swelling will be tense stretched & shiny in case of strangulated hernia. On deep ring occlusion test swelling does not appear on coughing

indicates its an indirect hernia, if the swelling appears it's a direct hernia. Three finger test , index finger kept over deep ring, middle finger on superficial ring & ring finger over femoral ring, When impulse is felt on the index finger the case is one of indirect hernia, when impulse is felt on the middle finger the case is one of direct hernia and when it is felt on the ring finger the case is one of femoral hernia. Finger invagination test index finger is inserted along the bottom of the scrotum to the inguinal canal if the impulse felt on the tip of the finger indicates indirect hernia , if impulse felt on pulp of the finger indicates direct hernia.

1.Reducible hernia.— Normally an uncomplicated hernia is reducible. That means its contents can be returned into the abdominal cavity, but the sac remains in its position.

2. Irreducible hernia.— In this hernia the contents cannot be returned to the abdomen, irreducibility can be due to (i) adhesion of its contents to each other, (ii) adhesion of its contents with the sac, (iii) adhesion of one part of the sac to the other part, (iv) sliding hernia and (v) very large scrotal hernia (scrotal abdomen).

irreducible, but it is extremely tender and tense and the overlying skin may be red. These

3. Obstructed or incarcerated hernia (irreducibility + Intestinal obstruction).— An obstructed hernia means the hernia is associated with intestinal obstruction due to occlusion of the lumen of the bowel.

4. Strangulated hernia (irreducibility + obstruction + arrest of blood supply to the contents).— strangulated hernia means when the contents are so constricted as to be interfered with their blood supply.

5. inflamed hernia - This hernia may occur when its content such as an appendix, a salpinx or a Meckel's diverticulum becomes inflamed.

6. Hernia-en-glissade or Sliding Hernia.— In this type of hernia a piece of extraperitoneal bowel, usually the caecum on the right side or the pelvic colon on the left side or the urinary bladder on either side slides down outside the hernial sac forming a part of its wall being covered by the peritoneum on the hernial aspect only

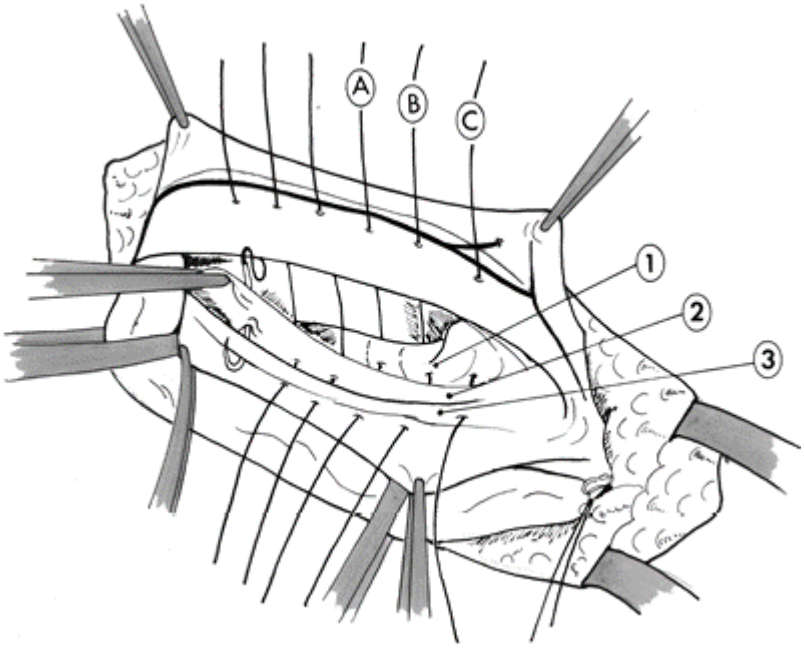
7. Maydl’s hernia (Hernia-en-W) or retrograde strangulation.— In this condition two loops of bowels remain in the sac and the connecting loop remains within the abdomen and becomes strangulated

Surgeries on inguinal hernia

The definitive and corrective surgery in the inguinal region seems to have begun by Marcy, a student of Joseph Lister, who apparently first recognized the importance of the transversalis fascia in reconstituting the internal ring closure. He used carbolized catgut with a two-suture technique in order to close the internal ring.

Eduardo Bassini, whose name is synonymous with the early repair of inguinal hernia, Bassini's contribution was to repair the transversalis fascia defect by reinforcing the canal's posterior wall using a three-layer technique. the internal oblique and transversus abdominus muscles and transversalis fascia into a conjoint triple layer that he sutured to the shelving edge of Poupart's ligament with interrupted silk sutures.

The sutures must not allow a too large or deep inguinal ring so as to avoid the risk of recurrence; on the other hand, it must not be too tight to avoid circulatory trouble caused by the pressure on the spermatic vessels. The spermatic cord is laid on this new wall, and the superficial plane is reconstructed using the external oblique aponeurosis.



Anterior repairs are the most common operative approach for inguinal hernias. Tension-free repairs are now standard, and there are a variety of different types. Older tissue types of repair are rarely indicated, except for patients with simultaneous contamination or concomitant bowel resection, when placement of a mesh prosthesis may be contraindicated.

There are some technical aspects of the operation common to all anterior repairs. Open hernia repair is begun by making a transversely oriented linear or slightly curvilinear incision above the inguinal ligament and a fingerbreadth below the internal inguinal ring. The internal inguinal ring is located topographically at the midpoint between the anterior superior iliac spine and ipsilateral pubic tubercle. Dissection is continued through the subcutaneous tissues and Scarpa fascia. The external oblique fascia

and external inguinal ring are identified. The external oblique fascia is incised through the superficial inguinal ring to expose the inguinal canal. The genital branch of the genitofemoral nerve and the ilioinguinal and iliohypogastric nerves are identified and avoided or mobilized to prevent transection and entrapment. The spermatic cord is mobilized at the pubic tubercle by a combination of blunt and sharp dissection. Improper mobilization of the spermatic cord too lateral to the pubic tubercle can cause confusion in the identification of tissue planes and essential structures and may result in injury to the spermatic cord structures or disruption of the floor of the inguinal canal.

The cremaster muscle of the mobilized spermatic cord is separated parallel to its fibers from the underlying cord structures. The cremaster artery and vein, which join the cremaster muscle near the inguinal ring, can usually be avoided but may need to be cauterized or ligated and divided. When an indirect hernia is present, the hernia sac is located deep to the cremaster muscle and anterior and superior to the spermatic cord structures. Incising the cremaster muscle in a longitudinal direction and dividing it circumferentially near the internal inguinal ring help expose the indirect hernia sac. The hernia sac is carefully separated from adjacent cord structures and dissected to the level of the internal inguinal ring. The sac is

opened and examined for visceral contents if it is large; however, this step is unnecessary in small hernias. The sac can be mobilized and placed within the preperitoneal space, or the neck of the sac can be ligated at the level of the internal ring and any excess sac excised. If a large hernia sac is present, it can be divided with use of electrocautery to facilitate ligation. It is not necessary to excise the distal portion of the sac.

If the sac is broad based, it may be easier to displace it into the peritoneal cavity rather than to ligate it. Direct hernia sacs protrude through the floor of the inguinal canal and can be reduced below the transversalis fascia before repair. A "lipoma" of the cord actually represents retroperitoneal fat that has herniated through the deep inguinal ring; this should be suture ligated and removed. A sliding hernia presents a special challenge in handling the hernia sac. With a sliding hernia, a portion of the sac is composed of visceral peritoneum covering part of a retroperitoneal organ, usually the colon or bladder. In this situation, the grossly redundant portion of the sac (if present) is excised and the peritoneum reclosed. The organ and sac then can be reduced below the transversalis fascia, similar to the procedure for a direct hernia.

Tissue repairs - although tissue repairs have largely been abandoned because of unacceptably high recurrence rates, they remain useful in certain

situations. In strangulated hernias, for which bowel resection is necessary, mesh prostheses are contraindicated and a tissue repair is necessary. Available options for tissue repair include iliopubic tract, Shouldice, Bassini, and McVay repairs. The iliopubic tract repair approximates the transversus abdominis aponeurotic arch to the iliopubic tract with the use of interrupted sutures. The repair begins at the pubic tubercle and extends laterally past the internal inguinal ring. This repair

was initially described using a relaxing incision; however, many surgeons who use this repair do not perform a relaxing incision.

The Shouldice repair emphasizes a multilayer imbricated repair of the posterior wall of the inguinal canal with a continuous running suture technique. After completion of the dissection, the posterior wall of the inguinal canal is reconstructed by superimposing running suture lines progressing from deep to more superficial layers. The initial suture line secures the transversus abdominis aponeurotic arch to the iliopubic tract. Next, the internal oblique and transversus abdominis muscles and aponeuroses are sutured to the inguinal ligament. The Shouldice repair is associated with a very low recurrence rate and a high degree of patient satisfaction in highly selected patients. The Bassini repair is performed by

suturing the transversus abdominis and internal oblique musculo - aponeurotic arches or conjoined tendon to the inguinal ligament. This

once popular technique is the basic approach to nonanatomic hernia repairs and was the most popular type of repair done before the advent of tension-free repairs. Cooper ligament repair, also known as the McVay repair, has traditionally been popular for the correction of direct inguinal

hernias, large indirect hernias, recurrent hernias, and femoral hernias. Interrupted nonabsorbable sutures are used to approximate the edge of the transversus abdominis aponeurosis to Cooper ligament. When the medial aspect of the femoral canal is reached, a transition suture is placed to incorporate Cooper ligament and the iliopubic tract. Lateral to this transition stitch, the transversus abdominis aponeurosis is secured to the iliopubic tract. An important principle of this repair is the need for a relaxing incision. This incision is made by reflecting the external oblique aponeurosis cephalad and medial to expose the anterior rectus sheath. An incision is then made in a curvilinear direction, beginning 1 cm above the pubic tubercle throughout the extent of the anterior sheath to near its lateral border. This relieves tension on the suture line and results in decreased postoperative pain and hernia recurrence. The fascial defect is covered by the body of the rectus muscle, which prevents herniation at the relaxing incision site. The

McVay repair is particularly suited for strangulated femoral hernias because it provides obliteration of the femoral space without the use of mesh. Advantages of a McVay Repair The Cooper ligament repair restores normal anatomic planes and provides the best anchor for a strong posterior wall reconstruction. It closes the femoral canal and displays the femoral vessels to protect them from injury. It is the only anterior repair that closes the complete myopectineal orifice. It can repair all of the hernias that occur in the groin.

