PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE LIGHTWEIGHT MESH AND CONVENTIONAL PROLENE MESH IN LICHTENSTEIN HERNIA REPAIR

By

Dr. GUGRI MUKTHINATH

DISSERTATION SUBMITTED TO SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTRE, KOLAR, KARNATAKA

In partial fulfillment of the requirements for the degree of

MASTER OF SURGERY
IN
GENERAL SURGERY

UNDER THE GUIDANCE OF
Prof. A. BHASKARAN

DEPARTMENT OF GENERAL SURGERY
SRI DEVARAJ URS MEDICAL COLLEGE
TAMAKA, KOLAR-563101

MAY-2015

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation/thesis entitled "**PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE LIGHTWEIGHT MESH AND CONVENTIONAL PROLENE MESH IN LICHTENSTEIN HERNIA REPAIR** " is a bonafide and genuine research work carried out by me under the guidance of Prof.A.BHASKARAN, Department of General Surgery, Sri Devaraj Urs Medical College, Tamaka, Kolar

Dr. GUGRI MUKTHINATH

Date:

Place: Kolar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION, TAMAKA, KOLAR, KARNATAKA

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled "**PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE LIGHTWEIGHT MESH AND CONVENTIONAL PROLENE MESH IN LICHTENSTEIN HERNIA REPAIR**" in partial fulfillment of the requirement for the Degree of MASTER OF SURGERY in GENERAL SURGERY.

Signature of the Guide

Date:

Place: Kolar

Prof. A.BHASKARAN,
Department of General Surgery,
Sri Devaraj Urs Medical College,
& Research Centre, Tamaka, Kolar.

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTRE, TAMAKA, KOLAR, KARNATAKA

ENDORSEMENT BY THE HOD,

PRINCIPAL / HEAD OF THE INSTITUTION

This is to certify that the dissertation entitled "**PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE LIGHTWEIGHT MESH AND CONVENTIONAL PROLENE MESH IN LICHTENSTEIN HERNIA REPAIR** "s a bonafide research work done by Dr. GUGRI MUKTHINATH under the guidance of Prof.A.BHASKARAN, Department Of General Surgery

Dr. K.MOHAN KUMAR
Professor,
Department of General Surgery,
Sri Devaraj Urs Medical College,
& Research Centre, Tamaka, Kolar.

Date:
Place: Kolar

Dr. M. B. SANIKOP
Principal,
Sri Devaraj Urs Medical College,
& Research Centre, Tamaka, Kolar.

Date:
Place: Kolar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH

CENTRE, TAMAKA, KOLAR, KARNATAKA

ETHICAL COMMITTEE CERTIFICATE

This is to certify that the Ethical committee of Sri Devaraj Urs Medical College & Research Center, Tamaka, Kolar has unanimously approved

Dr. GUGRI MUKTHINATH

Post-Graduate student in the subject of

GENERAL SURGERY at Sri Devaraj Urs Medical College, Kolar

to take up the Dissertation work entitled

"**PROSPECTIVE OBSERVATIONAL STUDY TO COMPARE LIGHTWEIGHT MESH AND CONVENTIONAL PROLENE MESH IN LICHTENSTEIN HERNIA REPAIR** "

to be submitted to the

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH

CENTRE, TAMAKA, KOLAR, KARNATAKA,

Member Secretary
Ethical Committee,
Sri Devaraj Urs Medical College,
Research Centre,
Tamaka, Kolar-563101

Date:
Place: Kolar

SRI DEVARAJ URS ACADEMY OF HIGHER EDUCATION AND RESEARCH CENTRE, TAMAKA, KOLAR, KARNATAKA

COPY RIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that the Sri Devaraj Urs Academy of Higher Education and Research Centre, Kolar, Karnataka shall have the rights to preserve, use and disseminate this dissertation/thesis in print or electronic format for academic /research purpose.

Date:

Place: Kolar **Dr. GUGRI MUKTHINATH**

ACKNOWLEDGEMENT

I am highly indebted to my guide ***Dr. A.BHASKARAN,*** Professor, Department of General Surgery, Sri Devaraj Urs Medical College, Tamaka, Kolar, who guided me in bringing out this work with his thought provoking ideas and constant encouragement.

