

**DISSERTATION ON**

**PROSPECTIVE STUDY OF INCISIONAL HERNIA AND  
THE OUTCOME OF VARIOUS SURGICAL TECHNIQUES**

**M.S.DEGREE EXAMINATION  
BRANCH – I  
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# CERTIFICATE

This is to certify that dissertation entitled '**PROSPECTIVE STUDY OF INCISIONAL HERNIA AND THE OUTCOME OF VARIOUS SURGICAL TECHNIQUES**' is a bonafide record of work done by **xxxxxxxxxxxxxxxxxx**, in the Department of General Surgery, Thanjavur Medical College, Thanjavur, during his Post Graduate Course from 2006-2009 under the guidance and supervision of **PROF. DR. V. BALAKRISHNAN, M.S., and PROF. DR. G. AMBUJAM, M.S. FICS.** This is submitted in partial fulfillment for the award of **M.S. DEGREE EXAMINATION- BRANCH I (GENERAL SURGERY)** to be held in March 2009 under the **Tamilnadu Dr. M.G.R. Medical University, Chennai.**

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## INTRODUCTION

**Definition** - An incisional hernia after open or laparoscopic surgery is defined as an abdominal wall defect that develops at the site of previously made incision through the abdominal wall thickness with or without a bulge, visible and palpable when the patient is standing and often requiring support or repair <sup>(1)</sup>.

It is a common complication of abdominal surgery reported in 4% to 11 % of patients generally <sup>(2-4)</sup> and 23% of those who develop postoperative wound infection. It is an important source of morbidity.

A considerable proportion of patients present with incarceration and strangulation, requiring emergency abdominal surgery. Others may need to alter their lifestyle, or change or give up gainful employment, which results in an economic burden that has not been fully evaluated <sup>(5, 6)</sup>.

Incisional hernia is the only abdominal hernia that is iatrogenic.

Controversy exists regarding the ideal treatment of incisional hernia.

Treatment involves further major surgery and the results may be poor, with recurrence rate of upto 49 % reported <sup>(7)</sup>. These high recurrence rates prompted recommendations of a cautious attitude to surgical treatment of incisional hernia in the mid -1980's <sup>(8)</sup>. Since then, in spite of the frequency of the condition and its potential morbidity, no consensus on the best treatment has been forthcoming <sup>(9)</sup>. A wide spectrum of surgical techniques has been developed and recommended, ranging from sutured techniques to the use of various types of prosthetic mesh.

Suture repair was the standard surgical treatment of incisional hernia until 1990's. Multiple retrospective studies in literature have demonstrated high recurrence rate (25-63%) of primary suture repair. This was supported by a large, prospective, randomized trial by Luijendijk and colleagues in a study comparing mesh and primary suture repair, they found a recurrence rate of 46% in suture repair compared to 23% in mesh repair and hence recommended that suture repair should be completely abandoned <sup>(10)</sup>. However an expert panel on incisional hernioraphy concluded that primary suture repair should be used only for simple small hernia <6cm diameter in both the axis and the repair is oriented horizontally with non absorbable, monofilament suture with a suture to wound length ratio of 4:1 <sup>(9)</sup>.

This has led to an increased application of prosthetic mesh for repair in all the complex incisional hernia defined as diameter >6cm size in either axis or multiple defects with defective abdominal musculature and even in most of the simple incisional hernia. The use of non absorbable mesh may lead to seroma, fistula and infection in short term and to foreign-body reaction, chronic inflammation, pain, paraesthesia, stiffness and mesh shrinkage as long term complications <sup>(11-14)</sup>. Mesh properties (material, pore size, filament structure), mesh position (onlay, inlay, sublay, intraperitoneal), use of autodermal tissues and other factors (drainage, antibiotics) influence mesh safety.

Long term safety and improved outcome of preperitoneal retro rectus sublay technique of mesh placement has been shown in recent trials <sup>(15-22)</sup>. However there is no randomized controlled study for comparison and validation of this useful technique with the other commonly done onlay technique.

This prospective study is meant to report the observations made on 109 consecutive cases of incisional hernia admitted and treated at Thanjavur Medical College Hospital over a period of

two and a half years between May 2006 and October 2008 and the comparison of short and long term outcomes between different open surgical techniques in a simple and complex incisional hernia repair and discuss it in the light of available literature.

## AIM OF THE STUDY

### **The objectives of this clinical study are**

1. Critical evaluation of the cases of Incisional Hernia to trace the obvious etiological factors and identifying the risk factors for Incisional hernia occurrence, such that these can be eliminated.
2. Compare and contrast the various surgical modalities and management procedures available to evolve at a consensus for effective management of such cases based on type and size of Incisional hernia.



# REVIEW OF THE LITERATURE

## SURGICAL ANATOMY OF ANTERIOR ABDOMINAL WALL

It is important to understand the anterior abdominal wall anatomy for better and safe access to abdominal organs and prevention of incisional hernia formation and importantly for proper repair of incisional hernia <sup>(26-29)</sup> (Figs: 1, 2, 3).

### THE SKIN:

The skin of anterior abdominal wall is capable of undergoing enormous stretching.

### THE SUPERFICIAL FASCIA:

The superficial fascia of the abdomen consists of a single layer containing a variable amount of fat; except near the groin where it is divisible into two layers namely the superficial fatty layer or fascia of camper and the deep membranous layer or the fascia of scarpa.

### THE MUSCULO- APONEUROTIC LAYER:

It can be divided into two parts: anterolateral and midline. The anterolateral part is composed of the external oblique, the internal oblique and the transverse abdominis muscle. The middle portion is composed of the rectus abdominis and the pyramidalis muscle.

### ANTEROLATERAL PORTION:

THE EXTERNAL OBLIQUE MUSCLE arises from the lower eight ribs. Its fibres run downwards, forwards and medially and forms the aponeurosis mostly which attaches from above to the xiphoid process, the linea alba, the pubic symphysis, the pubic crest and the pectineal line of the pubis and the lower fibres are inserted directly into the outer lip of iliac crest. The free lower border of the aponeurosis is folded upon itself as the inguinal ligament.

THE INTERNAL OBLIQUE MUSCLE takes origin from the thoracolumbar fascia, intermediate area of the anterior two third of the iliac crest and lateral two third of the inguinal ligament. They are attached to the costal cartilage and become aponeurotic thereafter. Medially it splits

to enclose the rectus abdominis and below the umbilicus the posterior lamella ends as the semicircular fold of Douglas or the arcuate line and passes in front of the rectus. Below, it arches and attaches to the pubic bone as the conjoint tendon along with the Transversus abdominis.

THE TRANSVERSUS ABDOMINIS MUSCLE takes origin from the inside of each costal cartilage interdigitating with the costal origin of the diaphragm and in continuity with the lower costal fibres, it arises from the lumbar fascia and from the inner lip of the anterior two third of iliac crest and from the lateral half of the inguinal ligament. The fibres become aponeurotic and pass behind the rectus to fuse with the internal oblique aponeurosis into the Linea alba. Below the arcuate line it passes in front of the rectus and below, it gets inserted into the pubic bone as the conjoint tendon.

MIDDLE PORTION:

THE RECTUS ABDOMINIS MUSCLE takes origin as two heads. The medial head arises from the symphysis pubis and lateral head arises from the upper border of the pubic crest. It is inserted to the front of the fifth to seventh costal cartilages.

THE PYRAMIDALIS MUSCLE is a small muscle taking origin from the pubic crest and it converges with its fellow into the Linea alba 4 cms above its origin.

THE RECTUS SHEATH is formed by the aponeurosis of the above three muscles. The internal oblique aponeurosis splits into anterior and posterior layers to enclose the rectus muscle. The external oblique aponeurosis fuses with the anterior layer, where as the transversus abdominis aponeurosis fuses with the posterior layer. Below the arcuate line all the three-aponeurosis pass in front of the muscle and hence the posterior wall is deficient below the arcuate line (Fig 3).

The tendinous intersections in the rectus muscle gains attachment to the anterior rectus sheath as well as to the lateral edge of the Linea alba. The site of attachments of the lower tendinous intersection is a critical spot and may be torn in severe contractions of the lower part of abdomen as in straining resulting in hernia at a later date.

The skin above the umbilicus is attached to the Linea Alba by fibrous bands. The absence of these bands below the umbilicus allows the formation of an obese pendulous belly below. These bands may exert a harmful traction downwards to the Linea Alba resulting in herniation. The linea alba is relatively avascular but it is perforated by blood vessels from below to the skin superficially. It is through these perforations hernia occurs.

#### **BLOOD SUPPLY OF THE ANTERIOR ABDOMINAL WALL;**

Anterolateral part is supplied superficially by three branches of the femoral artery namely; from lateral to medial superficial circumflex iliac artery, the superficial epigastric artery and the superficial external pudendal arteries which anastomoses with the deep arteries which lie between the transverse abdominis and the internal oblique muscles.

The deep arteries are posterior intercostal arteries 10 and 11, the anterior branches of the four lumbar arteries and the deep circumflex iliac artery. The rectus sheath is supplied by two arteries namely the superior epigastric artery from internal thoracic artery and the inferior epigastric artery from the external iliac artery. The veins follow the arteries.

#### **NERVE SUPPLY TO THE ANTERIOR ABDOMINAL WALL:**

Both the anterolateral portion of the abdominal wall and the rectus abdominis muscle are supplied by the anterior rami of the 7<sup>th</sup> to 12<sup>th</sup> thoracic nerves and the 1<sup>st</sup> lumbar nerve.

#### **CLINICAL MANIFESTATIONS:**

- \* Unsightly bulge in the operated scar
- \* Pain and discomfort - heavy, sickening, dragging sensation aggravated by Coughing and straining.