Tension-free anterior inguinal hernia repair:- The tension-free repair has become the dominant method of inguinal hernia repair. Recognizing that tension in a repair is the principal cause of recurrence, current practices in hernia management use a synthetic mesh prosthesis to bridge the defect, a concept popularized by Lichtenstein. There are several options for placement of mesh during anterior inguinal herniorrhaphy, including the Lichtenstein approach, plug and patch technique, and sandwich technique, with both an anterior and preperitoneal piece of mesh. In the Lichtenstein repair, a piece of prosthetic nonabsorbable mesh is fashioned to fit the canal. A slit is cut into the distal lateral edge of the mesh to accommodate the spermatic cord. There are various preformed, commercially available prostheses available for use. Monofilament nonabsorbable suture is used to

secure the mesh, beginning at the pubic tubercle and running a length of suture in both directions toward the superior aspect above the internal inguinal ring to the level of the tails of the mesh. The mesh is sutured to the aponeurotic tissue overlying the pubic tubercle medially, continuing superiorly along the transversus

abdominis or conjoined tendon. The inferolateral edge of the mesh is sutured to the iliopubic tract or shelving edge of the inguinal ligament to a point lateral to the internal inguinal ring. At this point, the tails created by the slit are sutured together around the spermatic cord, snugly forming a new internal inguinal ring. It is important to protect the ilioinguinal nerve and genital branch of the genitofemoral nerve from entrapment by placing them with the cord structures as they are passed through this newly fashioned internal inguinal ring or avoiding their enclosure in the repair.

Adapting the principles of tension-free repair, Gilbert has reported using a cone-shaped plug of polypropylene mesh that when inserted into the internal inguinal ring would deploy like an upside-down umbrella and occlude the hernia. This plug is sewn to the surrounding tissues and held in place by an additional overlying mesh patch. This patch may not need to be secured by sutures; however, to do so requires dissection to create a sufficient space between the external and internal oblique muscles for the patch to lie flat

over the inguinal canal. This so-called plug and patch repair, an extension of Lichtenstein's original mesh repair, has now become the most commonly performed primary anterior inguinal hernia repair. Plug and patch is several monofilament nonabsorbable sutures,

especially for very weak inguinal floors or large defects.

The sandwich technique involves a bilayered device, with three polypropylene components. An underlay patch provides a posterior repair similar to that of the laparoscopic approach, a connector functions similar to a plug, and an onlay patch covers the posterior inguinal floor. The use of interrupted fixating sutures place three or four fixation sutures in this repair. Another option for a tension-free mesh repair involves a preperitoneal approach using a self-expanding polypropylene patch. A pocket is created in the preperitoneal space by blunt dissection, and then a preformed mesh patch is inserted into the hernia defect, which expands to cover the direct, indirect, and femoral spaces. The patch lies parallel to the inguinal ligament. It can remain without suture fixation, or a tacking suture can be placed. The Stoppa-Rives repair uses a subumbilical midline incision to place a large mesh prosthesis into the preperitoneal space. Blunt dissection is used to create an extraperitoneal space that extends into the prevesical space, beyond the obturator foramen, and posterolateral to the pelvic brim. This

technique has the advantage of distributing the natural intra-abdominal pressure across a broad area to retain the mesh in a proper location. The Stoppa-Rives technique is particularly useful for large, recurrent, or bilateral hernias.

Preperitoneal repair :- The open preperitoneal approach is useful for the repair of recurrent inguinal hernias, sliding hernias, femoral hernias, and some strangulated hernias. A transverse skin incision is made 2 cm above the internal inguinal ring and is directed to the medial border of the rectus sheath. The muscles of the anterior abdominal wall are incised transversely, and the preperitoneal space is identified. If further exposure is needed, the anterior rectus sheath can be incised and the rectus muscle retracted medially. The preperitoneal tissues are retracted cephalad to visualize the posterior inguinal wall and the site of herniation.

The inferior epigastric artery and veins are generally beneath the midportion of the posterior rectus sheath and usually do not need to be divided. This approach avoids mobilization of the spermatic cord and injury to the sensory nerves of the inguinal canal, which is particularly important for hernias previously repaired through an anterior approach. If the peritoneum is incised, it is sutured closed to avoid the evisceration of intraperitoneal contents into the operative field. The transversalis fascia and transversus

abdominis aponeurosis are identified and sutured to the iliopubic tract with permanent sutures. Femoral hernias repaired by this approach require closure of the femoral canal by securing the repair to Cooper ligament. A mesh prosthesis is frequently used to obliterate the defect in the femoral canal, particularly with large hernias.

COMPLICATIONS OF HERNIA SURGERY

1) CHRONIC GROIN PAIN :- With the recurrence rate after different varieties of prosthetic hernia repair dramatically decreasing at this point in time, chronic post - herniorrhaphy inguinodynia is the focus of attention of hernia surgery. Within the inguinal canal, the iliohypogastric and ilioinguinal nerves are both invested by the investing fascia of the internal oblique muscle and the genital nerve is covered by the deep cremasteric fascia. When the mesh is placed in front of the transversalis fascia, such as the Lichtenstein tension-free hernioplasty, chronic inguinodynia due perineural fibrosis can be avoided by not disrupting their investing fascia and removing them from their natural bed, and by not removing the cremasteric muscle. Chronic inguinodynia resulting from entrapment of the nerves by sutures and staples, and neuroma formation from accidental division of the nerves, can be avoided by identifying the nerves and protecting them throughout the operation. Exercising the aforementioned

care during open hernia repairs reduces the postherniorrhaphy chronic inguinodynia to less than 1%. Placement of mesh in the preperitoneal space via open or laparoscopic repair can endanger the nerves both in front and behind the transversalis in the properitoneal space. In front of the transversalis fascia, the nerves are at risk of entrapment by staples or tacks. The iliohypogastric nerve is at risk along its entire course in the groin, including its intramuscular segment. The genital nerve is at risk medial to the internal ring and the inguinal nerve is at risk lateral to the internal ring, behind the transversalis fascia, in the preperitoneal space, the main trunk of the genitofemoral nerve, the femoral branch of the genitofemoral nerve, the properitoneal segment of the genital branch of the genitofemoral nerve and the paravasal nerves (located within the lamina propria of the vas deferens) are at risk of perineural fibrosis because of direct contact with the mesh or entrapment by slightest wrinkling of the mesh. This is because, in the preperitoneal space, the above-mentioned nerves are not covered by an investing fascia that can protect them from direct contact with the mesh. The recommended surgical treatment for chronic postherniorrhaphy inguinodynia is triple neurectomy (resection of the ilioinguinal, iliohypogastric, and genital nerves), including the intramuscular portion of the iliohypogastric nerve with cut-end ligation and proximal end

implantation of the nerves within the internal oblique muscle in order to keep the nerve stumps away from future scarring of the surgical field.

2) Seroma / hematoma formation :- It is a common complication after hernia surgery, the incidence being in the range of 5-25%. They are specially seen after large indirect hernia repair. Most resolve spontaneously over 4-6 weeks. A seroma can be avoided by minimizing dissection of the hernial sac from the cord structures, fixing the direct sac to pubic bone and fenestrating the transversalis fascia in a direct hernia. Drain can be put if there is excessive bleeding or after extensive dissection.

3) **Urinary retention** : This complication after hernia repair has a reported incidence of 1.3 to 5.8%. It is usually precipitated in elderly patients, especially if symptoms of prostatism are present. These patients are best catheterized prior to surgery and catheter removed the next day morning.

4) **Testicular pain and swelling** : It occurs due to excessive dissection of a sac from the cord structures, especially a complete sac. Incidence is of 0.9 to 1.5%. Most are transient. Orchitis was found in a small number of patients, but did not lead to testicular atrophy.

5) **Mesh infection and wound infection** : Wound infection rates are very low. Mesh infection is a very serious complication and care must be taken

to maintain strict aseptic precautions during the entire procedure. Any endogenous infection must be treated with an adequate course of antibiotics prior to surgery.

6) Recurrence : It is the most important endpoint of any hernia surgery. It requires a proper and thorough knowledge of anatomy and a thorough technique of repair to help keep the recurrence in endoscopic repair to a minimum.

Types and properties of mesh's :

The use of hernia mesh products to surgically repair or reconstruct anatomical defects has been widely adopted. The surgical mesh firmly reinforces the weakened area and provides tension-free repair that facilitates the incorporation of fibrocollagenous tissue. However, there are many types of meshes and there is a strong controversy regarding optimum performance and success of surgical procedures. Researchers have investigated metals, composites, polymers and biodegradable biomaterials in their quest to attain the ideal surgical mesh and implantation procedure. The sought-after characteristics are inertness, resistance to infection, the ability to maintain adequate long-term tensile strength to prevent early recurrence, rapid incorporation into the host tissue, adequate flexibility to avoid fragmentation, non-carcinogenic response and the capability to maintain or restore the natural respiratory movements of the abdominal wall.

Currently, utilized surgical meshes exhibit many but not all of the desired characteristics. Therefore, current research efforts focus on providing potential solutions that range from the utilization of novel materials to new designs that could ameliorate existent shortcomings.

The use of a prosthetic mesh is the preferred way to repair hernias. It should be emphasized that in the past, the success of repair was evaluated based on the strength and permanency of the mesh itself, not on the degree of scar tissue or other factors, which subsequently develop in and around the mesh. The biocompatibility of the material has proven to be a strong contributor in the rejection of the prosthesis due to scar tissue developed by the immunological system. When a surgical mesh is implanted and lacks appropriate biocompatibility (either due to the material that it is made of or its structural design) the body responds by encapsulating the foreign system leading to the formation of a stiff scar which consequently results in poor tissue incorporation, causing hernia recurrence or infection of the mesh. A large percentage of meshes then have to be removed: approximately 69% of the explanted meshes are due to prosthesis infection.

Although the only treatment is surgery, there are new surgical procedures that ameliorate postoperative side effects such as the laparoscopic approach. Open surgery repair is performed by making an incision in the abdomen to identify and dissect the hernia sac through the subcutaneous tissues and fascia. Once the hernia sac is dissected away from any adjacent structures and examined for contents (intestine or any other tissues), these are inserted back into the peritoneal space, and hernia repair is carried out. Repair can

be executed in two ways: (1) primary repair and (2) patch or mesh. The first involves sewing the tissue of the abdominal wall using sutures, while the second technique relies in the placement of a mesh to cover the hernia defect and reinforce surrounding tissue, fixing it with fibrin glue, staples or sutures. In the case of a laparoscopic procedure, the surgeon starts by making several small incisions in the abdominal wall surrounding the hernia sac, in order to introduce surgical instruments and a laparoscope. In one of the incisions, carbon dioxide gas is introduced into the abdomen. The mesh or patch is then introduced, unrolled and fixed with staples or tacks. The procedure then continues with the release of the gas from the abdomen and closure of cutaneous incisions with sutures.