It gives me immense pleasure to express my gratitude and sincere thanks to ***Dr.K.MOHAN KUMAR,*** Professor and H.O.D., Department of General Surgery, Sri Devaraj Urs Medical College, Tamaka, Kolar, who took deep interest and gave constant support by encouraging in moulding this work.

I also acknowledge my debt to ***Dr. P.N .SREERAMULU, Dr. K.KRISHNA PRASAD, Dr. MADAN.M, Dr. K. N. NAGARAJ ,Dr. NISCHAL*** professor's Department of General Surgery, Sri Devaraj Urs Medical College, Tamaka, Kolar, who gave me moral support and guidance by correcting me at every step.

I express my sincere thanks to all my teachers and Professors of Department of General Surgery, Sri Devaraj Urs Medical College, Tamaka, Kolar.

I remain thankful to ***Dr AMBIKAVATHY, Dr SHASHIREKHA, Dr MAHESH.M.S, Dr VASANTH, Dr PAVAN.B.K, Dr. PRABHU T*** all my assistant professors and lecturers for their support and encouragement. I acknowledge my sincere thanks to all my fellow P.G.'s for their help and support at every step throughout my study.

I am very much thankful to my family ***Dr. SHASHIKALA / Dr. SIDDARAMESH / Chi. MUGDHE*** and my friends Late ***Dr. CHETAN Y./*** Late ***Dr. PRANAM B. PATIL*** for their love and support. Last, but not the least, I thank the Almighty and my patients for providing me the opportunity to carry out my study.

Dr. GUGRI MUKTHINATH

LIST OF ABBREVIATIONS

ASIS	-	Anterior superior iliac spine
BA	-	Bronchial asthma
BEP	-	Benign enlargement of prostate
BP	-	Blood pressure
Br	-	Bronchitis
BT	-	Bleeding time
CT	-	Clotting time
DC	-	Differential leucocyte count
DM	-	Diabetes mellitus
DOA	-	Date of admission
DOD	-	Date of discharge
DOS	-	Date of surgery
ESR	-	Erythrocyte sedimentation rate
Hb	-	Hemoglobin
HS	-	Highly Significant
HTN	-	Hypertension
LDIH	-	Left direct inguinal hernia
LIIH	-	Left indirect inguinal hernia
MRI	-	Magnetic resonance imaging
N	-	Nil
NS	-	Not Significant
RDIH	-	Right direct inguinal hernia
RIIH	-	Right indirect inguinal hernia
S	-	Significant
Sm	-	Smoker
T	-	Time taken to return to normal activity
TB	-	Tuberculosis
TC	-	Total leucocyte count
US	-	Urethral stricture
VAS	-	Visual Analogue Scale

ABSTRACT

Background and objectives:

Inguinal hernia repair is the most frequently performed operation in any general surgical unit. A surgical mesh for hernia repair was introduced in 1959. The main interest of hernia surgeons, in the past 2 decades was focused on surgical techniques to optimize hernia repair and the application of mesh. The trend changed in early and mid-1990's with increasing number of case reports, which reported mesh related early complications such as seromas, abdominal discomfort, decreased abdominal wall mobility which were frequently observed, whereas delayed complications such as recurrences, chronic persisting pain, infection, fistula formation were rare after using heavy weight mesh in inguinal hernioplasty. These complications have been the rationale to examine the role of mesh in hernia repair in detail and to begin investigating the biocompatibility of different mesh modifications and to challenge old mesh concepts. Prolene is a monofilament heavyweight Polypropylene mesh (>85g/m^2) with small pores <1mm with high tensile strength available at cheaper cost, Ultrapro is a multifilament (Polypropylene and Poliglecaprone) lightweight mesh (28 g/m^2) with large pores 3-4 mm with lesser tensile strength but costlier.Since in India there not many studies available, therefore a study is needed for local population.

The aim of this study is to compare Lightweight mesh (Ultrapro) with Conventional Prolene mesh in Lichtenstein hernia repair in terms of postoperative complications like seroma, pain, infection, hematoma formation, foreign body sensation and recurrences.

Methods :

Thirty one patients with primary unilateral inguinal hernia were subjected either to lightweight mesh lichtenstein's hernioplasty or standard prolene mesh lichtenstein's hernioplasty. All the hernia repairs were performed under spinal anaesthesia. In case, of any associated conditions like hypertension, diabetes mellitus were present, treatment was first given for these associated conditions. A note was taken of any technical difficulty during surgery. The patients were followed in the surgical OPD at 1 month, 6 months and 1 year for time taken to return to normal activities, chronic groin pain, foreign body sensation, seroma formation and recurrence.