**\* Complications:**

- Intestinal obstruction,
  - Strangulation.
  - Ulceration, Rupture.
- Cosmetic disfigurement.

# REVIEW OF THE LITERATURE

## ETIOLOGY

Many factors singly or in combinations may cause failure of the wound to heal satisfactorily and may lead to the development of a postoperative hernia <sup>(23-24, 37)</sup>. Two main causes are poor surgical technique and sepsis. There are two types of incisional hernia early and late.

### EARLY HERNIA:

The early occurring type that appears soon after the original laparotomy closure, often involves the whole length of the wound, get widened and become a large one.

### Causes:

#### 1. Poor Surgical Technique:

##### (a) Non anatomical incisions:

Vertical Para rectus incisions on the outside of the lateral border of the rectus sheath, which destroys the nerve and vascular supply to the tissues medial to the incision causing atrophy.

##### (b) Layered closures:

Layered closures are followed by a greater incidence of postoperative hernias than wounds that are closed by a single layer-mass closure technique. This may be owing to the fact that when many sutures are used, they are closely placed and sutures are taken close to the edge of the wound.

(c) Inappropriate suture material:

80 % of the final wound strength is reached after 6 months. Healed wound gain its maximum strength after one year. Hence the wound must be supported for at least up to this time. The sutures are entirely responsible for the integrity of the wound for the first 6 months, so any material that does not survive and maintain its strength for this time is not suitable for wound closure.

Catgut and synthetic absorbable sutures should not be used for closure of Laparotomy wounds. Biologic sutures such as silk, cotton and linen disintegrate after 2 months and also should not be used. Further more, these sutures, specially silk are more prone for wound infection and sinuses.

The ideal suture material for abdominal closure in the past was monofilament stainless steel wire (28G). Nowadays monofilament polyamide or polypropylene (1 or metric 4) is the suture material of choice for abdominal closure.

(d) Suturing Techniques:

Great number of small sutures, which are closely placed and tight Tied, with each taking a small bite of tissue have lead to incisional hernia. A small, tightly tied sutures causes ischemia and necrosis of the tissue it contains and also of an area on each side of the suture. When these small, tightly tied sutures are placed close to each other, their ischemic areas merge and thus cause necrosis of a strip of tissue all along the edge of the incision, which separates with sutures, from the rest of the abdominal wall leading to wound gaping.

(e) Tension:

Closing the wound with tension leads to hernia. The lateral pull of the abdominal wall against the suture line tends to pull the edges in opposite directions and create an area of pressure necrosis where the suture meets the tissues. This pressure necrosis is a primary cause of wound dehiscence.

## 2. Sepsis:

Sepsis is the second major cause for delay in wound healing or failure of it. It may range from

frank acute cellulitis, with fasciitis and necrosis of the tissues to low-grade chronic infection. The infection causes inflammation and edema of the tissues which become soft and weakened so that the sutures tear the tissues.

### **3. Drainage tubes:**

Drainage tubes brought out through the operation wound are a potent cause of incisional hernia. Since various layers of the wound along the track of the drainage are not sutured, an open and weak passage is present through all the layer of the wound through which a hernia may develop. Also the irritation caused by the drain causes edema or softening and tearing of the tissues and cutting out of the sutures.

### **4. Obesity:**

Cutting through large masses of fat and increased retraction needed may raise the infection rate in patients. Tissues infiltrated with fat are not able to hold the suture, especially since the excess intra or extra abdominal accumulations of many kilograms of fat may add enormous tension on suture lines causing the tissues to tear under strain and to bring about a defect in abdominal wall. In addition obese patients are tend to develop other post operative complications like wound infections and pulmonary complications.

### **5. General Conditions:**

The factors influencing the rate of incisional hernia are age, malnutrition, hypoproteinemia, avitaminosis, diabetes mellitus, anemia, jaundice, irradiation, uremia and other co morbid conditions affecting wound healing.

### **6. Post operative complications:**

Prolonged post operative paralytic ileus and intestinal obstruction with abdominal distention which places enormous vertical tension on the wound by increasing the length and at the same time raising the lateral pull on the sutures by increased girth of the abdomen.

Chest complications such as chronic obstructive airway disease, pulmonary collapse, bronchopneumonia, emphysema and asthma are also factors.

#### **7. Type of operation:**

Certain types of operations have a tendency to be followed by incisional hernia they include laparotomy for generalized or localized peritonitis, operation for intra- abdominal malignant disease and re-operation through the original wound within the first 6 months after initial operation. The cause of the wound failure is not in the operation itself but in the presence of many factors previously mentioned.

#### **LATE HERNIAS:**

It is due to tissue failure and collagen abnormalities.

Tissue failure:

The etiology of the late occurring hernia is not clear. The hernia develops in what apparently is a perfectly healed wound that has functioned satisfactorily for 5, 10 or even more years after operation. The incidence is not related to the method used for closing the original incision and is presumably the result of the failure of the collagen that has served well for a number of years should change its structure.

Rodriguez has recently shown a decrease in oxytalan fibres and an increase in the amorphous substance of the elastic fibres as a function of age. This may be the factor responsible for alterations in the resistance of the transversalis fascia and abdominal wall scar tissue. The aging and weakening of the tissues and the raised intra-abdominal pressure associated with chronic cough, constipation and



prostatism are cited as factors.

#### Collagen Abnormalities:

Abnormal collagen production and maintenance have been shown to be associated with recurrent hernias in certain patients. There is a deficiency of collagen and abnormalities in its physicochemical structure, manifesting in reduced hydroxyproline production and in changes in the diameter of the collagen fibers. These changes have been demonstrated in these patients in other sites such as skin, lung and pericardium and may be associated with the imbalance between proteolytic enzymes and their inhibitors and the enzyme abnormalities found in patients with emphysema and those who smoke. These collagen mechanisms may play a part in the development of late postoperative hernias.

In Summary the various etiological factors can be classified as follows:

#### 1) PREOPERATIVE FACTORS:

- Delayed wound healing due to comorbid conditions as enumerated.
- Conditions causing raised intra abdominal pressure like chronic cough, constipation, stricture urethra and prostate enlargement.
- Factors weakening the abdominal wall like steroids, nerve injury, prolonged stretching due to multiple scars.

#### 2) PEROPERATIVE FACTORS:

- Type of incision.
- Type of surgery- emergency or elective; peritonitis, malignancy.
- Suture material used.

- Technical failure like inadequate hemostasis, repair under tension, presence of dead space, improper knots, drain tubes, inappropriate approximation, etc.

### 3) POSTOPERATIVE FACTORS:

- Wound infection and wound failure.

General condition and complications.      - Drugs, etc.

# REVIEW OF THE LITERATURE

## *LAPAROSCOPIC INCISIONAL HERNIA REPAIR*

Laparoscopic approach for incisional hernia repair gained popularity in the last decade with advances in minimal access surgery and the advantages of the laparoscopic repair <sup>(39 - 45)</sup>.

The principles underlying a sound laparoscopic repair are the same as the open repair such as: tensionless closure of defect, prosthetic reinforcement of the defect and eliminating the risk of infection.

Patient selection for laparoscopic repair is important. The contraindications for this approach include: grossly obese patients, wide defects with divarication of recti, densely scarred abdomen and an acute abdomen having a septic focus or strangulated bowel.

Port placement is a key consideration in the laparoscopic approach, which are placed as far away from the defect as possible to allow access to the anterior abdominal wall with adequate room for prosthetic overlap and also to prevent any inadvertent bowel injury.

After substantial adhesiolysis, the fascial edges are cleared for at least 5 cm around the hernial defect and the defect is fully elucidated, a prosthetic material is chosen to cover the hernial defect. The Underlay intraperitoneal technique is more commonly used and the prosthetic material is secured posteriorly to the abdominal wall musculature (Fig. 31) . Substantial overlap of the defect with a large prosthesis with fixation by sutures to the posterior abdominal wall is necessary to facilitate ingrowth of tissues into the mesh and prevent recurrences and mesh migration.

Advantages of laparoscopic repair over open repair are as follows:

1. Fewer postoperative wound complications due to less dissection of the subcutaneous tissues.
2. Shortened hospital stay and less pain and better outcomes like lower recurrence.
3. Allows the repair of large or multiple hernias without extending the incision.
4. Evaluates the abdominal wall completely permitting identification of remote or “Swiss-cheese”

defects.

Disadvantages of laparoscopic repair include the following:

1. Seromas are common in laparoscopic repair since drains are not routinely placed. This can be reduced significantly by placing the patient in abdominal binder postoperatively.
2. Potential risk of bowel injury while accessing the abdomen or during adhesiolysis.
3. Mesh migration and failure of the repair with recurrence.
4. Bleeding from the abdominal wall vessels.
5. Persistent pain at the site of transfixation sutures.
6. Inability to deal with the unsightly scar and poor cosmetic appearance needing other procedures like abdominoplasty.
7. Rarely enterocutaneous fistula can occur, prevented by using composite mesh or covering the prosthesis with omentum.

Surgical expertise in laparoscopic incisional hernia repair is considered to be of marked importance to achieve better results and prevent complications. Thus even though laparoscopy is an appropriate approach for the repair of incisional hernia, it needs a steep learning curve and ushers a new era of incisional hernia repair.

# REVIEW OF THE LITERATURE

## MESH REPAIR

The ideal mesh must have the following characteristics <sup>(11-22)</sup>.

- Biologically and chemically inert
- Easily sterilizable
- Pliable
- Immediate and permanent strength.
- X-ray transparency.
- Free availability
- Low cost
- Fabricated in the form required.
- No inflammatory (or) foreign body reaction.
- Should elicit good Fibroblastic activity
- Permeable for tissue in growth
- No carcinogenic risk
- No allergy.