Most surgical meshes used currently are chemically and physically inert, nontoxic, stable and non-immunogenic. However, none of them are biologically inert, a property related to the mesh physiology and its role into the hernia repair process. Implantation of any prosthetic material is quickly followed by an extraordinarily complex series of events that mark the initiation of the healing process. As for the physiology of abdominal mesh implantation, perhaps the greatest concern, and hence the area that most research focuses on, is inflammation and wound healing. The passive substrate of the biomaterials in conjunction with devitalized tissues can

actively contribute to bacterial growth, resulting in infection, which delays the wound healing process. The introduction of a foreign material into the body triggers a healing response characterized by one of three stereotypical reactions: (1) destruction or lysis, (2) inclusion or tolerance, and (3) rejection or removal. When an implant is introduced into the body, the immune system recognizes it as a foreign material and therefore attempts to destroy it; immunosuppressive drugs must be administered to prevent the body from attacking it . The rejection of an implant is primarily driven by the immune response of the T lymphocytes (T cells). The T cells are stimulated by the presence of an antigenic determinant on the foreign material. T cells are reproduced faster than the time required for immunosuppressants to interfere with its proliferation, therefore resulting in rejection of the implant given the large number of T cells attacking the foreign material. Inflammation is the reaction of vascularized living tissue to injury and is the primary biological reaction to implanted medical devices. In the case of implanted meshes, the inflammatory response is presented in four stages that are related both temporally and hierarchically. Immediately after implantation, prosthetics adsorb proteins, which create a coagulum around it. Coagulums are composed of albumin, fibrinogen, plasminogen, complement factors and immunoglobulins. Platelets adhere to

the proteins releasing a host of chemo attractants that invite other cells such as polymorphonucleocytes (PMNs), fibroblasts, smooth muscle cells and macrophages to the area in a different sequence. The chemotaxis process is defined as the movement of cells towards a preferred migration site triggered by a chemical stimulus [33]. The attraction of PMNs, also known as neutrophils, to the wound site is attributed to chemotaxis, and is observed as the first stage of biological response to the injured site. During the first stage or acute phase of inflammation, neutrophils phagocytoze microorganisms. The neutrophil may also degenerate and die during this process, releasing its cytoplasmic and granular components near or over the surface of the prosthesis, which may also mediate the subsequent inflammatory response

When the acute inflammatory response is unable to eliminate the injurious agent or restore injured tissue to its normal physiological state, the condition could progress into a state of chronic inflammation, known as second stage of inflammation. In this stage, monocytes that have migrated to the wound site during the acute inflammatory response rapidly differentiate into macrophages. In addition to macrophages, other primary cellular components such as plasma cells and lymphocytes actively contribute to the inflammatory process. Macrophages increasingly populate the area to

consume foreign bodies as well as dead organisms and tissue. In most of the cases where chronic inflammation is related to a medical device or biomaterial, the inflammation process will lead to an immune response or foreign body reaction, corresponding to the third stage of inflammation, where chronic inflammation macrophages fuse into a foreign body giant cell as a response to the presence of large foreign bodies. Foreign body reaction is a complex defense reaction involving: foreign body giant cells, macrophages, fibroblast, and capillaries in varying amounts depending upon the form and topography of the implanted material. The fourth stage of inflammation occurs in the wound healing phase and is characterized by the replacement of damaged tissue with various cells that specialize in secreting extracellular matrix materials to form a scar. Wound healing and scar formation follow the initiation of inflammation, but their progression and the magnitude of scarring can be affected by the degree of persistent inflammatory activity as well as the severity of the primary injury. Fibroblasts are cells that mediate the wound healing phase. These cells enter the wound site two to five days after the injury occurs, typically once the inflammatory phase has ended. Fibroblasts proliferate at the wound site, reaching peak levels after one to two weeks. The main function of fibroblasts is to synthesize extracellular matrix and collagen to maintain the

structural integrity of connective tissues; at the end of the first week, these are the only cells in charge of collagen deposition. Cells involved in the regulation of inflammation, angiogenesis (formation of new blood vessels from preexisting vasculature) and further connective tissue reconstruction attach to, proliferate, and differentiate on the collagen matrix laid down by fibroblasts.

From a histological standpoint, the interaction between prosthesis and organism is characterized by three main aspects: size of tissue reaction; cell density; and fibroblastic activity. Fibroblastic activity peaks one to two weeks post-wounding, usually on the 8th day for the intraperitoneal plane and on the 10th day for the extraperitoneal plane. The optimum quantity of fibroblasts needed for a successful integration of the mesh is achieved approximately two weeks after wounding. Further accumulation of fibroblasts will cause an inflammatory phase with increased fibrosis and faster prosthesis integration associated with paresthesia and pain. Furthermore, the inflammatory process could cause contraction and shrinkage of the mesh, resulting in adhesions and fistulas, leading to prosthesis rejection and eventually explantation.

These wound repair process creates a mesh integration due to the conformational changes of the proteins. This integration is progressive,

starting from the prosthesis implantation that is accompanied by the foreign body reaction followed by the inclusion of the prosthesis, which occurs within the first two weeks. The process is finalized as the overall strength increases gradually, which last about 12 weeks and results in a relatively less elastic tissue that has only 70–80% of the strength of the native connective tissue. Although integration and collagen deposition that result from the inflammatory response provide long-term strength, as pointed out, an aggressive integration could also be harmful to the tissue that surrounds the wound site causing a severe body reaction, inflammation, fibrosis, infection, and mesh rejection. The fibrotic reaction generated by the body when a prosthetic material is introduced, such as in the case of surgical meshes for a hernia repair, is governed by the chemical nature of the material implanted and its physical characteristics. The integration and overall healing process of implantable surgical meshes is highly dependent upon the intrinsic mesh characteristics such as, the primary material, filament structure, tailored coatings, and pore size. Research in abdominal wall repair has provided valuable information on the parameters, properties, and design of the meshes that influence the immune reaction of the body to the prosthesis as well as the optimal parameters to reduce fibrosis.

1. *Elasticity and Tensile Strength:* A deterioration of the tensile strength of the mesh or a strained mesh could potentially lead to hernia recurrence or a poor functional result. Hence, materials employed in surgical meshes must possess the minimum mechanical properties necessary to withstand the stresses placed on the abdominal wall. The maximum intra-abdominal pressure generated in a healthy adult occurs when coughing or jumping and is estimated to be approximately 170mmHg. The mesh used to repair abdominal hernias must withstand at least 180 mmHg (20 kPa) before failing. The tension placed on the abdominal wall can be calculated using Laplace's law relating the tension,

pressure, thickness, and diameter of the abdominal wall. According to the thin-walled cylinder model, the total tensile strength is independent of the thickness of the layer. Hence, a physiological tensile strength of 16 N/cm is defined, using a pressure of 20 kPa (2 N/cm2 as the maximum pressure to be experienced in the intra-abdominal wall), and 32 cm as the longitudinal diameter of the abdominal wall.

2. *Pore Size* : Porosity plays a key role in the reaction of the tissue to the prostheses. Bacterial growth and cell proliferation are highly dependent upon porosity and pore size. Bacterial colonies are established principally in the spaces between pores and fibers. Macroporous meshes that have large

pores have shown to facilitate entry of macrophages, fibroblasts and collagen fibers that will constitute the new connective tissue, integrate the prosthesis to the organism and prevent colonization of bacteria. Large pores have shown easy infiltration of immunocompetent cells, providing protection from infection. Microporous meshes, with pores of <10 μm, have shown a higher rejection rate given that scar tissue rapidly bridges small pores resulting in minimum integration, these meshes are associated with chronic inflammation. Although it would be helpful to classify pore size in a standard form, currently, there is not a formal classification. Earl and Mark proposed the following: very large pore: >2000 μm; large pore: 1000–2000 μm; medium pore: 600–1000 μm; small pore: 100–600 μm and microporous (solid) <100 μm

3. *Weight (Density)* : Prostheses can be classified as: heavy-weight (HW), when they are above 80 g/m2; mediumweight (MW), between 50 and 80 g/m2; light-weight (LW), between 35 and 50 g/m2; and ultra-lightweight,

below 35 g/m2. While a heavy-weight mesh is produced with heavy materials, small pore size and high tensile strength, a light-weight is composed of thin filaments with large pores, generally larger than 1 mm. Light-weight meshes contain less material less pronounced foreign body

reaction is to be expected. A decreased inflammatory response results in better tissue incorporation.

4. *Constitution* : Surgical meshes could be fabricated using monofilament or multifilament (twisted) systems. A surgical mesh formed of monofilament yarns provides satisfactory reinforcement ability, but with stiffness and limited pliability. In contrast, a surgical mesh formed of multifilament yarns is soft and pliable. However, multifilament yarns meshes tend to harbor infectious matter such as bacteria, increasing erosion rates by 20–30%. Particularly, the small void areas or interstitial spaces between the multifilament yarns may promote the replication and breeding of such bacteria, which measures approximately 10 μm.

5. *Material Absorption* : Surgical meshes could be made from an absorbable or non-absorbable material. Non-absorbable meshes can with stand the mechanical requirements, are easy to shape intraoperative and have long-term stability. However, complications such as mesh stiffness over time, hernia recurrence, mesh erosion, and adhesions have been documented. On the other hand, absorbable meshes were developed to reduce these long-term complications. These meshes favour postoperative fibroblast activity. Nevertheless, after prosthesis absorption, the resulting scar tissue is not as

strong as it was, and alone is insufficient to provide the needed strength and could result in hernia recurrence.

6. *Commercially Available Surgical Meshes* : The ideal mesh should be able to be held in situ by peripheral sutures, resist the possibility of loading under biaxial tension (coughing or lifting actions) without failure especially during the early postoperative period, and should promote a fast and organized response from fibrous tissue with minimal inflammation. Given the difficulty to find a single surgical mesh that fulfills all of the "ideal" characteristics, there are more than 70 meshes for hernia repair available in the market. These are classified according to the composition or type of material as: (1) first generation (synthetic non-absorbable prosthesis), (2) second generation (mixed or composite prosthesis), and (3) third generation (biological prosthesis).

A) *First Generation Meshes* : First generation surgical meshes are predominantly based on polypropylene (PP) systems. In 1958, the first polypropylene mesh was used to repair an abdominal wall; it was a heavyweight mesh with small pores. Due to intense fibrotic reactions, the search for an "ideal" mesh continued. In 1998, a lightweight first generation mesh was introduced: this system had larger pores and smaller surface area. First generation meshes are mostly classified into three categories: (1)

macroporous meshes, (2) microporous meshes, and (3) macroporous meshes with multifilament or microporous components. Macroporous prostheses are characterized by a pore size larger than 75µm. Polypropylene has been thematerial of choice. Microporous meshes have smaller pores, commonly less than 10 µm and commonly made from expanded polytetrafluoroethylene (e-PTFE). Macroporous meshes with multifilament or microporous components contain plaited multifilamentary threads in their composition, the space between the threads is less than 10 µm and their pores are larger than 75 µm. they are available in various forms like plaited polyester (PL), meshes and; plaited polypropylene, and perforated polytetrafluoroethylene (PTFE).

b)*Second Generation Meshes* : Despite the improvements made within the first generation meshes, which include high tensile strength in order to support intra-abdominal pressure, several complications such as hernia recurrence, infection, and adhesions still prevailed. Therefore, second generation meshes were developed combining more than one synthetic material into their composition. Nearly all of these kinds of meshes continued to use PP, PL or e-PTFE but now in combination with each other and/or with other materials such as titanium (Ti), omega 3, poliglecaprone 25 (PGC-25) and polyvinylidene fluoride (PVDF) as composite systems.