Results :

Chronic pain among patients in standard prolene mesh group at 1 month, 6 month, and 1 year follow up was seen in 45.2%, 16% and 3.2% of the patients respectively, in light weight mesh group patients at 1 month, 6 month and 1 year follow up was 32.2% , 6.4% and none at one year respectively. Foreign body sensation in the light weight mesh group is significantly less compared to patients in standard prolene mesh group. Time taken to return to work was relatively shorter among patients in Light weight mesh group. There was no recurrence in both groups.

Interpretation and conclusion :

Light weight mesh is an ideal choice in Lichenstein's hernioplasty whenever feasible.

Keywords: Inguinal hernia, Prolene mesh, Lightweight mesh, tension free repair.

TABLE OF CONTENTS

SLNO	CONTENTS	PAGE NO
1	INTRODUCTION	1
2	OBJECTIVES	3
3	REVIEW OF LITERATURE	4
4	METHODOLOGY	49
5	RESULTS	57
6	DISCUSSION	73
7	CONCLUSION	77
8	SUMMARY	78
9	BIBLIOGRAPHY	79
10	ANNEXURES PROFORMA CONSENT FORM MASTER CHART	83 88 89

LIST OF TABLES

TABLE NO	TABLES	PAGE NO
1	AGE DISTRIBUTION OF SUBJECTS	58
2	SIDE OF HERNIA AMONG SUBJECTS	59
3	DIAGNOSIS AMONG THE SUBJECTS IN BOTH METHODS	60
4	DURATION OF SYMPTOMS AMONG THE SUBJECTS	61
5	NUMBERS OF ASSOCIATED CONDITIONS AMONG THE SUBJECTS	62
6	ASSOCIATED CONDITIONS AMONG THE SUBJECTS	63
7	PAIN IN BOTH THE PROCEDURES POST OPERATIVELY	64
8	HEMATOMA, SEROMA AND WOUND INFECTION IN BOTH THE PROCEDURES POST OPERATIVELLY	65
9	PAIN IN BOTH PROCEDURES AT ONE MONTH OF FOLLOW UP	66
10	PAIN IN BOTH PROCEDURES AT SIX MONTH OF FOLLOW UP	67
11	PAIN IN BOTH PROCEDURES AT 1 YEAR OF FOLLOW UP	68
12	RECURRENCE OF HERNIA IN BOTH THE PROCEDURES AT DIFFERENT INTERVALS OF FOLLOW UP	69
13	TIME TAKEN TO RETURN TO NORMAL ACTIVITY IN DAYS AMONG BOTH THE GROUPS	70
14	FOREIGN BODY SENSATION AMONG BOTH THE GROUPS	71
15	SEROMA FORMATION AMONG BOTH GROUPS	72
16	CHRONIC PAIN COMPARED WITH OTHER STUDIES	74
17	TIME TAKEN TO RESUME NORMAL ACTIVITIES	75
18	FOREIGN BODY SENSATION COMPARED WITH OTHER STUDIES	76
19	RECURRENCE RATE COMPARED WITH OTHER STUDIES	76

LIST OF GRAPHS

GRAPH NO	GRAPHS	PAGE NO
1	BAR DIAGRAM SHOWING AGE DISTRIBUTION	58
2	BAR DIAGRAM SHOWING SIDE OF HERNIA	59
3	BAR DIAGRAM SHOWING DIAGNOSIS AMONG THE SUBJECTS	60
4	BAR DIAGRAM SHOWING DURATION OF SWELLING AND PAIN AMONG THE SUBJECTS	61
5	BAR DIAGRAM SHOWING ASSOCIATED CONDITION AMONG THE SUBJECTS	62
6	BAR DIAGRAM SHOWING PRESENCE OF ASSOCIATED CONDITION AMONG THE SUBJECT	63
7	BAR DIAGRAM SHOWING PAIN IN BOTH THE METHODS POSTOPERATIVELY	64
8	BAR DIAGRAM SHOWING IMMEDIATE COMPLICATIONS	65
9	BAR DIAGRAM SHOWING CHRONIC PAIN AT 1MONTH FOLLOW UP	66
10	BAR DIAGRAM SHOWING CHRONIC PAIN AT 6MONTHS FOLLOW UP	67
11	BAR DIAGRAM SHOWING CHRONIC PAIN AT 1 YEAR FOLLOW UP	68
12	BAR DIAGRAM SHOWING ABSENCE OF RECURRENCE DURING FOLLOW UP	69
13	BAR DIAGRAM SHOWING MEAN TIME TAKEN TO RETURN TO NORMAL ACTIVITY	70
14	BAR DIAGRAM SHOWING FOREIGN BODY SENSATION IN BOTH THE PROCEDURES DURING FOLLOW UP	71
15	BAR DIAGRAM SHOWING SEROMA FORMATION DURING FOLLOW UP	72