**Current synthetic biomaterials** in use are

1. Polyester mesh
2. Polypropylene mesh
3. Expanded polytetrafloro Ethylene mesh
4. Composite mesh.

**Polyester mesh:**

They are supple, Elastic, grainy texture and grip the surrounding tissues and “prevent” slippage. They induce rapid fibroblastic activity and are hydrophilic. Knitted multifilament polyester has been available as MERSILENE and DACRON.

**Polypropylene mesh:**

These meshes are made of monofilament. They are loosely woven, more supple and easy to handle and are hydrophobic. Heavy weight polypropylene is available as MARLEX and PROLENE, which are the most commonly, used types. Lightweight is available as ULTRAPRO

**Expanded Poly tetra floro ethylene:**

They are soft tissue patch of 1 x 2 mm thickness. Microscopy shows laminated structure with different porosity for tissue in growth. They are coated and is commonly used for Intraperitoneal placement of mesh.

**Composite mesh:**

They have a combination of Marlex mesh and expanded polytetra fluoro ethylene. Marlex is directed to the wall side and ePTFE to the bowel side.

**Dual mesh with ePTFE:**

A two Layered mesh; on one side pores of 3 micrometer, which acts as barrier to tissue incorporation and other 17-22 micrometer for in growth of fibroblast and collagen.

## METHODS OF SECURING THE MESH:

Repairs that use permanent prostheses differ based on where the prosthesis is placed anatomically (Fig. 20):

1. Onlay (superficial) technique,
2. Inlay (patch) technique,
3. Sublay (extra peritoneal yet intramural) also called as modified Rives- Stoppa technique and
5. Underlay (intraperitoneal) technique.

### 1. ONLAY SINGLE LAYER REPAIR

The onlay technique is popular among surgeons because it avoids direct contact with the bowel and imparts less tension on the repair.

The disadvantages are that it requires wide tissue undermining, which may predispose to wound related complications, and that the pressure required to disrupt the mesh from the anterior abdominal wall is less than other repairs. The technique of onlay mesh placement is as follows:

1. After mobilizing adequate flaps, a series of 1-0 monofilament nylon or polypropylene mattress sutures are placed through the full thickness of the fascia 5 to 6 cm from the margin of the hernia defect encompassing 1-1.5 cm of tissue, in 1.5 to 2 cm gap. The ends of the sutures are left long and are collected in hemostats (Fig.21).
2. The hernia defect is then closed primarily with interrupted sutures (Fig.22).
3. A piece of mesh 1 cm wider than the circle of mattress sutures is cut.
4. The ends of all sutures are brought through the prosthesis and tied (Fig.23, 24).
5. Suction drains are placed and brought out through remote stab wounds.

## **2. INLAY REPAIR TECHNIQUE:**

The Inlay technique involves excision of the hernia sac and identification of healthy fascial margins. This technique provides for a tensionless repair at the time of surgery and avoids the wide undermining of the Onlay repair. Without the overlapping support of the anterior abdominal wall, activities that increase intra-abdominal pressure impart significant tension to the mesh-fascial interface, which is the weakest point of the repair. High recurrence rates of 10 – 20 % have resulted in use of other techniques to optimize strength of the mesh-fascia interface by sandwich techniques and Inlay repair alone has gone out of favor with the surgeons.

### **TWO LAYER INLAY AND ONLAY MESH REPAIR (SANDWICH TECHNIQUE)**

In this repair one mesh is kept at subcutaneous plane superficial to musculoaponeurotic abdominal wall and deep in the extra peritoneal plane. In this method the hernia orifice is not sutured. This technique is not commonly used.

## **3. RETRO RECTUS SUBLAY TECHNIQUE:**

The Retro rectus placement of mesh, popularized by Rives and Stoppa, has been used with increasing frequency. The Mesh is placed extra peritoneally above the posterior rectus sheath and beneath the rectus muscle. Below the arcuate line, the mesh is placed in the preperitoneal space (Fig. 26-30) <sup>(15-22)</sup>.

The advantages of placing mesh in this plane are as follows:

1. The extensive overlap between the prosthesis and the fascial edges allows a tension free closure as well as a large surface area for tissue incorporation (Pascal's principle);



2. The mechanical strength of the prosthesis reinforces the abdominal wall, especially when there is increased intraabdominal pressure; and

3. Placement of the prosthesis adjacent to the vascular-rich rectus muscles facilitates tissue incorporation, promotes resistance to mesh infection, and allows interposition of autologous tissue between the prosthesis and the skin/subcutaneous tissues anteriorly and the peritoneum posteriorly.

#### **4. INTRA PERITONEAL UNDERLAY TECHNIQUE:**

The Intraperitoneal underlay placement is a common technique used in open and Laparoscopic approaches. Proponents of this technique cite that the ability to place the mesh with a large underlay allows for better tissue ingrowths and a more secure mesh-fascial interface. The fear of Enterocutaneous fistula is a dreaded complication of this technique though the incidence is very low (Fig. 31) <sup>(14)</sup>.

#### **COMPLICATIONS OF MESH REPAIR:**

Although the application of mesh has resulted in significant improvements in recurrence rates, the use of mesh is associated with specific complications like:

1. Infection;
2. Seroma;
3. Mesh extrusion due to inadequate soft tissue overage;
4. Pain and induration due to wide undermining and tissue ingrowths.
5. Enterocutaneous Fistula formation.

## **PRINCIPLES OF REPAIR**

### **1. No tension:**

The body accommodate to tension by gradually retracting the wound margins, filling the wound only with thin scar that does not adequately resist the intra abdominal pressures created by normal daily activities. Over time the scar yields and recurrence will occur. The maximum force that should be applied to close a wound is 3 Lb.

### **2. Bowel should not be exposed to synthetic mesh:**

If the bowel is exposed to the prosthesis during this process, it becomes densely adherent and the mesh may become incorporated into the bowel wall resulting in bowel obstruction and fistula.

### **3. Prosthesis should not be stapled (or) sutured to the margins of the hernia orifice:**

Staples should not be used to fix the mesh, as they do not encompass enough strong tissue to assure a solid anchor.

The prosthesis should not be attached directly to the margins of the hernia defect, since this serves to concentrate the forces generated by normal physical activity directly on the prosthesis tissue interface, increasing the risk of separation leading to failure.

### **4. Attention to skin Hygiene:**

Many patients especially those with recurrent ventral hernia, are so obese that they suffer from intertriginous infection of skin in the groin, perineum, lower abdomen and sub mammary areas. Failure to control the infection will leads to wound infection and prosthesis contamination.

### **5. Antibiotic prophylaxis:**

The presence of prosthesis within the wound disables normal host defense mechanisms that

protect against the low level of bacterial contamination that occurs in every surgical wound. This justifies the administration of perioperative antibiotics.

**6. Avoid counter relaxing incision:**

Relaxing incision on lateral of the wound to relieve the tension on repair should be avoided as this will interfere with blood supply to that area and interfere with healing leading to recurrence.

**7. Adequate overlapping of mesh:**

The mesh should be adequately over lap the hernia 4-6cm from the hernia orifice to prevent recurrence.

# REVIEW OF THE LITERATURE

## OTHER TECHNIQUES

### COMPONENT SEPARATION TECHNIQUE:

Ramirez and colleagues made significant contribution in Incisional Hernia repair by noting that by separating the overlapping muscle layers by preserving their innervations and blood supply, especially elevation of the external oblique muscle and releasing the rectus from the posterior sheath and advancing a compound flap of rectus muscle and attached internal oblique transverse abdominis complex can be used to cover large midline defects. Unilateral advancement of 5 cm in the epigastric region, 10 cm at the umbilicus, and 3 cm in the suprapubic region has been described. Wound related complications related to wide undermining have been problematic with this technique <sup>(34, 35)</sup>.

### FLAP RECONSTRUCTION:

Local advancement flaps have been used to reconstruct hernia defects in which there is significant absolute loss of domain and in lateral defects that are not amenable to advancement techniques.

Fasciocutaneous and Myocutaneous flaps like local rectus abdominis flap or distant muscle flaps like the tensor fascia lata, anterolateral thigh flaps, rectus femoris flap and latismus dorsi flaps are commonly used.

# REVIEW OF THE LITERATURE

## PRE OPERATIVE PREPARATIONS

The following pre operative measures may be of considerable benefit in achieving an excellent degree of success in repair of hernias.

1. Optimal skin hygiene
2. Weight reduction
3. Management of intercurrent disease
4. Repair of nutritional and vitamin deficiencies
5. Therapeutic pneumoperitoneum

### **Optimal Skin Hygiene:**

Optimal skin hygiene is extremely important when the patient is obese or has intertigo or diabetes mellitus. Twice daily showers with hexachlorophene soap or cream and application of organic iodine containing lotion four times daily will help to reduce skin flora and facilitate intra operative skin asepsis. If an ulcer is present the patient should be kept at bed rest. The ulcer should be debrided. The fungal infection should be controlled with a bland fungicidal cream.

### **Weight Reduction:**

Weight reduction is one of the most difficult yet highly important step in a successful incisional hernia repair.

### **Management of Intercurrent disease:**

It includes control of chronic obstructive airway disease, chronic bronchitis, and cessation of smoking for a minimum of 2 weeks before the operation.

Hypertension and Diabetes mellitus should be controlled adequately.

## **Correction of Nutritional and vitamin deficiencies:**

Hypoproteinemia should be corrected. Vitamin deficiencies should be corrected either by oral (or) parental supplements.

## **Therapeutic pneumoperitoneum:**

In case of long standing large incisional hernias, the viscera are said to have lost the right of domicile because of prolonged period of stay outside the peritoneal cavity, within the hernial sac. The hazards attendant on an operation for such giant hernias centered about the profound changes in ventilator capacity and the reduced venous return to the right side of the heart occasioned by the forcing of a large volume of intestine and omentum back into the abdominal cavity. It was a common experience in the past to operate on such patients, encountering severe cardio respiratory failure within 6-8 hours post operatively.