The main advantage of these composite meshes relied in the fact that these could be employed in intraperitoneal spaces causing minimal adhesion formation to neighboring surfaces given that each side of the mesh is tailored to specific needs. These meshes therefore require a specific orientation during implantation; the visceral side has a microporous surface to prevent visceral adhesion, whereas the non-visceral side is often macroporous to allow parietal tissue ingrowth. there are two categories of composite meshes: absorbable and permanent (non-absorbable). Absorbable composite meshes require hydration prior to usage, are not amenable to modification, mitigate viscera-mesh related complications, and can aid in tissue ingrowth. Parietex is the first composite mesh to offer a resorbable collagen barrier on one side to limit visceral attachments combined with a three- dimensional polyester knit structure on the other side, to promote tissue ingrowth. Permanent composite meshes can be modified to fit specific applications and present less visceral adhesions and complications, taking advantage of the properties of both macro and micro porous meshes.

C). Third Generation Meshes

Even with the improvements made on the second generation meshes where composite systems were designed to maintain the mechanical stability of

first generation meshes and reduce inflammation and nfection risk by mesh surface modification, the problems encountered with second generation meshes, such as the prevalence of adhesions, led to the development of biologic prostheses. Biologic mesh materials are based on collagen scaffolds derived from donor sources and they represent the so-called third generation meshes. Dermis from human, porcine, and fetal bovine sources are decellularized to leave only the highly organized collagen sources in addition to the dermal products included in porcine small intestine submucosa and bovine pericardium. The concept of these surgical meshes is that they provide a matrix for native cells to populate and generate connective tissue that could replace the tissue in the hernia defect. Third generation surgical meshes serve as biological scaffolds for repopulation and revascularization of host cells, showing a superior biocompatibility than first and second generations. These meshes do not trigger an inflammatory response from the body, though their high cost has hampered their wide acceptance.

7. *Manufacturing Processes for Surgical Meshes* : Surgical meshes are produced from different synthetic materials and in different mesh structures, the knitted structure being the most common. Surgical filaments are mainly manufactured by extrusion processes and then knitted accordingly. These

meshes are typically manufactured from PL, PP, PTFE, e-PTFE, PVDF and composite materials (e-PTFE/PP). The knitting pattern can be significantly altered resulting in a broad range of properties. Thickness, pore size, tensile strength, flexural rigidity, and surface texture are highly dependent upon the knitting pattern; the resultant interplay among these characteristics imparts different performance]. These characteristics, besides altering the biocompatibility of the mesh given its affinity to cells, also dictate the mechanical properties of the mesh such as rigidity and deformation. Knitted meshes are a subset of the non-woven mesh configuration. However, there is much more order and consistency with pore size using a knitted design. Knitting, by definition, is the construction of a fabric or cloth from the interlocking of threads through the formation of loops. Recent studies have been focused on treating the surgical mesh as a high-tech textile rather than as a prosthesis.

a) The Extrusion Process

Melt extrusion is the least expensive and simplest form of fiber extrusion. This process consists of melting the polymer pellets through a combination of applied heat and friction. The molten polymer is then forced under high pressure through a small orifice or a “shower head” spinneret. The molten polymer flows out of the spinneret and freezes into a solid fiber, which is

then typically reheated and drawn numerous times to further align the molecules and hence strengthen the fiber. Most of the surgical meshes are made from filaments initially developed to be used for surgical sutures. Surgical sutures are made from polymers like PP, PL, e-PTFE or PVDF monofilaments and have been successfully used. Filaments used for surgical sutures have to possess several characteristics such as :

1. Ability to attach to needles by the usual procedure.

2. Capability to be sterilized using ethylene oxide or ultraviolet radiation.

3. Ability to pass easily through tissue.

4. Ability to resist breakdown without developing an infection.

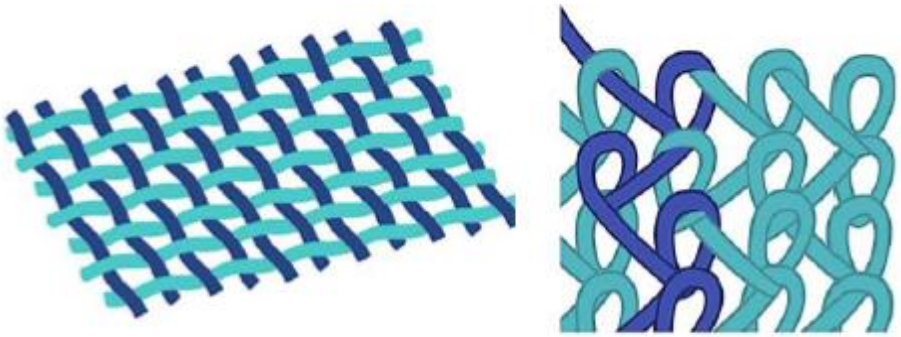
5. Possess minimal reaction with tissue.

6. Maintain its in vivo tensile strength over extended periods

The monofilaments used for surgical meshes have diameters in the range of 100–300 microns. Multifilaments have also gained attention and have been used to fabricate surgical meshes. Lubricants are commonly applied to these filaments before the yarns are knitted. Suitable lubricants can be either hydrophobic lubricants or hydrophilic lubricants such as polyalky Glycol.

b) The Knitting Process

During the knitting process, fibers or yarns are curved to follow a meandering path and not oriented unilaterally as in weaving; therefore, the resulting fabric tends to be much more flexible and elastic than woven fabrics. The basic structure of a knitted fabric consists of courses and wales. Courses are rows running across the width of the fabric, while wales are columns running across the length of the fabric. When the wales are perpendicular to the course of the fiber/yarn, this is called weft knitting. When the courses and wales are approximately parallel to the direction of the fiber/yarn,the process is known as warp knitting



(a) (b)

Warp knits and weft knits have been generated for use as implantable meshes to repair specific tissue sites and organs, such as those needed in hernia repair. Because of the looped stitches, the knitted structure is soft, flexible, and stretchable. It easily adapts to the movement of the human body, and has high elasticity, tensile strength, bursting strength and excellent porosity, which are key requirements for any implantable device

that needs to mimic the biomechanical characteristics of the abdominal wall: tension of 16 N/cm with a 38% elasticity. Given the interweaving, warp-knitted materials have a fixed structure that neither loosens nor peels off during cutting, regardless of the direction.

The most commonly used systems in the knitting manufacturing process are the Tricot and Raschel knitting machines , which are used to create warp or weft knitting structures. Warp knitted meshes are the most popular system used to repair hernia defects, and are manufactured using the Raschel machine with a basic configuration consisting of two bars where latch-type needlesare collectively mounted (running the full knitting width of the machine) and guide bars to hold yarn beams individually. The needle bars follow up and down movements, while the guide bars move back and forth across the needles of each bar to form continuous loops. The warp knit fabric design and lapping sequence is controlled by the shagging or traverse motion of the guide bars. In principle, the Tricot knitting machine is very similar to the Raschel knitting; the only difference is the use of spring beard or compound needles instead of the latch needles used in the Raschel knitting machine. In addition, Tricot sinkers not only performed the function of holding down the loops whilst the needles rise as Raschel sinkers, but also support the fabric loops. The small angle of fabric take-away and the

type of knitting action in Tricots creates a gentle and lower tension on the knitted fabric, ideal for high-speed production of fine gauge. A double Raschel warp knitting machine (DR 16 EEC/EAC) has 16 guide bars and enables the production of textiles with different yarn materials and counts. The machine is equipped with two different gauges, E18 and E30. This system allows the design of a mesh configuration that could be adjusted to match given design parameters such as size, shape, Young modulus, and porosity. The ultimate mechanical properties of the meshes are determined by the intrinsic properties of the filaments and the final configuration of the knitted fabrics.

Glue

The healing process is a sophisticated mechanism that depends on some factors and they all must be in harmony so the process can develop properly and without complications. It is divided didactically in three phases but they are overlapped and progress continuosly, each one of them being critical to the wound healing success. Cyanoacrylates were discovered in 1949 by Ardis and, about ten years later, they had their use documented in surgical procedures. They are liquid monomers that when come in contact with liquids or basic substances become strong glue that is similar to traditional methods of suture when in touch with skin. During its development, it was

observed that despite the strong sealing process, they produced an intense and long-lasting inflammatory reaction. By increasig the size of the chain molecule, these reactions reduced and increased the glue effectiveness. In tissue healing process, particularly in inflammatory stage, a suture should cause a minimal inflammatory reaction and limited local duration. Nonabsorbable sutures may remain longer in the surgical site causing chronic inflammation and higher chances of infecitions. Wound closure techniques researches substantially evolved in the last few years, leading to several studies involving synthetic and absorbable sutures, use of staplers, tapes and

others methods. The appearance of surgical glue fits in new methods of wound closure and they have been studied for about four decades. Surgical glue, besides being an alternative to conventional sutures, have some advantages like technical easiness, decreases surgical time and, since it is not necessary the introduction of a strange substance in the

body, decreases wound recovery time.

They have unique properties including bacteriostatic effect, haemostatic, it`s biodegradable and biocompatible, except for methylcyanoacrylate. They are easily manipulated but show some drawbacks such as lower resistance

in high tension areas when compared with conventional sutures and toxicity in some patients, one of the most relevant advantages is the surgical time reduction and the easy handling compared to others methods of synthesis. n-butylcyanoacrylate show that when this glue is used properlyresults were similar like that of the conventional sutures, with similar rates of infection and dehiscense. n-butylcyanoacrylate is a glue which creates a layer over the wound keeping the edges together allowing the healing process. It can be used to replace sutures with 5-0 strands or smaller in incisional wounds or lacerations, besides being waterproof.

William D. Spotnitz provided a useful system of classifying surgical glues divided into groups and categories . The groups are based on their purpose (haemostats, sealants, and adhesives) and categories based on their functional characteristics and mechanism of action. The purpose of topical haemostats is to accelerate haemostasis by causing blood clot formation and it requires the presence of blood. The sealants stop leakage of fluid from tissue openings such as CSF from CNS, but the fluid does not have to be blood. The adhesives bond tissue together, such as a surgical incision wound. It is notable that some agents can have multiple purposes, such as a fibrin sealant that can act as a hemostat, a sealant, and an adhesive. A significant number of surgical glues functionally depend on a physiologic

coagulation cascade. Two of the essential components of the coagulation cascade are thrombin and fibrinogen. In the presence of calcium ions, thrombin cleaves the fibrinogen chains. The resulting fibrinogen monomers eventually polymerize and form a fibrin clot. These steps are independent of the coagulation pathway and can be reproduced artificially. The rate of the clot formation increases with thrombin concentration. The strength of the clot, on the other hand, depends on the concentration of fibrinogen.

Porcine gelatin, bovine collagen, oxidized regenerated

cellulose, and polysaccharide spheres : These compounds work by creating a mechanical barrier and a surface to stop haemorrhage or accelerate blood clotting. Hence, they act as haemostats. They are relatively safe and easy to use. However, swelling and infection are drawbacks. Removal of the glue is recommended after achieving haemostasis to minimize side effects

Bovine thrombin, pooled human thrombin, and

recombinant thrombin: These compounds essentially provide concentrated levels of thrombin for rapid conversion of fibrinogen to a fibrin clot. They act as haemostats and can be effective in stopping both local and diffuse haemorrhage. They are relatively easy to use, but the side effects include antibody formation (bovine) that can lead to coagulopathy. Viral or prion

disease may potentially be associated with pooled human plasma. Allergic reactions to hamster or snake protein are possible for recombinant products. More importantly, intravascular use of these products is counter-indicated.