LIST OF FIGURES

FIGURE NO	FIGURES	PAGE NO
1	VESSELS AND NERVES OF THE ANTERIOR ABDOMINAL WALL	15
2	INGUINAL CANAL IN THE MALE	16
3	CONTINUITY OF DIFFERENT LAYERS OF ANTERIOR ABDOMINAL WALL WITH COVERINGS OF SPERMATIC CORD	17
4	MACROPOROUS LIGHTWEIGHT MESH	36
5	MICROPOROUS HEAVYWEIGHT MESH	36
6	PROLENE MESH	37
7	ULTRAPRO MESH	37
8	MESH SHRINKAGE AS SEEN IN PROLENE MESH	38
9	SCAR PLATE AND SCAR MESH	38
10	SCAR MESH	38
11	EXPOSURE OF EXTERNAL OBLIQUE APONEUROSES	54
12	EXPOSURE OF SPERMATIC CORD	54
13	DISSECTED AND OPENED HERNIAL SAC	55
14	TWISTING TO REDUCE CONTENTS OF HERNIAL SAC	55
15	FIXING MESH TO INGUINAL LIGAMENT AND CONJOINT TENDON	55
16	STANDARD PROLENE MESH INSITU	56
17	ULTRAPRO MESH INSITU	56

INTRODUCTION

Inguinal hernias is one of the most common conditions requiring surgery among abdominal wall hernia. Despite the frequency of surgical repair, perfect results continue to elude surgeons.

Since 19th century, when modern techniques for repair of groin hernia were first described recurrence was a problem. At that period in late 19th century Bassini's repair which was developed became revolutionary at that time for low recurrence rates. It involved suturing of Bassini's triple layer (internal oblique, transverse abdominis, fascia transversalis) to inguinal ligament with interrupted sutures with recurrence rates of 5 to 15%[1].

Various tissue based repairs since that period started evolving such as Mc Vays repair which had similar recurrence rate that involves suturing of triple layer to Coopers ligament, Shouldice repair achieved recurrence rate below 2% at the hands of its originators but failed to gain widespread acceptance due to its technical difficulties and inconsistent results outside Shouldice clinic[2] .

In 1986 Lichenstein described the tension free inguinal hernia repair with mesh which has become the most popular open technique for inguinal hernia repair and has been shown to have simplicity of repair, the decreased post operative pain and decreased recurrence rates when compared with tissue based hernia repair.

Implantation of conventional prolene mesh resulted in inflammatory reaction which also lead to the formation of a rigid scar plate with loss of abdominal wall pliability and changes in abdominal wall compliance. Patients started to complain of a sensation of stiffness, physical discomfort which started to limit in the activities of daily living.

This led to discovery of Lightweight meshes with reduced polypropylene content and larger pore size which demonstrated reduced inflammation and improved integration in surrounding tissues. They are also associated with decreased complaints of pain, paraesthesia and improved abdominal wall compliance while providing adequate strength.

The current study intends to compare post operative complications of patients undergoing Lichenstein's hernioplasty with Light weight and conventional prolene mesh.

OBJECTIVES

- To study postoperative complications of Light weight mesh in Lichtenstein hernia repair.
- To study postoperative complications of Conventional Prolene mesh in Lichtenstein hernia repair.
- To compare postoperative complications in both Light weight mesh and Conventional Prolene mesh.

REVIEW OF LITERATURE

EMBRYOLOGY [3]:

In the testicular descent inguinal canal forms a pathway from their intra abdominal position through the anterior abdominal wall, into the scrotum. Both males and females inguinal canal develops in a different way because of morphologically indifferent state of sexual development. A ligament gubernaculum passes obliquely through the developing anterior abdominal wall at the site of future inguinal canal as the mesonephros degenerates. The gubernaculum attaches caudally to the internal surface of the labioscrotal swellings (future halves of the scrotum or labia minora).