This hazard can be avoided by creating therapeutic pneumoperitoneum. This procedure stretches the abdominal wall, allows pre operative adjustment to increased intra abdominal volume, increases diaphragmatic tone, and prepares the abdomen for the reduction of a large bulk of viscera.

# REVIEW OF THE LITERATURE

## *RECURRENCE FOLLOWING INCISIONAL HERNIA REPAIR*

Of all the complications of incisional hernia repair, recurrence is considered as primary outcome and guides in the selection of the technique which is most appropriate for incisional hernia repair <sup>(41, 42)</sup>.

### FACTORS CAUSING RECURRENCE:

#### 1. Inappropriate selection of suture material:-

Healing proceeds more slowly in heavily scarred tissues, with its impaired blood supply and loss of elastic fibres. So using absorbable suture material may fail to maintain approximation long enough.

#### 2. Infection.

#### 3. Haematoma.

#### 4. Obese patients.

#### 5. Preoperative comorbid conditions affecting wound healing.

#### 6. Post operative complications like abdominal distension, pulmonary complications.

#### 7. Glucocorticoid therapy.

#### 8. Failure to overlap the mesh for atleast 2-4 cms from the margin of the hernial defect or inadequate fixation of the mesh.

#### 9. Inadequate relaxation during surgery.

#### 10. Repair under tension, etc.

## FACTORS IN PREVENTING RECURRENCE OF INCISIONAL HERNIAS:

### 1. Sound surgical principles

- Gentle handling of tissues.
- Sharp dissection.
- Perfect hemostasis.
- Use of non absorbable suture material.
- Avoidance of excessive tension.

### 2. Avoidance of infection

- Preoperative antibiotics.
- Strict aseptic precautions.
- When it occurs to treat it properly and vigorously.

### 3. Use of suction drains to aspirate blood and serum.

### 4. Avoidance of post operative complications like abdominal distension by Ryles tube aspiration.

### 5. Treatment of pulmonary complications pre and post operatively.

### 6. Weight reduction in obese patients.

### 7. Using of Mesh and appropriate surgical techniques.



## MATERIALS AND METHODS

### MATERIALS:

The study was a prospective study of 109 consecutive patients admitted with the diagnosis of incisional hernia in the Thanjavur medical college and hospital between May 2006 and October 2008.

Patients were considered eligible if they had an incisional hernia, defined as a palpable fascia or muscle defect at the site of a previous abdominal incision. Hernias were detected clinically and assessed by ultrasonography.

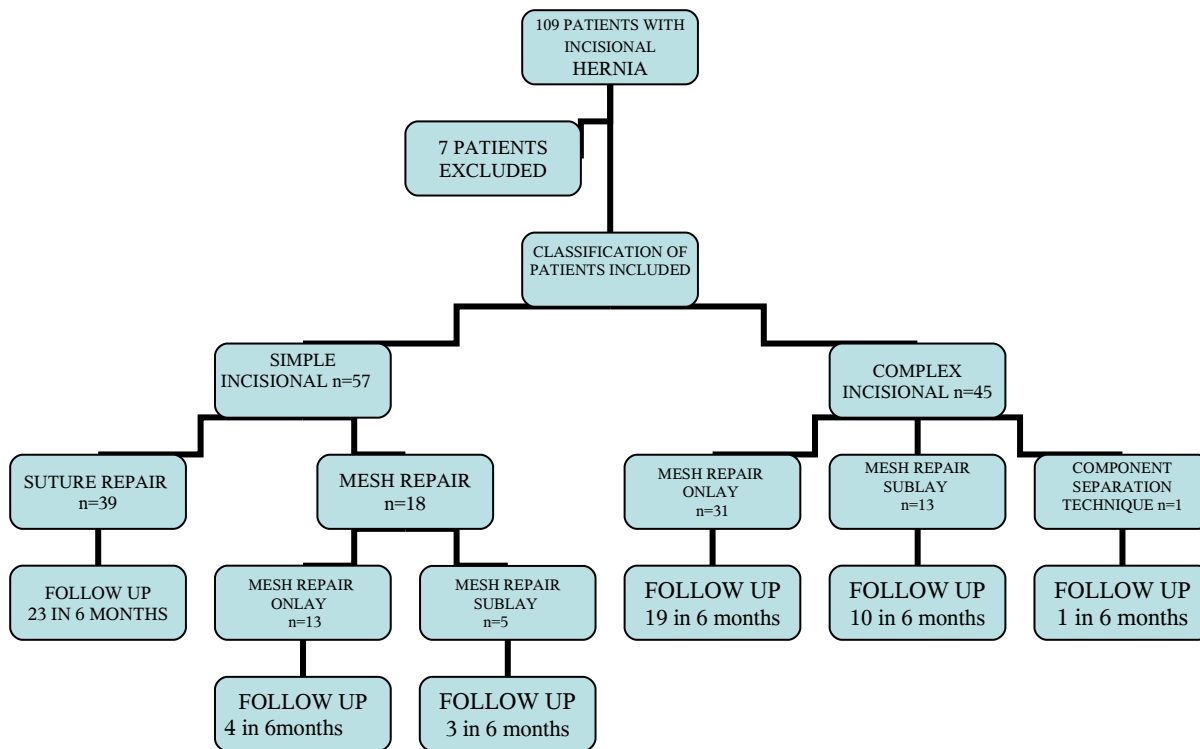
Patients who were not fit for general anesthesia, with other general contraindications for laparotomy or laparoscopy and were not operated for repair of incisional hernia were excluded. Patients presenting in emergency with obstructed or strangulated incisional hernia and who were in moribund condition also were excluded from the study. Thus 7 patients were excluded from the study.

Patients with a hernial defect of less than 6 cms in both the axis were included in "Simple" hernia group (no=57) who were subjected to Suture repair (no=39) or Mesh Onlay repair (no=13) or Preperitoneal Mesh Sublay (no=5) technique as per the discretion of the operating surgeon.

Patients with a hernial defect of more than 6 cms in either horizontal or vertical axis or with multiple defects or recurrent incisional hernia or with pathologically weak abdominal musculature assessed intraoperatively were included in "Complex" hernia group (no=45) who were subjected to Mesh Onlay repair (no=31) or Preperitoneal Mesh Sublay repair (no=13) or Autologous tissue repair (no=1) as per the discretion of the surgeon.

Results of the various techniques were compared and the short term and long term outcome were measured. All the patients gave informed consent. The college ethics committee approved the study protocol.

# STUDY DESIGN



## METHODS: -

The methods include obtaining information from the patient, thorough clinical examination and doing investigations necessary for management. All the information was entered in a proforma specially designed for this study. All the preoperative, peroperative and postoperative details and events were recorded (Annexure: A 1-5). Outcome measures and data collection were done. Health related quality of life was measured by the questionnaire prepared based on European Organization for Research and Treatment of cancer EORTC Questionnaire module. All the outcome measures were

analyzed statistically for significant difference between the treatment groups.

## METHODOLOGY: -

The patient related preoperative factors including age, sex, presence of obesity, mode of presentation, cough, constipation, prostatism, diabetes mellitus, steroid therapy, smoking status and previous abdominal surgical details were recorded.

Factors related to the previous surgical techniques and presence of seroma, hematoma, infection and dehiscence in the postoperative period of the previous surgery were recorded.

Thorough clinical examination of the patient was carried out .All the details of the incisional hernia were recorded. Rectal examination for prostate hypertrophy, external genitalia for stricture urethra and meatal stenosis were noted. Respiratory system examined for bronchial asthma, lower respiratory tract infection or chronic bronchitis.

Basic investigation like Hemoglobin %, urine examination, blood sugar, renal function parameters were done in all patients. X ray chest and ECG were taken to assess the cardiac status as examine by specialist and ECHOCARDIOGRAM was taken if necessary. ULTRASOUND abdomen and pelvis was done to assess the hernia defect and to rule out other associated factors. Urologist opinion was obtained in case of BPH and managed accordingly. Based on the above investigations patients were assessed for regional or general anesthesia and managed surgically.

## MANAGEMENT

Informed written consent was obtained in all the patients after explaining the disease and surgical techniques and postoperative complications.

All the patients were operated under general or regional anesthesia.

All the patients were prepared preoperatively as suggested and all of them received preoperative intravenous antibiotics at the time of anesthetic induction.

All the operating surgeons had wide experience of the procedure done and all the operative findings and surgical details regarding the duration of surgery, intra operative findings and type of surgical repair were recorded meticulously in all the cases. All the patients received suction drainage at the operated site as suggested.

Post operative care of all patients consisted of hernia truss, analgesics, antibiotics, Ryle's tube aspiration and bladder drainage if indicated. Drains were removed 48hours to 5 days at the latest. Low dose heparin was continued until the fifth day after surgery at the latest or as early as the patient is ambulant. Patients were informed about the type of surgery performed and instructed to avoid heavy lifting during convalescence.

#### FOLLOW UP AND OUTCOME MEASURES

The primary outcome measure was hernia recurrence. Short-term outcome results were duration of surgery and length of hospital stay.

Follow up examinations of the patients were done at 1, 2, 3, 6, 12, 18 and 24 months.

Complications served as a secondary outcome measure. Wound healing disorders were defined as any event that required reopening of the wound or treated by aspiration or puncture.

Other outcome measures included return to usual daily activities, pain and stiffness of abdominal wall and quality of life. Pain was graded post operatively and at 6 weeks and 6 months follow up by VISUAL ANALOGUE SCALE and consumption of analgesics was documented (Annexure: B 1).