Bovine or porcine gelatin with thrombin : These substances function both by creating a mechanical barrier and a surface to stop hemorrhage or accelerate blood clotting and by providing concentrated levels of thrombin for rapid conversion of fibrinogen to a fibrin clot. They act as hemostats. It appears that this combination is more effective than the individual categories. The advantages and the potential side effects are similar to those of individual ingredients discussed above.

Fibrin sealant : Fibrin sealant is the most versatile substance. It is approved by the FDA as a hemostat, sealant, and adhesive. The use of fibrin was first recognized in 1909. Human plasma-derived fibrin sealants are now available. Fibrin sealants are mainly comprised of fibrinogen and thrombin. They reproduce the cardinal steps of the physiologic coagulation cascade. Given that they supply both thrombin and fibrinogen, they do not depend on active bleeding for the source of fibrinogen. The concentration of each component varies between different manufacturers. The fibrin sealants are most effective when applied to a dry surface. The potential side effects

include viral or prion disease, antibody formation, allergic reaction, and swelling. The fibrin sealants are dependent on an intact coagulation system.

Polyethylene glycol (peg) polymer : This is a synthetic material and can be used as a moderately strong sealant. It is user-friendly and is most effective when applied to a dry surface. Polymerization takes approximately one minute. A major disadvantage is significant swelling.

Albumin and glutaraldehyde : This is a bovine serum albumin cross-linked with glutaraldehyde. It can be used both as a strong sealant and as an adhesive. It is user friendly, but there are several possible side effects, including tissue necrosis and adhesive embolism.

Cyanoacrylate : presence of a lateral chain made by a methyl or ethyl radical, the polymerization of cyanoacrylate is too exothermic, with local production of high temperature. This can cause tissue injury and also systemic problems, On the contrary, butyl- and octyl-cyanoacrylates demonstrated very good tissue compatibility and have been used extensively in medicine and surgery. Cyanoacrylate tissue adhesive is quite cheap, with respect to fibrin glue, it is easily stored even for long time and can be easily applied. Methyl or EthylCyanoacrylate can be associated with foreign body reaction and a sensation of warmth.

Lysine-derived urethane adhesive : This adhesive acts to bond together tissue layers, thereby reducing dead space. This is particularly relevant after certain surgical procedures such as abdominoplasty. A recent study demonstrated a decreased rate of seroma formation and fluid drainage following abdominoplasty when the adhesive is utilized. This adhesive is

biodegradable and over time is absorbed by the body through hydrolysis.

Hydrophobic light-activated adhesive (HLAA) : This adhesive is based on polyglycerol sebacate acrylate (PGSA). It is a thick gel that is applied to a tissue and then cross-linked within seconds by ultraviolet light. The resulting bond is strong but flexible. Hence, it sustains under high pressure and flowing blood. It can potentially be used to seal defects in the heart and arteries, but so far, the testing has been limited to animal models.

MATERIALS AND METHODS

SOURCE OF DATA:-

This study is a prospective study of glue mesh fixation for primary unilateral inguinal hernia's during the period December 2017 – November 2018, Government Rajaji Hospital, Madurai Medical college. Number of cases studied is 60

SELECTION OF STUDY SUBJECTS :-

Male adults with primary unilateral inguinal hernia in govt. Rajaji hospital Madurai, randomized to undergo open hernia repair with suture fixation (Group A) & cyanoacrylate glue fixation of the mesh (Group B). short-term outcomes like length of operation time, pain, postoperative analgesia requirement within 24hrs, hematoma, seroma, long term out comes like chronic pain, sensation of extraneous body, recurrence & time to return to work/normal activities were monitored in frequent intervals for 1st month, 3rd month, 6th month & 1 year These parameters were analyzed using chi square test & P value.

Following are the eligiblity criteria taken for the study

ELIGIBILITY CRITERIA

A.Inclusion criteria:

1. All patients with evidence of primary uncomplicated inguinal hernia admitted In GRH madurai.
2. Patients above 18 years age.
3. Patients undergoing elective Lichtenstein mesh hernioplasty

4. Patients consented for inclusion in the study according to designated proforma

B.Exclusion criteria:

Recurrent hernia

Femoral hernia

Emergency presentation

Age less that 12years

Coagulation disorders

Ongoing chemotherapy

Connective tissue disorders

Patients with psychological or physical disorders that could affect the ability to feel and elaborate pain

Patient not consented for inclusion in the study.

Patient with metabolic disease ex. DM

METHODOLOGY:

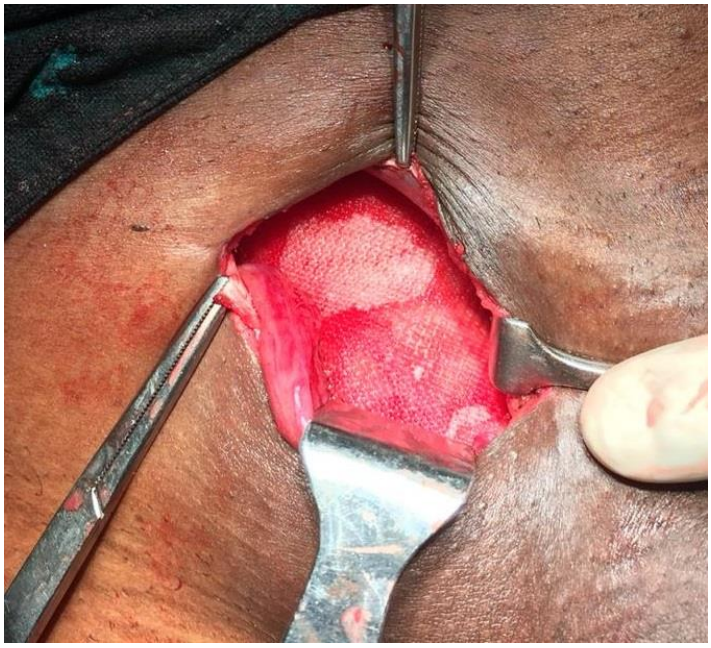
The patients were seen in surgical OPD routine hours and were diagnosed on the basis of history, clinical examination and investigations like USG.

Surgery was done under regional anaesthesia, supine position, according to the Lichtenstein Tension-Free Hernia Repair.

Lichtenstein Tension-Free Hernia Repair :- This procedure is performed by classical inguinal incision half inch above & parallel to the medial half of the inguinal ligament. Wound opened in layers. The external oblique aponeurosis is visualized & separated along the direction of fibers and opened. Care is taken not to injury the ilioinguinal nerve & genital branch of genitofemoral nerve. External oblique aponeurosis is separated from the underlying internal oblique muscle high enough to accommodate a 6- to 8-cm-wide mesh patch. Overlap of the internal oblique muscle edge by 2 to 3 cm if necessary. The spermatic cord structures are retracted

inferiorly, sac identified in case of indirect hernia, High ligation of an indirect hernia sac is performed. A sheet of polypropylene mesh is fashioned to fit the inguinal canal. A slit is made in the lateral aspect of the mesh, and the spermatic cord is placed between the two tails of the mesh. The spermatic cord is retracted in the cephalad direction. The medial aspect of the mesh overlaps the pubic bone by approximately 2 cm. The mesh is secured to the aponeurotic tissue overlying the pubic tubercle by a running suture of nonabsorbable monofilament material in Group A . These suture is continued laterally by suturing the inferior edge of the mesh to the

shelving edge of the inguinal ligament to a point just lateral to the internal inguinal ring. A second monofilament suture is placed at the level of the pubic tubercle and continued laterally by suturing the mesh to the internal oblique aponeurosis or muscle approximately 2 cm from the aponeurotic edge. The lower edges of the two tails are sutured to the shelving edge of the inguinal ligament to create a new internal ring made of mesh. In group B the fashioned mesh is place over the posterior wall of the inguinal canal & fixed with cyanoacrylate glue inferiorly along shelved edge of inguinal ligament & mediaclly 2 cms medial to pubic tubercle, superiorly along the internal oblique aponeurosis or muscle approximately 2 cm from the aponeurotic edge. The spermatic cord structures are placed within the inguinal canal overlying the mesh. The external oblique aponeurosis is closed over the spermatic cord. Skin closure done with non absorbable sutures. Both the groups were evaluated at immediate post operative period for pain & requirement of the analgesics. After 2 to 3 days for hematoma & seroma. On followup at 1^{st} , 3^{rd}, 6^{th} and at 1 year for pain , foreign body sensation & recurrence.



STATISTICAL ANALYSIS: The data were analysed using statistical software like SPSS Ver.13.0, Microsoft Excel 2007.Chi Square test was used to analyse the incidence of hematoma , seroma , foreign body sensation. lso, ain score , duration of surgery, hospital stay & distribution data were assessed and p-value for each of them was computed.

OBSERVATIONS AND RESULTS :

Age distribution: In study group most of the subjects belong to 60-70 age, and in control group most of them belong to 40-50 years of age.

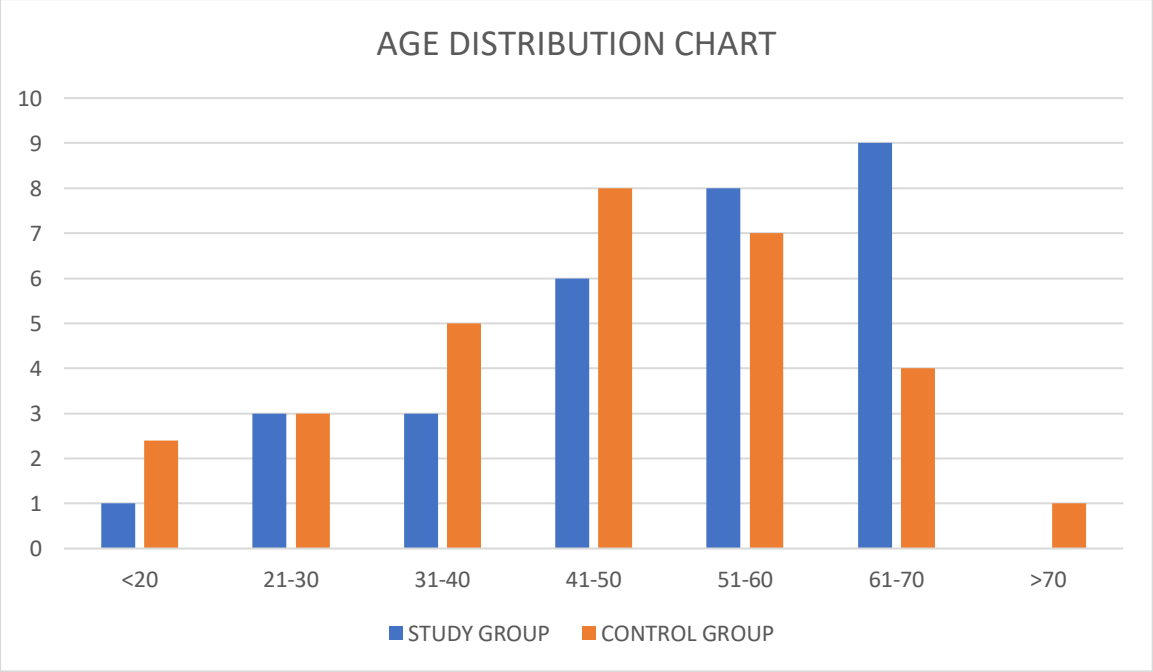
STUDY GROUP

GROUP

Age group	number	Percentage
<20	1	3.3
21-30	3	10
31-40	3	10
41-50	6	20
51-60	8	26.7
61-70	9	30
>70	0	0
Total	30	100