Processes vaginalis is produced from parietal peritoneum forming a peritoneal diverticulum, which is more important to the male fetus as it will permit the descent of the testes. The embryologic entities between skin and peritoneum permit the processes vaginalis to penetrate them and form the inguinal canal, so the downward journey of the testicle to the scrotum is allowed.

The walls of the inguinal canal is being formed from the vaginal process which carries extensions of the layers of the abdominal wall before it. In males these layers also form the coverings of the spermatic cord and testes. Deep ring being formed from the opening in the transversalis fascia and the superficial ring opening created in the external oblique aponeurosis.

SURGICAL ANATOMY [4,5,6,7,8,9,10] :

The groin is most often defined as a transitional area in which the thigh and abdomen are joined, bounded by

- Anterior superior iliac spine
- Inguinal ligament, pubic tubercle and crest uptothe sypmhysis
- Line alba, upto a perpendicular line drawn to it from the Anterior superior iliac spine

General architecture of the groin

Skin
Fat
Fascia
Aponeuroses
} Anterior wall of inguinal canal

Spermatic cord with internal oblique arching over it
}

Aponeuroses
Fascia
Fat
Peritoneum
} Posterior wall of inguinal canal

Layers of the anterior abdominal wall :

Skin : Langer's line are transverse in the groin with a subtle convexity in pedal direction.

Subcutaneous tissues : Superficial fascia below umbilicus divided into 2 layers superficial fatty layer (Camper's fascia) and deep fibrous layer (Scarpa's fascia).

Innominate fascia : Well developed layer that intimately covers external oblique aponeuroses and inguinal ligament.

Musculo-aponeurotic structures :

External Oblique Muscle :

The most superficial muscle of anterior abdominal wall, arises from the lower eight ribs or costal cartilages. Its upper four slips interdigitate with serratus anterior, its lower four slips with latissimus dorsi. The slips unite to form a wide flat muscle whose posterior fibres pass downwards to insert into the anterior half of the iliac crest and whose middle and anterior fibres insert into the aponeuroses called the external oblique aponeuroses. The insertion takes place near the lateral edge of the rectus muscle and the aponeuroses passes in front of the rectus muscle to insert into Linea alba.

Internal Oblique Muscle :

It arises from the thoraco-lumbar fascia, Its fibres posteriorly ascend to insert into the seventh to ninth costal cartilage. Most fleshy in inguinal area, becomes aponeurotic just lateral to semilunar line. Bears triple reation to inguinal canal, forming its anterior wall, roof & posterior wall.

Transversus Abdominus Muscle :

This is the deepest of the three abdominal wall muscles. It arises by fleshy slips which interdigitate with diaphragmatic muscle from the lower 6 ribs, then the thoraco lumbar fascia, anterior two thirds of the iliac crest and lateral third of the inguinal ligament. Its fibres run mainly in a transverse direction to end in a broad aponeurosis which is inserted into the xiphoid process, the Linea alba, the pubic crest and the pectineal line of the pubis. The lowest fibres of the muscle fuse with the lowest fibres of internal oblique to form the conjoined tendon.

Rectus abdominus muscle :

The muscle arises by two tendinous heads: Lateral head from the lateral part of pubic crest and medial head from the anterior pubic ligament. It fibres run vertically upwards. It is inserted on the front of the wall of the thorax, along a horizontal line passing laterally from the xiphoid process.

Transversalis Fascia :

A thin layer of connective tissue lying between the inner surface of transverse abdominis and extraperitoneal fat. In the inguinal region, it is thick and dense, and augmented by the aponeurosis of transverses abdominis muscle. On the medial margin of the deep ring, the fascia transversalias is condensed into a 'U' shaped sling, with the cord supported in the concavity of the ring and the two limbs extending superiorly and laterally to be suspended from the posterior aspect of the transverses muscle.

The curve of the 'U' lies at or just above the lower border arch of the aponeuroses of the Transversus muscle. This 'U' shaped fold, the fascia transversals sling, is the functional basis of the inguinal shutter mechanism. As the Transversus muscle contracts during coughing or straining, the pillars of the sling are pulled together and the entire sling drawn upward and laterally.