HEALTH RELATED QUALITY OF LIFE was measured by Questionnaire based on the

European Organization for Research and Treatment of Cancer questionnaire module EORTC QLQ-C30 scoring manual. It measures 5 functional scales, 3 general symptom scales, 6 specific disease item scales and global quality of life. It also included a component to assess the cosmetic acceptability after surgery (Annexure: C 1). This HRQOL scores were transformed into percentages with 100% indicating maximum quality of life. One HRQOL item was use to assess the cosmetic result of the operation <sup>(36)</sup>.

## STATISTICAL ANALYSIS

Taking the two armed design and follow up losses into account, the aim was to recruit 150 patients with Incisional hernia. Primarily, data were analyzed by intention to treat. Recurrence rate were analysed by Kaplan-Meier survival analysis and the log rank test. Parametric or non-parametric tests were used according to the distribution of the continuous data. And statistical significance was calculated by using NCSS-PASS statistical software package. A Value of  $p < 0.05$  was considered statistically significant.

# OBSERVATION AND RESULTS

## PATIENT CHARACTERISTICS AND SURGICAL MANAGEMENT:

Among the 109 consecutive patients admitted with Incisional Hernia in Thanjavur medical college and hospital between May 2006 and October 2008, 2 patients were not fit for surgery and 5 patients presented with obstruction and strangulation needing emergency surgery; all these 7 patients were excluded from this prospective study.

Among the 102 patients enrolled in this study and underwent treatment; 57 patients had a simple hernia and 45 patients had a complex incisional hernia. The clinical characteristics of the patients in each group were as follows (Fig. 40-51):

## AGE INCIDENCE:

All the patients were in the age group from 21 to 80 years among them

## SEX INCIDENCE

FEMALE		MALE	
NO	%	NO	%
74	72.54	28	27.45

The various clinical characteristics and co morbid conditions associated are enumerated in next table

### CLINICAL CHARACTERISTICS OF PATIENTS

	SIMPLE HERNIA N=57		COMPLEX HERNIA N=45		
	SUTURE REPAIR N=39	MESH REPAIR N=18	MESH ONLAY N=31	MESH SUBLAY N=13	COMPONENT SEPARATION TECHNIQUE N=1
Age(years)					
Median	40	42	43	38	50
Range	22-70	30-60	25-65	25-76	
Gender					
Male	10	6	7	5	
Female	29	12	24	8	1
Specific risk factors					
Obesity					
BMI>30	5	2	6	1	
Pulmonary disease	7	5	10	6	
Smoking	1	3	1		
Cardiovascular diseases	3	2	6	3	1
Diabetes			3		
Renal disease	1	1	1		

Constipation	2		1		
Steroid treatment	1		1		
Other	2 (jaundice, anemia)		1 (hypo Thyroid)		

### HERNIA CHARACTERISTIC

The various clinical details of hernia size, modes of presentation and site of hernia and previous incision are summarised in the following table (Fig. 32- 36):

	SIMPLE HERNIA			COMPLEX HERNIA		
	SUTURE REPAIR	MESH ONLAY	MESH SUBLAY	MESH ONLAY	MESH SUBLAY	OTHERS
MEAN HERNIA SIZE CM						
VERTICAL	3.65	4.23	2.80	7.41	7.09	8
HORIZONTAL	3.59	3.92	3.40	6.18	5.37	6
MODES OF PRESENTATION						
SWELLING ONLY	26	9	3	19	8	
SWELLING AND PAIN	3	2	2	9	5	1
COMPLICATED (LOCAL, IRREDUCIBLE, OBSTRUCTED, OTHERS)	10	2		3	1	



## INDEX OPERATION:

An index operation is the previous surgery, which resulted in the incisional hernia.

Gynecological operations accounted for 68.1% of our incisional hernias. Emergency procedures accounted for 43% and Elective gynecological procedures for 57% showing almost equal incidence. However in Gastrointestinal procedures accounting for 29.3% of incisional hernias Emergency procedures carry a higher incidence of postoperative wound complications and incisional hernia formation (76.5%) compared to Elective procedures, which account for only 23.5%.

## INITIAL OPERATIVE PRECEDURES AND ORGANS OPERATED UPON

INDEX OPERATION	EMERGENCY	ELECTIVE
GYNAECOLOGICAL		
LSCS	20	20
HYSTERECTOMY	12	6
TUBECTOMY		14
OOPHERECTOMY +/-	2	2
SALPHINGECTOMY		
LAPAROSCOPIC STERILISATION		3
GASTROINTESTINAL		
UPPER GI / BILLIARY		
GASTRO DUODENAL	6	1
CHOLECYSTECTOMY		3
LOWER GASTRO INTESTINAL		
APPENDICECTOMY	11	2
OTHERS	7	1
PENETATING ABDOMINAL	2	
INJURY		
MALIGNANCY		1
PYEOLITHOTOMY		2
OTHERS (UMBILICAL HERNIA		1
REPAIR)		

## COMPLICATIONS FOLLOWING INDEX OPERATION

COMPLICATION**	NUMBER
WOUND INFECTION	37
WOUND SEROMA	21
WOUND HEMATOMA	10
WOUND DISRUPTION	10
BURST ABDOMEN	4
SECONDARY SUTURING	14

SINUS / FISTULA / ULCER	3
OTHERS*	3

\* Include general complication like Ileus, Peritonitis and Cardiovascular problems.

\*\* Most of the complications were common in Emergency procedure.

#### TIME OF ONSET FOLLOWING INDEX OPERATION

Early time of onset following the Index operation occurred mostly in patient with wound dehiscence post operatively, which was more common in Emergency procedures and gastrointestinal procedures. In Gynecological procedure like lower segment caesarian section (LSCS) and Tubectomy, Incisional hernia presented late; while in hysterectomy patients, it presented earlier. The distribution of the time of onset following Index operation is shown below.

TIME	NUMBER
FIRST MONTH	14
2-6 MONTHS	29
7-12 MONTHS	5
2-3 YEARS	19
4-5 YEARS	9
LONGER	32

### COMPARISON BETWEEN THE OUTCOMES OF VARIOUS TECHNIQUES FOR INCISIONAL HERNIA REPAIR.

A) COMPARISON BETWEEN SUTURE REPAIR AND MESH REPAIR:

#### SHORT AND LONG TERM OUTCOMES

	SIMPLE HERNIA		
	SUTURE REPAIR n=39	MESH REPAIR n=18	p VALUE
Short term Results			
Length of operation (min)*	41.8 (12.4)	42.94 (7.93)	0.687 <sup>^</sup>
Hospital stay (days)+	8 (5.5-9.5)	9.5 (7.25-1.75)	0.04 <sup>^^</sup>
Results at 6 weeks			
Return to full activity(weeks)+	4 (3-8) n=37	4 (3-4.75) n=18	0.317 <sup>^^</sup>
Pain intensity (VAS)+	0 (0-0)	0.5 (0-1.75)	0.03 <sup>^^</sup>
Presence of pain (VAS >0)	9 of 37	9 of 18	0.04 <sup>^^^</sup>
Results at 6 months			
Pain intensity (VAS)+	0 (0-0) n=23	0 (0-0.75) n=6	0.08 <sup>^^</sup>
Presence of pain (VAS >0)	0 of 23	2 of 6	0.13 <sup>^^^</sup>

Quality of life (%) **	72 (5.38)	66.57 (13.25)	0.306 <sup>^</sup>
Follow up			
Duration (months)+	6 (3-10)	4 (3-6.75)	0.154 <sup>^^</sup>

\* Values are mean (s.d) or +median (25<sup>th</sup> and 75<sup>th</sup> percentiles):

\*\*Mean values (s.d), a value of 100% indicate perfect quality of life;

<sup>^</sup>t-test; <sup>^^</sup> Mann-Whitney U test; <sup>^^^</sup>Chi-squares test; VAS-visual analogue scale.

## B) COMPARISON BETWEEN MESH SUBLAY AND MESH ONLY TECHNIQUES FOR INCISIONAL HERNIA REPAIR:

### SHORT AND LONG TERM OUTCOMES

	SIMPLE HERNIA			COMPLEX HERNIA		
	MESH SUBLAY n=5	MESH ONLY n=13	p value	MESH SUBLAY n=13	MESH ONLY n=31	p value
Short term Results						
Length of operation (min)*	36.2 (6.57)	45.54 (6.96)	0.02 <sup>^</sup>	57.85 (48-72)	53.58 (47-58)	0.39 <sup>^</sup>
Hospital stay (days)+	6 (4-7)	10 (9-15)	0.01 <sup>^^</sup>	8 (8-10)	14 (9.5-17)	0.001 <sup>^^</sup>
Results at 6 weeks						
Return to full activity (weeks)+	2 (2-3) n=5	4 (4-6) n=13	0.001 <sup>^^</sup>	3 (2-3) n=13	9.5 (5.25-12) n=31	0.001 <sup>^^</sup>
Pain intensity (VAS)+	0 (0-0)	1 (0-3)	0.001 <sup>^^</sup>	0 (0-0)	1(1-2)	0.001 <sup>^^</sup>
Presence of pain (VAS >0)	0 of 5	9 of 13	0.01 <sup>^^^</sup>	2 of 13	26 of 29	0.02 <sup>^^^</sup>
Results at 6 months						
Pain intensity (VAS)+	0 (0-0) n=3	1 (0.5-2) n=3	0.08 <sup>^^</sup>	0 (0-0) n=10	0 (0-1) n=19	0.04 <sup>^^</sup>
Presence of pain (VAS >0)	0 of 3	2 of 3	0.32 <sup>^^^</sup>	0 of 10	7 of 19	0.132 <sup>^^^</sup>
Quality of life (%) **	78 (3.46)	58 (10.7)	0.02 <sup>^</sup>	71.4 (4.22)	55.68 (5.87)	0.001 <sup>^</sup>
Follow up						
Duration (months)+	6 (3-15)	4(3-6)	0.17 <sup>^^</sup>	8 (6-15)	6 (3-10)	0.1 <sup>^^</sup>