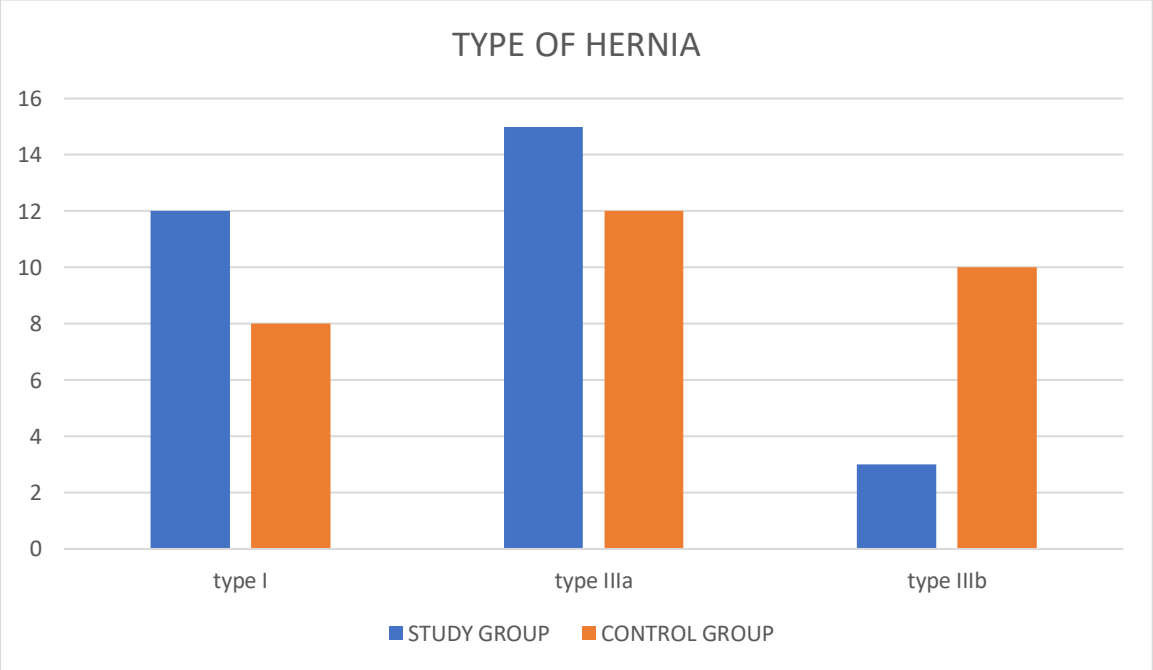
CONTROL

Age group	number	Percentage
<20	2	6.6
21-30	3	10
31-40	5	16.7
41-50	8	26.7
51-60	7	23.3
61-70	4	13.4
>70	1	3.3
Total	30	100



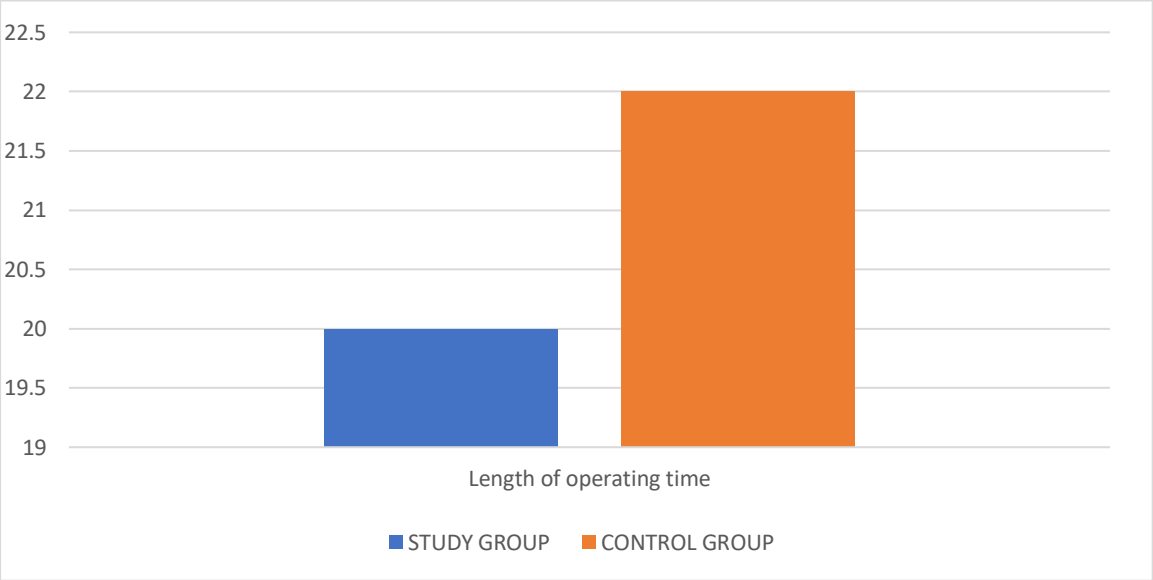
Type of hernia : In both study group and control group ,most of the subjects were of Nyhus type III A. In study group 12/30 belong to Nyhus type I; 15/30 belong to Nyhus IIIa; 3/30 belong to Nyhus IIIb. In control group, 8/30 belong to Nyhus I; 12/30 belong to Nyhus IIIa; 10/30 belong to Nyhus IIIb

Type of hernia (Nyhus)	study group	control group
type 1	12	8
type IIIa	15	12
type IIIb	3	10



COMPARISION LENGTH OF OPERATING TIME : The mean length of operating time in study group was 20minutes, where as in control group, slightly more 22minutes. The difference is statistically significant with a p value of 0.01

	STUDY GROUP	CONTROL GROUP
MEAN DURATION	20	22

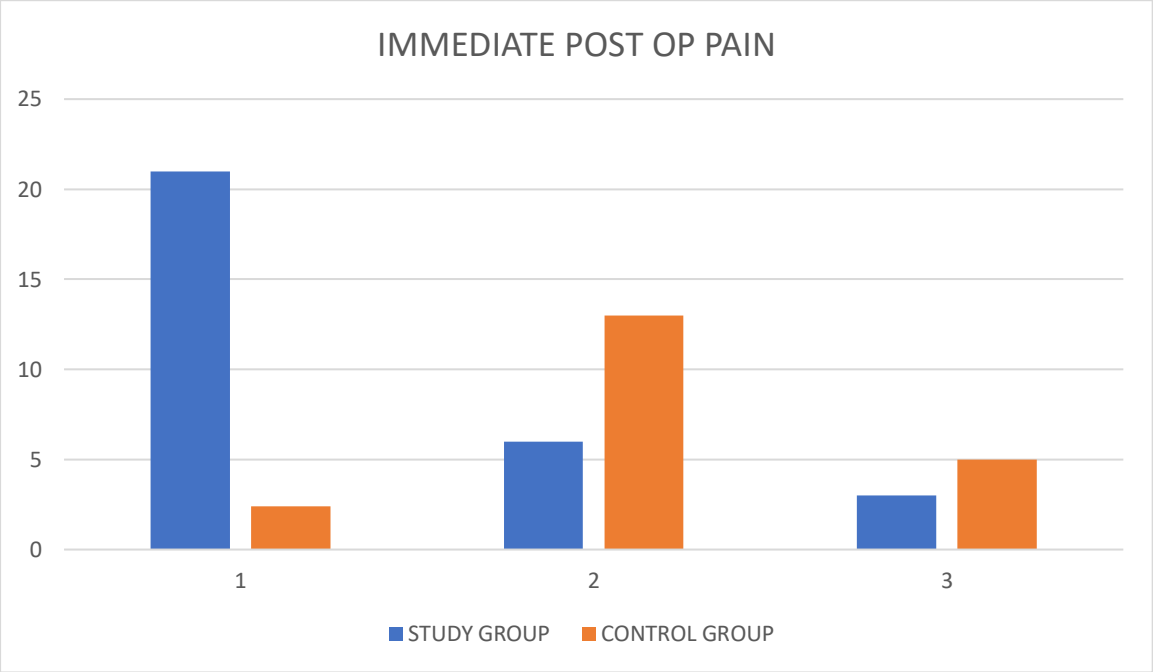


COMPARISON OF IMMEDIATE POST-OPERATIVE PERIOD

PAIN : Immediate post operative pain is compared between two groups using VAP score with in 24hours of surgery. In both the groups were having pain with varying intensity. In Study group 3/30(10%) had a score of 3; 6/30(20%) had a score of 2; 21/30(70%) had a score of 1. In control group, 5/30(16.6%) had a score of 3; 13/30(43.3%) had a score of 2; 12/30(40%) had a score of 1.

VAP score	STUDY GROUP	CONTROL GROUP
1	21	12

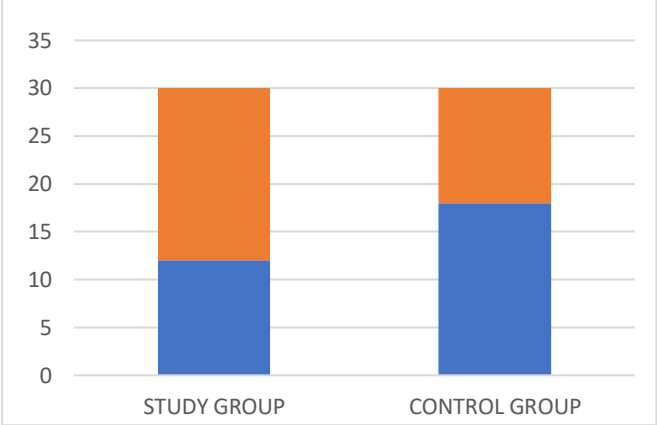
2	6	13
3	3	5



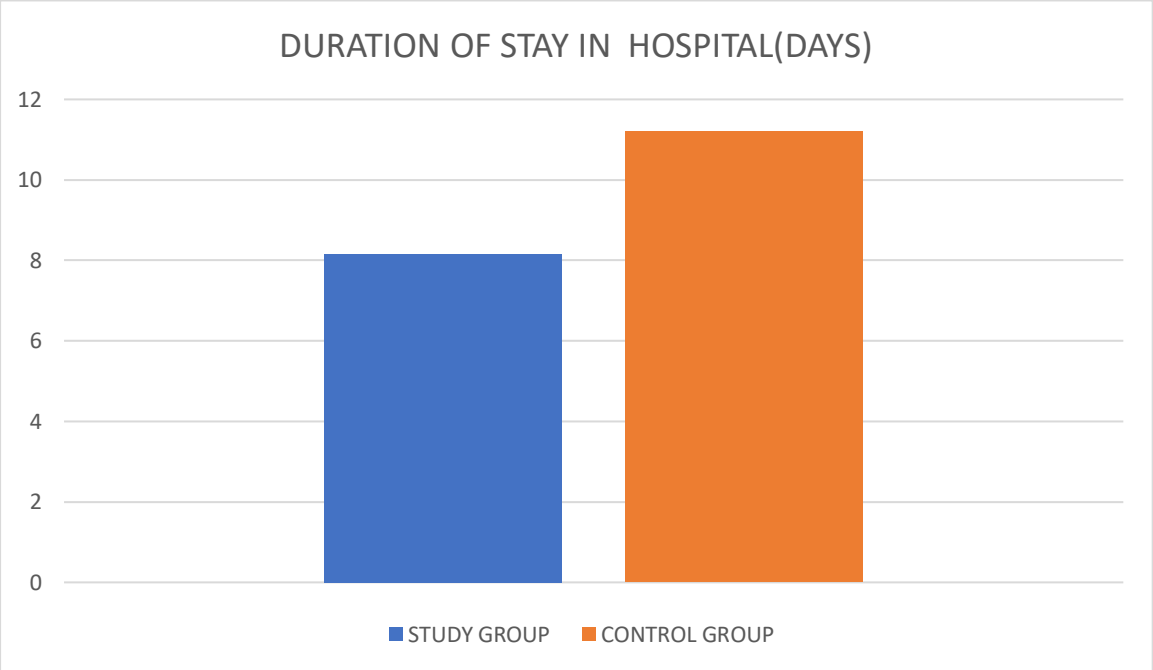
Comparison of seroma formation : The incidence of seroma in Study group was 40 % (12/30), which was lesser than Control group 60% (18/30). This difference was statistically significant with a p value of 0.03.

TECHNIQUE	N	%
STUDY GROUP	12	40%

CONTROL GROUP	18	60%



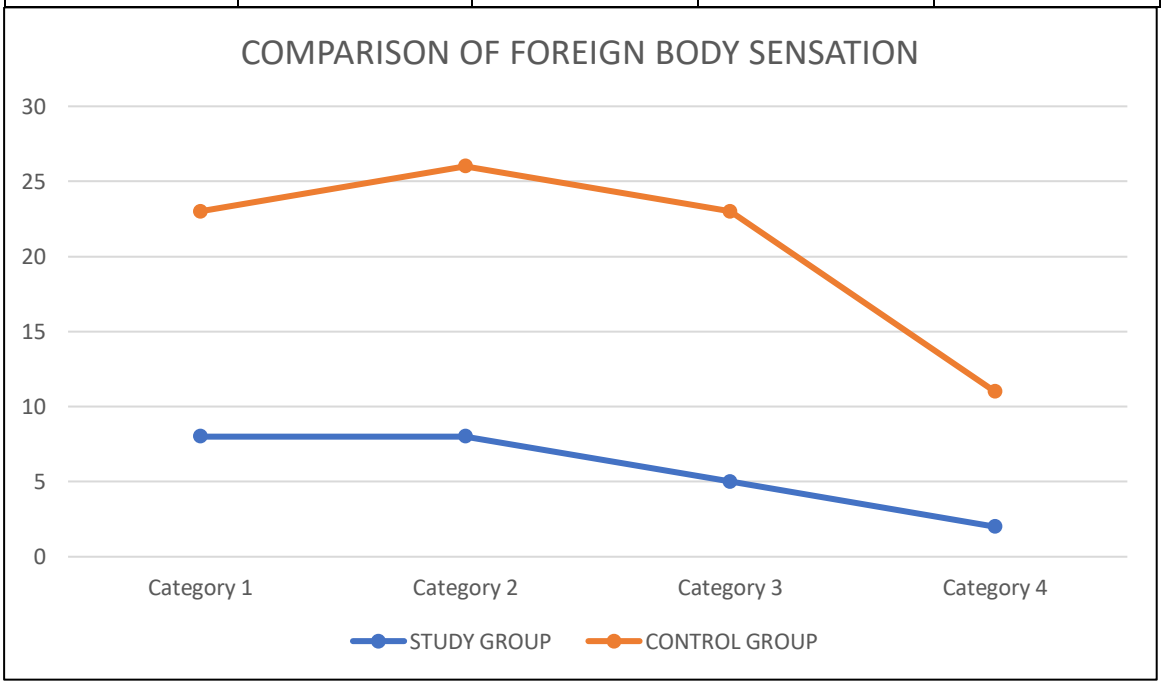
COMPARISON DURATION OF HOSPITAL STAY :- The mean duration of hospital stay in study group is 8.16 which is less compared to the control group 11.2. This difference was statistically significant with a p value of 0.02



<u>Comparison of foreign body sensation</u> : The incidence of foreign body sensation in study group was 6.6 %(2/30), which was much lesser than

control group 30%, (9/30). This difference was statistically significant with a p value of 0.01.

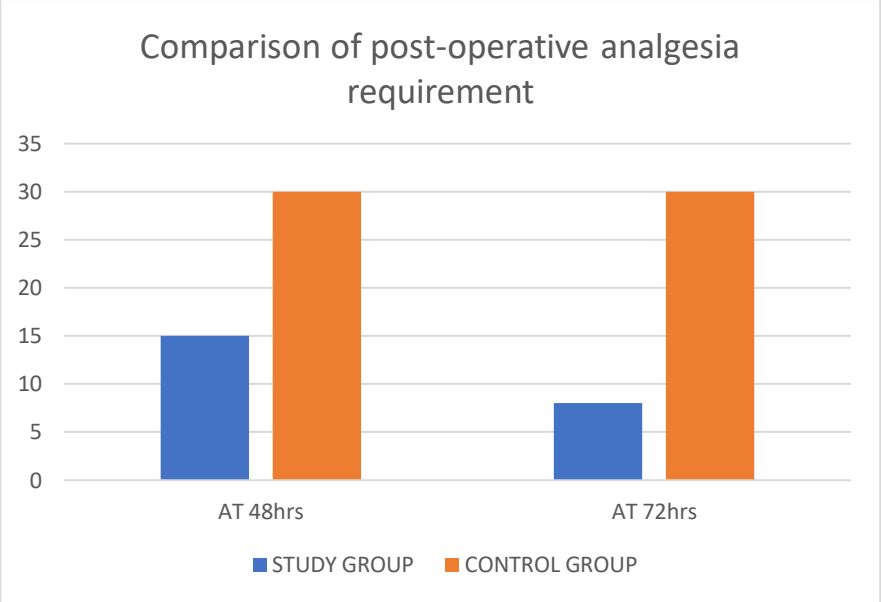
Follow up (months)	STUDY GROUP n	STUDY GROUP %	CONTROL GROUP n	CONTROL GROUP %
1	8	26.6	15	50
3	8	26.6	18	60
6	5	16.3	18	60
12	2	6.6	9	23.3



Comparison of post-operative analgesia requirement : Within 24 hrs post- operative period, all the subjects in both groups required analgesia.

However, at 48 hrs post-operative period 15/30 (50%) of subjects in study group required analgesia compared to (30/30,100%) of control group. This difference was statistically significant. Similarly, at 72 hrs post-operative period, 26 %(8/30) of study group required analgesia, compared to 100 %(30/30) in control group. This difference was statistically significant with a p values of 0.016

POST OPERATIVE PERIOD(hrs)	STUDY GROUP n	STUDY GROUP %	CONTROL GROUP N	CONTROL GROUP %
With in 24	30	100	30	100
48	15	50	30	100
72	8	26	30	100


Comparison of post-operative analgesia requirement
35
30
25
20
15
10
5
0
AT 48hrs
AT 72hrs
STUDY GROUP
CONTROL GROUP

Discussion

This is a prospective comparative study, comparing 60 patients who had undergone Lichtenstein's hernioplasty for inguinal hernia, of which 30 had undergone mesh fixation with n-butyl-2-cyanoacrylate glue and the remaining 30 with prolene sutures. In this study the mean length of operative time required in study group was 20minutes, which was slightly more than in control group 22minutes. The difference is statistically significant with a p value of 0.01. In this study the incidence of seroma in study group was 40 % (12/30), which was lesser than Control group 60% (18/30). This difference was statistically significant with a p value of 0.03, similarly to the study conducted by M. Canziani, et al. for fixation of mesh using glue in 40 patients there was no seroma formation in any patient. In this study, the incidence of haematoma formation in study group was 16.6%(5/30) where as in control group 76.6%(23/30). This difference is statistically significant with a p value of <0.01 similar to study conducted by Negro P, et al. i.e study on use of glue versus sutures for mesh fixation in open tension-free Lichtenstein repair of inguinal hernia Patients who received glue were also less likely to experience hematoma than those in the suture group (P = 0.001). in this study, The incidence of seroma in Study group was 40 % (12/30), which was lesser than Control group 60% (18/30). This

difference was statistically significant with a p value of 0.03. Similar to the study conducted by M. Canziani, et al. for fixation of mesh using glue in 40 patients there was hematoma formation only in 3 patients (3/40) and no seroma formation in any patients.

In this study, the incidence of foreign body sensation in study group was 6.6% (2/30), which was much lesser than control group 30%, (9/30). This difference was statistically significant with a p value of 0.0001, similar to study conducted by Mario Testini, et al. on a single-surgeon randomized trial comparing sutures, glue for mesh fixation during primary inguinal hernia repair sensation of extraneous body was reported in 5 (8.47%) patients who received sutures. There were no reported cases in the glue group. The mean duration of hospital stay in study group is 8.16 which is less compared to the control group 11.2. This difference was statistically significant with a p value of 0.01. where as in the study conducted by Mario Testini, et al.There was no significant difference between the groups in terms of mean duration of hospital stay.

In this study, the requirement of analgesia in the 24 hrs post-operative period, all the subjects in both groups required analgesia. However, at 48 hrs. Post-operative period 15/30(50%) of subjects in study group required analgesia compared to (30/30,100%) of control group required analgesia.

This difference was statistically significant with <0.001. Similarly, at 72 hrs Post-operative period, 26% (8/30) of study group required analgesia compared to 100 %(30/30) in control group. This difference was also statistically significant with a p value of <0.0001 at both 48 and 72 hrs, similar to the study conducted by M.Canziani, et al 40 patients underwent mesh fixation with 2 ml of glue in which postoperative pain occurred in two patients, while chronic pain occurred in one patient; the remaining 37 patients were pain-free. In this study none of the groups had recurrence similar to the study conducted by Colvin HS, et al.In which Glue fixation was not associated with an increased risk of hernia recurrence and also in the study done by Mario Testini, et al. where there is no recurrence in any of the groups.