\* Values are mean (s.d) or +median (25<sup>th</sup> and 75<sup>th</sup> percentiles):

\*\*mean values (s.d), a value of 100% indicate perfect quality of life;

<sup>^</sup>t-test; <sup>^^</sup> Mann-Whitney U test; <sup>^^^</sup>Chi-squares test; VAS-visual analogue scale

## COMPLICATIONS OF SURGERY AND HERNIA RECURRENCES

	SIMPLE HERNIA			COMPLEX HERNIA	
	SUTURE	MESH	MESH	MESH	MESH
	REPAIR	ONLAY	SUBLAY	ONLAY	SUBLAY
<b>LOCAL COMPLICATIONS</b>					
INFECTION MAJOR	3	2	-	5	-
INFECTION MINOR	2	2	-	3	1
HEMATOMA	1	-	-	1	-
SEROMA	3	2	-	5	1
FLAP NECROSIS	2	2	-	4	-
WOUND DEHISCENCE	-	-	-	1	-
SINUS	1	1	-	2	-
INDURATION AND PAIN	9	9	-	7	-
MESH INFECTION AND REMOVAL	-	-	-	1	-
TOTAL (intention to treat analysis)	6 of 39 (15.38%)	3 of 13 (23.07%)	0 of 5	15 of 31 (48.38%)	1 of 13 (0.07%)
TOTAL (analysis as treated)	4 of 39 (10.25%)	3 of 13 (23.07%)	-	13 of 31 (41.93%)	0 of 13
<b>GENERAL COMPLICATIONS</b>					
ILEUS	2	1	-	2	-
INADVERTANT ENTEROTOMY	1	-	-	1	-
MAJOR (CARDIO PULMONARY, THROMBOEMBOLIC, NEUROLOGIC)	1	-	-	1	-
MORTALITY*	-	-	-	-	-
RECURRENCE**	1(3)	-	-	(1)	-

\* 1 MORTALITY OCCURRED IN A STRANGULATED INCISIONAL HERNIA, WHICH WAS NOT INCLUDED IN THE STUDY.

\*\*ONLY ONE CASE OF RECURRENCE IN SUTURE GROUP WAS NOTED IN THE PATIENTS OPERATED DURING THE STUDY PERIOD; THERE WAS TWO OTHER CASES OF RECURRENCE OF SUTURE REPAIR DONE BEFORE THE STUDY PERIOD, WHICH WERE TREATED BY MESH REPAIR, AND SIMILARLY RECURRENCE OF ONE CASE OF MESH REPAIR OPERATED BEFORE THE STUDY WAS ALSO TREATED.

## DISCUSSION

All the patients who were included in the study were admitted at our hospital. And detailed history and physical examination was done as discussed above and all were recorded in the appropriate proforma prepared and stored.

Analysis of observed data were done to trace the etiological factors and identify the risk factors for incisional hernia formation and compare the various surgical techniques for incisional hernia repair and evaluate the short term and long term outcomes of the surgical techniques.

### AGE AND SEX INCIDENCE

In this study of 109 patients with incisional hernia, the gynecological causes of laparotomy were most commonly associated with incisional hernia formation (68.1%) and naturally the incidence was found to high among females (72.5%). If we consider only those operations performed on both the sexes, then incisional hernia occurred more frequently in males than females by a ratio of approximately 4.5:1. This in comparison with a similar study done at Henry Ford Hospital of 794 patients, the sex distribution was in the ratio of 3:2 (Fig. 41).

The incisional hernia occurrence was most commonly noted between the age group of 30-50 years in this study, compared to the Henry Ford Hospital group, which had more patients above 40 years. This could be explained by the large number of gynecological procedures done at younger age group <sup>(23)</sup> (Fig. 40).

### CLINICAL CHARACTERISTICS

Most of the patients with incisional hernia presented with swelling alone and even in large hernia only discomfort was present. Pain was noticed in patients with very narrow neck and with features of obstruction. Among the 109 patients, 5 patients presented with acute intestinal obstruction and features of strangulation and immediate emergency intervention was done and one patient expired among them due to various causes. This was the only mortality in this study group. All these 5 patients were excluded from further study for outcome measurement (Fig. 42).

Many comorbid conditions were identified with the patients predisposing to incisional hernia formation (Fig. 43). Obesity accounted for 13.7% of patients, as already discussed it is an important predisposing factor. Pulmonary diseases and smoking were found in 32.5 % patients which cause chronic cough and lead on to wound dehiscence and cardiovascular diseases were found in 14.7 % patients. Other factors predisposing to raised intra abdominal pressure like constipation and prostatism were present in 6 patients and factors affecting wound healing like diabetes, steroid intake, anemia and jaundice were found in 8 patients. In general, in 44.4% patients certain comorbid conditions were found.

Physical examination of the patient was done to identify the hernia size, site and other characters. In 57 patients the hernia was simple with defect less than 6 cms in size and 47 patients had complex hernia with large defects or multiple defects or weak abdominal wall (Fig. 44). All the findings were noted and summarized.

#### SITE OF HERNIA

The most common site of hernia was found in the lower midline below the umbilicus. It was found in about 40.1% of patients. It is well known and as already discussed lower vertical midline incisions were more prone for incisional hernia formation. It was commonly used for in gynecological

operations. It was impossible to obtain accurate statistics on the exact frequency of incisional hernias following various operations since precise records of the procedures were not available (Fig. 32)

Next in frequency were umbilical/paraumbilical used for tubectomy and lower transverse incisions (pfanensteil) used mostly in elective gynecological operations accounting in 14 and 11 patients each (Fig. 33).

Upper midline vertical incisions used for upper gastrointestinal procedures accounted for 9 patients and combined upper and lower midline incision were used in emergency procedures (Fig. 34). Other rare sites were Paramedian, Mcburneys (Fig. 35), Lumbar (Fig. 36) and multiple incisions scar used for multiple laparotomies (23, 33) (Fig. 45, 46).

#### INDEX OPERATION AND ITS POST OPERATIVE COMPLICATIONS:

An index operation is the previous surgery, which resulted in the incisional Hernia (Fig. 47). Gynecological operations accounted for 68.1% of our incisional hernias Emergency procedures accounted for 43% and Elective gynecological procedures for 57% showing almost equal incidence. Lower segment caesarian section was the most common operation either by midline or pfanensteil incision. Other procedures included tubectomy, hysterectomy and ovarian cyst excision.

In Gastrointestinal procedures which accounted for 29.3% of incisional hernias. Emergency procedures carry a higher incidence of post operative wound complications and incisional hernia formation (76.5%) compared to Elective procedures, which account for only 23.5%.

Upper gastrointestinal procedures mainly included complications of duodenal ulcer and biliary tract procedures. Lower gastrointestinal tract mainly involved emergency appendectomy. All these

procedures were complicated by wound infection and predisposed to incisional hernia formation.

Operations following trauma like penetrating injuries also had a higher incidence of hernia. Elective lower gastrointestinal tract had fewer incidence of hernia.

Complications following the Index operations mainly predominated by wound related infections and seroma and ultimately leading to wound failure and resulting in incisional hernia formation.

Although precise incidence of wound infection as a factor in genesis of incisional hernia has not been determined, it was found to be a major factor for the occurrence of incisional hernia in about 50% of the reported patients in this study. Other general complications like ileus and peritonitis were rare.

Onset of incisional hernia after the index operation was very interesting and informative (Fig. 48). It was found out that in 42.15% of patients incisional hernia occurred within 6 months of the operation. This observation suggests that the technique of wound closure was inadequate and use of non-absorbable suture material is important in the prevention of incisional hernias.

## **ETIOLOGICAL FACTORS IN INCISIONAL HERNIA**

It was impossible to ascribe the appearance of an incisional hernia to a single cause, since so often more than one factor was operative in causation <sup>(23, 31, 37)</sup>. But it was important to identify the factors predisposing to incisional hernia so that it can be eliminated and incisional hernia occurrence can be prevented. From the above observations in this study, the various factors predisposing to incisional hernia were identified as follows:

1. Wound infection and disruption – as a factor was identified in more than 50% of the patients, which can be prevented, by strict aseptic precautions and appropriate antibiotic treatment.
2. Faulty technique – as identified in 42.15% of patient with early onset of incisional hernia was



probably due to faulty techniques, which can be eliminated by using proper technique and evaluating its outcome.

3. Comorbid conditions - were found in 44.4% of patients. Although all the factors cannot be eliminated, most can be treated in anticipation of incisional hernia and thus it can be prevented.

4. Undetermined cause- the etiologic factors could not be identified in a large number of patients.

## CLINICAL OUTCOMES OF VARIOUS SURGICAL TECHNIQUES

### PRIMARY OUTCOME MEASURES

#### SIMPLE HERNIA:

##### COMPARISON BETWEEN SUTURE REPAIR AND MESH REPAIR

#### SHORT TERM RESULTS:

The short-term results were evaluated based on the duration of surgery and the length of hospital stay.

It was found out that the duration of surgery was almost similar between both the groups (p value=0.687; not significant)

Study	Suture repair	Mesh repair
Our study	41.8 mins.	42.94 mins.
Luijendijk et al <sup>(10)</sup>	45 mins.	58 mins.

#### Length of hospital stay

Study	Suture repair	Mesh repair
Our study	8 (5.5-9.5) days	9.5 (7.25-11.75) days.
Luijendijk et al <sup>(10)</sup>	6.2 (1-27) days	6.3 (1-28) days

In our study it was found out that patients with suture repair had significant shorter hospital stay (p Value- <0.04) compared to mesh repair. This may be due to less complication rate in suture repair.