CONTROL GROUP

S: NO	NAME OF THE PATIENT	AGE		SEX	TYPE OF HERNIA	LENGTH OFOPERATING TIME (MINUTES)	IMMEDIATE POST OP PAIN SCORE	REQUIREMENT OF ANALGESICS	HEMATOMA	SEROMA	DURATION OF STAY IN HOSPITAL(DAYS)
1	GANESAN	53		M	III A	30	2	YES	YES	NO	14
2	THIRUPATHI	18		M	I	60	3	YES	YES	YES	11
3	parameshwaran	19		M	III B	60	2	YES	NO	NO	11
4	ARMUGAM	60		M	III A	40	2	YES	YES	YES	14
5	SONNAI	50		M	III A	40	2	NO	YES	YES	11
6	PERUMAL	34		M	I	30	3	YES	NO	NO	11
7	RAGAVAN	68		M	III A	35	2	YES	YES	NO	11
8	RAMACHANDRAN	57		M	I	40	2	YES	YES	YES	11
9	RASU	49		M	III A	45	1	YES	YES	YES	11
10	VIJAYAN	62		M	III A	60	1	YES	YES	NO	9
11	KALANAI	27		M	III B	40	1	YES	YES	YES	9
12	SEKAR	43		M	III B	45	2	YES	NO	YES	11
13	PANDI	50		M	III B	40	2	YES	YES	YES	11
14	ANANTH	32		M	III B	30	1	YES	YES	NO	11

15	Md.IBRAHIM	21		M	III B	35	1	YES	YES	YES	14
16	pandi	61		M	III B	60	1	YES	YES	YES	11
17	velayudam	55		M	I	40	2	YES	NO	YES	11
18	armugam	41		M	III A	40	2	YES	YES	NO	11
19	murugesan	50		M	III A	45	1	NO	YES	YES	11
20	muthuramalingam	50		M	III B	50	2	YES	YES	NO	14
21	aadhimolam	50		M	I	45	1	YES	YES	YES	11
22	VADAMALAI	40		M	III B	60	2	YES	NO	YES	9
23	RAJA	34		M	I	50	2	YES	YES	YES	14
24	Md.ISMAIL	50		M	III A	35	1	YES	YES	NO	11
25	SIVAKUMAR	37		M	I	45	3	YES	YES	YES	11
26	MYNOR	64		M	III B	60	1	YES	YES	NO	11
27	DAS	56		M	I	40	1	YES	NO	YES	9
28	MADASAMY	75		M	III A	45	3	YES	YES	YES	9
29	VINOTH KUMAR	25		M	III A	60	1	YES	NO	NO	14
30	MATHIVAN	54		M	III A	60	3	YES	YES	NO	9

S:	NAME OF THE	PAIN				FOREGN BODY SENSATION				RECURRENCE		
NO	PATIENT	1M	3M.	6M	12M	1M	3M	6M	12M	3M	6M	12M
1	GANESAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2	THIRUPATHI	YES	YES	YES	NO	NO	NO	YES	YES	NO	NO	NO
3	parameshwaran	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
4	ARMUGAM	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO
5	SONNAI	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6	PERUMAL	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO	NO
7	RAGAVAN	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO	NO
8	RAMACHANDRAN	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
9	RASU	NO	YES	YES	NO	YES	YES	YES	YES	NO	NO	NO
10	VIJAYAN	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
11	KALANAI	YES	YES	NO	NO	YES	YES	YES	NO	NO	NO	NO
12	SEKAR	NO	NO	NO	NO	NO	YES	YES	YES	NO	NO	NO
13	PANDI	YES	YES	YES	NO	YES	YES	YES	NO	NO	NO	NO
14	ANANTH	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

15	Md.IBRAHIM	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO
16	pandi	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
17	velayudam	NO	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO
18	armugam	YES	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO
19	murugesan	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
20	muthuramalingam	YES	YES	YES	NO	YES	YES	YES	YES	NO	NO	NO
21	aadhimolam	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
22	VADAMALAI	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO
23	RAJA	NO	NO	NO	NO	YES	YES	YES	NO	NO	NO	NO
24	Md.ISMAIL	NO	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO
25	SIVAKUMAR	YES	YES	YES	NO	NO	YES	YES	NO	NO	NO	NO
26	MYNOR	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
27	DAS	NO	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO
28	MADASAMY	NO	NO	NO	NO	YES	YES	YES	NO	NO	NO	NO
29	VINOTH KUMAR	YES	YES	YES	NO	YES	YES	YES	NO	NO	NO	NO
30	MATHIVAN	YES	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO

S: NO	NAME OF THE PATIENT	AGE	SEX	TYPE OF HERNIA	LENGTH OFOPERATING TIME (MINUTES)	IMMEDIATE POST OP PAIN SCORE	REQUIREMENT OF ANALGESICS	HEMATOMA	SEROMA	DURATION OF STAY IN HOSPITAL(DAYS)
1	Moorthy raja	45	M	III A	25	1	YES	NO	NO	7
2	sundarapandi	40	M	I	40	1	YES	NO	NO	9
3	parameshwaran	20	M	III A	30	1	NO	NO	NO	7
4	vinoth	21	M	III A	30	1	YES	YES	YES	7
5	chithambaram	70	M	I	30	1	YES	NO	NO	12
6	patchaikomban	70	M	I	40	1	YES	NO	YES	9
7	palanisamy	60	M	III A	30	1	YES	NO	YES	7
8	verakannayee	42	M	I	30	1	NO	NO	NO	7
9	muthu	54	M	III A	45	2	YES	NO	YES	8
10	adimolam	67	M	I	45	1	YES	NO	NO	7
11	santhanam	48	M	III A	45	1	NO	YES	YES	7
12	ganeshan	54	M	III B	50	2	YES	NO	YES	7
13	ravishankar	33	M	I	45	3	YES	NO	NO	7
14	manikam	61	M	III A	45	1	YES	NO	NO	11
15	saravanan	37	M	I	45	1	NO	NO	NO	7
16	pandi	65	M	I	40	1	YES	NO	NO	7
17	sundaram	48	M	III A	30	1	NO	NO	YES	8
18	palanisamy	60	M	III B	45	3	YES	NO	NO	9
19	muthu	52	M	III A	45	1	YES	NO	NO	7
20	periyathambi	53	M	I	45	1	YES	NO	NO	12
21	bakthavachalam	58	M	I	45	1	YES	NO	YES	8
22	david	70	M	III A	30	1	NO	NO	NO	7
23	ravi	50	M	III B	45	3	YES	NO	NO	9
24	rajendran	54	M	III A	45	1	YES	NO	NO	10
25	eswaran	30	M	III A	45	2	YES	YES	YES	7

26	muythaiya	42	M	I	45	1	YES	NO	NO	9
27	sankar	64	M	I	45	2	YES	YES	YES	7
28	nallan	70	M	III A	40	2	YES	NO	YES	7
29	arokiyasamy	68	M	III A	45	2	YES	NO	NO	7
30	bharathiraja	24	M	I	35	2	YES	YES	NO	12

S: NO	NAME OF THE PATIENT	PAIN				FOREIGN BODY SENSATION				RECURRENCE		
		1M	3M	6M	12M	1M	3M	6M	12M	3M	6M	12M
1	Moorthy raja	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2	sundarapandi	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3	parameshwaran	YES	NO	NO	NO	YES	YES	NO	NO	NO	NO	NO
4	vinoth	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5	chithambaram	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6	patchaikomban	YES	YES	NO	NO	YES	YES	YES	NO	NO	NO	NO
7	palanisamy	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
8	verakannayee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
9	muthu	YES	NO	NO	NO	YES	YES	YES	NO	NO	NO	NO
10	adimolam	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
11	santhanam	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
12	ganeshan	YES	YES	NO	NO	YES	YES	YES	YES	NO	NO	NO
13	ravishankar	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
14	manikam	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
15	saravanan	YES	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO
16	pandi	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
17	sundaram	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
18	palanisamy	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
19	muthu	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO

20	periyathambi	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO	NO
21	bakthavachalam	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
22	david	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
23	ravi	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
24	rajendran	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
25	eswaran	YES	NO	NO	NO	YES	YES	NO	NO	NO	NO	NO
26	muythaiya	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
27	sankar	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
28	nallan	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
29	arokiyasamy	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
30	bharathiraja	YES	NO	NO	NO	YES	YES	YES	NO	NO	NO	NO

Conclusion

The ultimate aim in hernioplasty procedures is to decrease the post-operative complications and morbidity of the patient without any increased risk of hernia recurrence. This study compares the post-operative morbidity of mesh fixation with cyanoarcylate glue in lichtenstein Hernioplasty over sutures. Cyanoarcylate glue for mesh fixation in the Lichtenstein repair of inguinal hernia shows advantages over sutures, including less duration of operating time(0.01) lower incidence of complications such as post-operative pain(0.017), post-operative analgesia requirement, seroma formation(0.03), foreign body sensation(0.01), chronic discomfort and duration of hospital stay(0.01). Hence our study favours the use of cyanoarcylate glue for hernia mesh fixation in Lichtenstein Hernioplasty which is better tolerated than sutures and is not associated with an increased risk of hernia recurrence.

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PROFORMA

1. NAME :- IP NO-

2. AGE :-

3. NYHUS TYPE :- TYPE OF ANAESTHESIA

4. LENGTH OF OPERATION TIME :-

5. PAIN (VAP SCORE):-

6. POST OPERATIVE ANALGESIA REQUIREMENT IN 24HRS :- YES/NO

IF YES, TIME SINCE SURGERY :-

ENTERAL / PARAENTERAL :-

POST OPERATIVE ANALGESIA REQUIREMENT AT 48 HRS

AT 72HRS

7. LOCAL NUMBNESS :- YES/NO

3D 7D 15D

8. HEMATOMA :-

9. SEROMA :-

FOLLOW UP'S 1M 3M 6M 12M

10. PAIN (VAP SCORE) :-

11. SENSATION OF EXTRANEOUS BODY :-

12. RECURRENCE :-

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Chennai, Tamil Nadu)

ETHICS COMMITTEE CERTIFICATE

Name of the Candidate	:	Dr.V.Radha Krishna
Course	:	PG in MS., General Surgery
Period of Study	:	2016-2019
College	:	MADURAI MEDICAL COLLEGE
Research Topic	:	A comparative study of cyanoacrylate glue versus sutured Mesh fixation for Lichtenstein Inguinal Hernia repair
Ethical Committee as on	:	21.11.2017

The Ethics Committee, Madurai Medical College has decided to inform that your Research proposal is accepted.

Member Secretary | Chairman | Dean / Convenor

Prof Dr V Nagaraajan
M.D., MNAMS, D.M., Dsc.,(Neuro), Dsc (Hon)
CHAIRMAN
IEC - Madurai Medical College
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This is to certify that this dissertation work titled A Comparative Study of cyanoacrylate glue versus sutured Mesh Fixation for Lichtenstein Inguinal Hernia repair of the candidate Dr.V.RADHA KRISHNA with registration Number 221611119 for the award of MASTER DEGREE in the branch of GENERAL SURGERY. I have personally verified the urkund.com website for the purpose of plagiarism check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows eight percentage of plagiarism in the dissertation.

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