## RESULTS AT 6 WEEK FOLLOW UP

Return to full activity:

Study	Suture repair	Mesh repair
Our study	4 (3-8) days n=37	4 (3-4.75) days n=18
Luijendijk et al	4-20 days	2-14 days

There was no statistically significant difference between the two groups (p Value =0.317).

Pain intensity and Presence of Pain:

Pain as measured by Visual Analogue Scale was statistically significant.

Pain intensity (VAS)+	0 (0-0)	0.5 (0-1.75)	0.03^^
Presence of pain (VAS >0)	9 of 37	9 of 18	0.04^^^

This was mainly due to the dull aching pain and induration, which were due to the foreign body reaction to the mesh.

## RESULTS AT 6 MONTHS FOLLOW UP

Pain intensity and Presence of Pain

Pain intensity (VAS)+	0 (0-0) n=23	0 (0-0.75) n=6	0.08^^
Presence of pain (VAS >0)	0 of 23	2 of 6	0.13^^^

This shows that at 6 months the presence of pain was not statistically significant.

## HEALTH RELATED QUALITY OF LIFE:

The health related quality of life as measured by the EORTC Questionnaire showed that there was no difference in quality of life, which also includes cosmetic effect in between the two groups.

Quality of life (%) **	72 (5.38)	66.57 (13.25)	0.306 <sup>^</sup>
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The mean duration of follow up was also similar between the two groups; hence the outcomes measured are reliable.

Duration (months)+	6 (3-10)	4 (3-6.75)	0.154 <sup>^^</sup>
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## COMPARISON BETWEEN MESH ONLAY AND MESH SUBLAY REPAIR IN BOTH SIMPLE AND COMPLEX HERNIA

### SHORT TERM RESULTS:

Duration of surgery

	Simple Hernia			Complex Hernia		
	Mesh sublay	Mesh onlay	p value	Mesh sublay	Mesh onlay	p value
Length of operation(min)*	36.2 (6.57)	45.54 (6.96)	0.02 <sup>^</sup>	57.85 (48-72)	53.58 (47-58)	0.39 <sup>^</sup>

This shows that the time taken for mesh sublay in a simple hernia is shorter, but in a complex hernia there is no significant difference.

Length of hospital stay

	SIMPLE HERNIA			COMPLEX HERNIA		
	MESH	MESH	p value	MESH	MESH	p value
	SUBLAY	ONLAY		SUBLAY	ONLAY	
	n=5	n=13		n=13	n=31	
Hospital stay (days)+	6 (4-7)	10 (9-15)	0.01 ^^	8 (8-10)	14 (9.5-17)	0.001 ^^

There was a very much significant difference between the sublay and onlay repair in both the hernia groups, this is mainly because of the absence of complications in sublay technique.

#### RESULTS AT 6 WEEK FOLLOW UP

Return to full activity:

	SIMPLE HERNIA			COMPLEX HERNIA		
	MESH	MESH	p value	MESH	MESH	p value
	SUBLAY	ONLAY		SUBLAY	ONLAY	
	n=5	n=13		n=13	n=31	
Return to full activity (weeks)	2 (2-3)	4 (4-6)	0.001^^	3 (2-3)	9.5	0.001^
+	n=5	n=13		n=13	(5.25-12 ) n=31	^

This also shows that sublay technique had better outcome in the form of early return to activity in both the groups.

Pain intensity and Presence of Pain at 6 weeks and 6 months

	SIMPLE HERNIA			COMPLEX HERNIA		
	MESH	MESH	p value	MESH	MESH	p value
	SUBLAY	ONLAY		SUBLAY	ONLAY	
	n=5	n=13		n=13	n=31	
Results at 6 weeks						
Pain intensity (VAS)+	0 (0-0)	1 (0-3)	0.001^^	0 (0-0)	1(1-2)	0.001^^
Presence of pain (VAS >0)	0 of 5	9 of 13	0.01^^^	2 of 13	26 of 29	0.02 ^^
Results at 6 months						
Pain intensity (VAS)+	0 (0-0)	1 (0.5-2)	0.08^^	0 (0-0)	0 (0-1)	0.04 ^^
	n=3	n=3		n=10	n-19	

Presence of pain (VAS >0)	0 of 3	2 of 3	0.32 <sup>^^</sup>	0 of 10	7 of 19	0.132 <sup>^^^</sup>
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There was significantly better painless outcome by sublay techniques in both the groups at 6 weeks time. By 6 months the pain is similar in both groups.

**RESULTS AT 6 MONTHS FOLLOW UP**

**HEALTH RELATED QUALITY OF LIFE:**

Quality of life (%) **	78 (3.46)	58 (10.7)	0.02 <sup>^</sup>	71.4 (4.22)	55.68 (5.87)	0.001 <sup>^</sup>
Follow up						
Duration (months)+	6 (3-15)	4(3-6)	0.17 <sup>^^</sup>	8 (6-15)	6 (3-10)	0.1 <sup>^^</sup>

The quality of life was found to be better after sublay technique significantly in both groups in a similar follow up period.

**SECONDARY OUTCOME MEASURES:**

**POST OPERATIVE COMPLICATIONS**

A) In the simple hernia group, both the suture repair group and in mesh repair mesh onlay group had similar pattern and rate of complications, which were not significant statistically.

In suture repair 4 patients out of 39 patients were treated for complications and mesh onlay group 3 out of 13 patients were treated. None of the patients in sublay group had any complications.

Pain was the major complaint in both the groups followed by wound infections, seroma, flap necrosis and sinus formation. All were treated accordingly.

Among general complications one patient had inadvertent bowel injury in the suture group and prolonged ileus in 2 patients and a cardiovascular incident unrelated to the surgical procedure (Fig.37, 38, 49, 50).

B) In a complex hernia, there was more wound related complications like wound infections, seroma, flap necrosis and wound dehiscence needing secondary suturing among patient treated with onlay repair. Severe infection resulting in mesh extrusion and removal occurred in one patient (Fig.39, 40, 49, 50).

There was no significant complication in mesh sublay group.

All the above findings were comparable with the randomized clinical trial for incisional hernia by M.Korenkov, S.Sauerland et all. <sup>(25)</sup>

## **RECURRENCES;**

Only one case of recurrence was noted in the follow up of patients operated during the study period 3 months following the suture repair using the Mayo's technique.

Two other cases of recurrences following suture repair that were operated before the study period came with first recurrence. Both the patients were treated by mesh repair.

Similarly one case of recurrence following mesh repair operated before the study period also presented as first recurrence that was also treated by mesh repair.

In order to compare the suture repair and mesh repair, the two cases of recurrence were considered as primary recurrence following suture repair along with the one recurrence that occurred during the study period and similarly one case of recurrence following mesh repair was considered as primary recurrence after mesh repair and analysed.

Recurrence rate were calculated and analysed by Kaplan-Meier survival analysis and log rank test (Fig. 51). There was no statistical difference between the recurrence rates between the suture repair and mesh repair in general ( $p = 0.69$ ). This was also similar to the results of M.Korenkov, et all <sup>(25)</sup>. Unlike Luijendijk who reported higher recurrence rate for suture repair (43%), our study didn't report high incidence rate at the end of 30 months follow up <sup>(10)</sup>.

## SUMMARY

The summary of the observations made in this study is as follows:

1. Of the 109 cases admitted in our hospital, 102 cases were included in this prospective study of incisional hernia and the outcomes of various surgical techniques; out of which 57 cases were included in simple hernia group and 45 cases were included in the complex hernia group.
2. Incisional hernia was common in the age group of 30-50 years. The minimum age of occurrence being 22 years and the maximum age being 76 years.
3. Female patients constituted the majority of about 72.5% since gynecological causes were the most common Index operation performed (68.1%). In operations common to both sexes males predominated in the ratio of 4.5:1.
4. The commonest site of Incisional hernia formation was following lower midline incision.
5. The commonest presentation was swelling alone in most of the patients, but pain over the swelling occurred in 21% of the patients and complications was found in 15.7% of the patients at the time of presentation.
6. The presentation of the incisional hernia occurred within 6 months duration in 42.16% and in 31.3% of the patients, it occurred late after 5 years.
7. The Etiological factors identified among the patients with incisional hernia were probably wound related complications in about 50% of the patients, faulty techniques in 42.15%, comorbid conditions in 44.4% and undetermined in most of the patients.
8. Of the simple hernia, 39 patients underwent suture repair by various techniques and 18 patients underwent mesh repair by onlay technique in 13 patients and sublay technique in 5 patients and were followed up and compared for analysis.
9. Of the complex hernia, 31 patients underwent onlay mesh repair, 13 patients underwent sublay repair and by component separation technique in one patient and were followed up and compared for analysis. In general onlay repair was done in 44 patients and sublay repair was done in 18 patients and

were compared for analysis.

10. Short-term clinical outcomes compared were length of operation and hospital stay. In simple hernia, the duration of the operation was the same for both the suture repair and mesh repair; but the hospital stay was significantly lower in suture repair group compared to mesh repair. On comparison between sublay and onlay group in both simple and complex hernia, both the duration of operation and the hospital stay were significantly lower in sublay repair.
11. Long term follow up at 6 weeks and 6 months were done and the clinical outcome measured were presence of pain and pain intensity, return to full activity and quality of life outcome which also included cosmetic appearance.
12. The pain was present in significant number of patients with mesh repair compared to suture repair in a simple hernia group, but the long term follow up of return to full activity and quality of life were similar.
13. On comparison of sublay type and onlay type of mesh repair, the pain levels, return to daily activity and quality of life were significantly better in sublay repair, in both the simple and complex hernia.
14. The incidence of complications in suture repair was about 15.38% and in mesh repair it was about 23.07%, which needed treatment in all the cases.
15. The incidence of complications was very significantly low in sublay type of mesh repair (0.07%) compared to onlay type of repair (48.35%).
16. There was only one case of recurrence noted in the suture repair group during the study period, even when first recurrence (2 after primary suture repair and one after primary mesh repair operated before the study period) were to be taken as primary, there was no statistical difference in recurrence rates between the suture repair and mesh repair in general.
17. In conclusion, onlay mesh repair of incisional hernia carried a high risk of infections and local wound related complications and pain in the current study. Therefore conventional suture techniques may still have a place in the repair of a small, simple incisional hernia.



18. In both the simple and complex incisional hernia, sublay technique in which mesh is placed in the retrorectus space is the most ideal repair technique.

19. The limitations of this study were as follows:

- There were no randomization of the patients done in this study
- It was limited in its validity due to small sample size and short follow up period.
- As it was an unblinded study, there was chance of observational bias.

20. The suggestion from this study was the need for a large randomized controlled trial comparing the sublay technique and onlay technique of mesh placement in incisional hernia repair.

## CONCLUSIONS

1. The main etiological factors identified for the occurrence of incisional hernia were wound related complications, faulty techniques, comorbid conditions and undetermined causes. Hence the incidence of the incisional hernia can be decreased by preventing these factors and by early identification and providing appropriate treatment.
2. In a small, simple incisional hernia, onlay mesh repair of incisional hernia carried a high risk of infections and local wound related complications and pain in the current study which was similar to various studies.
3. In a small, simple incisional hernia, suture repair had similar outcomes in terms of recurrence rates. The incidence of other complications was less compared to onlay mesh repair in a small, simple hernia. Hence in a small, simple incisional hernia, repair by conventional suture repair still has a role if proper technique is used and other factors for recurrences are taken care of. These findings correlated with that of the randomized trial conducted by M.Korenkov, S.Sauerland et al <sup>(25)</sup>.
4. In both the simple and complex hernia, Sublay technique of Mesh repair, where the mesh is placed preperitoneally in a retro-rectus plane had virtually no complications and both the short term and long term results were excellent.
5. Comparing with other techniques it has an excellent post operative quality of life and better patient acceptability, which is similar to other studies <sup>(15-20, 32)</sup>.
6. Preperitoneal Retro-rectus Sublay technique of incisional hernia repair is the ideal technique of choice, which needs further long term randomized trials for validation and confirmation.
- 7.

## BIBLIOGRAPHY

1. Cassar K, Munro A (2002). Surgical treatment of incisional hernia. *Br J Surg* 89:534-545.
2. Bucknall TE, Cox PJ, Ellis H. Burst abdomen and incisional hernia: a prospective study of 1129 major laparotomies. *BMJ* 1982; 284; 931-3.
3. Mudge M, Hughes LE. Incisional hernia: a 10-year prospective study of incidence and attitudes. *Br J Surg* 1985; 72:70-1.
4. Regnard JF, Hay JM, Rea s, Flamant Y, Fingerhut A, Maillard JN: Ventral incisional hernias: incidence, date of recurrence, localization and risk factors. *Ital J Surg Sci* 1988; 18:259-65.
5. Read RC, Yoder G. Recent trends in the management of incisional herniation. *Arch Surg* 1989; 124:485-8.
6. Santora TA, Rosyln JJ. Incisional hernia. *Surg Clin North Am* 1993; 73: 557-70.
7. Van der Linden FT, Van Vroonhoven TJ. Long term results after surgical correction of incisional hernia. *Neth J Surg* 1988; 40; 127-9.
8. Langer S, Christiansen J. Long term results after incisional hernia repair. *Acta Chir Scand* 1985; 151:217-19.
9. Korenkov M, Paul A, Sauerland S, Neugebauer E, Arndt M, Chevrel JP Et Al. Classification and surgical treatment of incisional hernia. Results of an experts' meeting. *Langenbecks Arch Surg* 2001: 386; 65-73.
10. Luijendijk RW, Hop WC, et al. A comparison of suture repair with mesh repair for incisional hernia. *N Engl J Med* 2000; 343; 392-8.
11. Morris- Stiff GJ, Hughes LE. The outcomes of non-absorbable mesh placed within the abdominal cavity: literature review and clinical experience. *J Am Coll Surg* 1998; 186:352-67.
12. Leber GE, Garb JL, Reed WP, et al, Long term complications associated with prosthetic repair of incisional hernia. *Arch Surg* 1998; 133:378-82.
13. Klinge U, Muller M, Schumpelick V. Shrinking of polypropylene mesh in vivo: an experimental study in dogs. *Eur J Surg* 1998; 164: 965-9.
14. Vrijland WW, Jeekel J , et al. Intraperitoneal polypropylene mesh repair of incisional hernia is not associated with enterocutaneous fistula. *Br J Surg* 2000; 87: 348-52.
15. Schumpelick V, Conze J, Klinge U. Preperitoneal mesh-plasty in incisional hernia repair. A comparative retrospective study of 272 operated incisional hernias. *Chirurg* 1996; 67: 1028-35.
16. Martin Kurzer, Allan Kark, et al, Open mesh repair of Incisional hernia using a sublay technique- long term follow up. *World J Surg* 2008: 32:31-36.
17. Corey W, Iqbal, Tuan H. Pham, Antony Joseph, Long-term follow up and outcome of 254 complex incisional hernia repairs using the modified Rives- Stoppa technique. *World J Surg* 2007; 31: 2398-2904.
18. Mclanahan D, King LT, et al, Retro rectus prosthetic mesh repair of midline abdominal hernia. *Am J Surg* 1997; 173: 445-9.
19. Temudom T, Siadati M, et al, Repair of complex giant or recurrent ventral hernias by using tension free intraperietal prosthetic repair (Stoppa). *Surgery* 1996; 120:738-43.
20. Gillion JF, Begin GF, et al. Expanded polytetrafluoroethylene patches used in the intraperitoneal or extra peritoneal position for repair of incisional hernias of the antero lateral abdominal wall. *Am J Surg* 1997; 174:16-19.
21. Ladurner R, TrupkaA, et al, The use of 100 underlay polypropylene mesh in complicated incisional hernias. *Minerva Chir* 2001; 56:111-17.
22. Martin DuceA, Lozano, et al. Modifications to Rives stoppa technique for midline incisional hernia. *Hernia* 2001; 5:70-2.
23. Joseph L. Ponka. Hernias of the abdominal wall. 1980.
24. Pollk R, Nyhus LM. Incisional hernias: IM: Schwartz SI, Ellis H, Maingot's abdominal

- operation, 8<sup>th</sup> edition. Vol 1.
25. Korenkov M, Sauerland S, Neugebauer E, Arndt M, Chevrel JP Et Al, Randomised controlled trial of suture repair, polypropylene mesh repair or autodermal hernioplasty for incisional hernia. *Br J Surg* 2002; 89:50-56.
  26. John E. Skandalaki's- *Surgical Anatomy – The Embryologic and Anatomic basis of modern surgery*. 2004.
  27. B.D. Chaurasia's. *Textbook of Human Anatomy*. 4<sup>th</sup> edition.
  28. *Gray's Anatomy*. 38<sup>th</sup> edition.
  29. *Mcminn's Atlas of Human Anatomy*.
  30. Loh A, Rajkumar JS, South LM. Anatomical Repair of large incisional hernias. *Ann R Coll Surg Eng* 1992; 74:100-5.
  31. Ravitch M.M. Ventral hernia. *Surg Cl. North Am*; 51:1341-1971.
  32. Mahabhaleswar G. Bhat, Santosh K. Somasundaram. Preperitoneal mesh repair of incisional hernia: a seven-year prospective study; *Indian J Surg*; Jun 2007; 69: 95-98.
  33. Marcelo A. Beltran, Karina S. Cruces, Incisional Hernia after McBurney Incision: Retrospective Case-control Study of Risk Factors and Surgical Treatment. *World J Surg*; 2008; 32: 596-601.
  34. deVries T.S. Reilingh, et al Repair of Giant Midline Abdominal wall Hernias: "Component Separation Technique" versus Prosthetic Repair. *World J Surg*. 2007; 31:756-763.
  35. deVries T.S. Reilingh, et al, Autologous tissue repair of large abdominal wall defects. *Br J Surg*. 2007; 94: 791-803.
  36. Fayer P, Aaronson NR, Bjordal K, Groenvald, Curran D, Bottomley A. The EORTC QLQ-C30 scoring manual (3rd edition). European Organization for Research and treatment of cancer. Brussels.2001.
  37. Dan H. Shell IV, Jorge de la Torre, et al., Open repair of ventral incisional hernia; *Advances in Abdominal wall hernia repair*; *Surg Clinics of North America*, Feb 2008, vol 88, No. 1.
  38. Robert J. Fitzgibbons et al., *Nyhus and Condon's Hernia*.
  39. Pradeep Chowbey., *Endoscopic repair of abdominal wall hernias*. 2004.
  40. Larson GM. Ventral hernia repair by the laparoscopic approach. *Surg Clin North America* 2000; 80:1329-40.
  41. Grecim IE, Kocak S, Ersoz S, et al . Recurrence after incisional hernia repair: results and risk factors. *Surg today* 1996;26 : 607-9.
  42. Leber GE, Garb JL, Alexander AI, Read WP. Long term complications associated with prosthetic repair of incisional hernias. *Arch Surg* 1998; 133: 378-82.
  43. Park A, Gagner M, Pomp A. Lapaoscopic repair of large incisional hernias. *Surg Lapaosc Endosc* 1996; 6: 123-8.
  44. Heinfeld BT, Park A, Ramshaw BJ, Voeller G. Laparoscopic ventral and incisional hernia repair in 407 patients. *J Am Coll Surg* 2000; 190: 645-50.