CUTANEOUS INNERVATION :

The cutaneous nerve supply to the anterior abdominal wall is derived from the anterior rami of the lower six thoracic and the first lumbar nerves. The ventral ramus of the first lumbar nerve contributes to the iliohypogastric, ilioinguinal and genitofemoral nerves.

SUPERFICIAL VESSELS :

The anterior abdominal wall receives its blood supply from paired superior epigastric artery (terminal branch of internal thoracic artery) and inferior epigastric artery (from the external iliac artery posterior to inguinal ligament) running vertically through the tissues, and from paired posterior intercostal, subcostal and lumbar vessels running obliquely around the anterolateral aspects of the abdomen.

Other vessels namely are the superficial circumflex iliac and external pudendal vessels arising from femoral artery. All the arteries are accompanied by their respective veins and form tributaries to the femoral vein.

THE INGUINAL CANAL:

The canal is an oblique intermuscular slit lying above the medial half of the inguinal ligament. It commences at the deep inguinal ring, ends at the superficial inguinal ring, and transmits the spermatic cord in the male and the round ligament of the uterus in the female and ilioinguinal nerve in both sexes.

- **Anterior wall** - External oblique aponeuroses assisted laterally by a portion of internal oblique.
- **Posterior wall** - strong conjoined tendon medially and the weak transversalis fascia laterally
- **Roof** - lower edge of the Internal Oblique and Transversus Abdominus muscle, which arch over from in front of the cord laterally to behind the cord medially, where their conjoined aponeuroses, constituting the Conjoined tendon is inserted in to the Pectineal line of pubic bone.
- **Floor** - inrolled lower edge of inguinal ligament, reinforced medially by the Lacunar ligament (Gimbernats ligament) and fusing more laterally with the transversals fascia.

Superficial inguinal ring:

It is a triangular hiatus in the external oblique aponeurosis, just above and lateral to the pubic crest with its apex pointing along the line of the deep fibres of the aponeurosis. Fibres from external oblique aponeurosis continue downward as a tubular fibrous tissue around the spermatic cord and testes as the external spermatic fascia.

Deep inguinal ring:

It is a oval slit in the transversalis fascia, midway between the anterior superior iliac spine and symphysis pubis approximately 1.25 cm above the inguinal ligament. Traction on this fascial ring exerted by internal oblique may constitute a valve - like safety mechanism when intra-abdominal pressure is increased.

Hesselbach's triangle:

The inguinal triangle / Hesselbach's triangle is bounded inferiorly by medial half of inguinal ligament, medially lower lateral border of rectus sheath and laterally - inferior epigastric artery. By definition a hernial sac passing lateral to the artery (i.e. through the deep ring) is an indirect hernia, one passing medial to the artery through the inguinal triangle is a direct hernia.

Spermatic cord:

It has 3 covering and 6 constituents. It begins in the preperitoneal space with the confluence in the region of the deep ring of testicular artery and vein and ductus deferens.

3 coverings of spermatic cord from inside outwards are :

- **Internal spermatic fascia-** derived from the transversalis fascia at the deep inguinal ring.
- **Cremaster muscle and cremasteric fascia -** loosely arranged layer consisting of striated muscle bundles united by areolar tissue and arises from the internal oblique and transverse abdominis muscle. The fibres spiral down the cord and loop back to get attached to public tubercle.
- **External spermatic fascia -** acquired from the external oblique aponeurosis as the cord passes between the crura of the superficial ring.

The constituents of the cord :

- **The Ductus deferens**- which usually lies in the lower and posterior part of the Cord.
- **Arteries-** Testicular artery (from the aorta), artery to ductus (from inferior vesical artery), and the cremasteric artery (from inferior epigastric artery).
- **Veins-** pampiniform plexus of veins, cremasteric veins, veins of ductus deferens.
- **Lymphatics** - especially those from the testis draining to para-aortic and inter- aortocaval lymphnodes, but some from the coverings of the cord draining into external iliac nodes.
- **Nerves** - genital branch of genitofemoral nerve supplying the cremaster muscle. Other nerves are sympathetic twigs which accompany the arteries.
- **Processes 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.

ETIOLOGY [11,12 13,14.]

A) Congenital :

➢ **Patent processes vaginalis :** It is the prime cause of indirect inguinal hernia in infants and children. The development of the processes, its migration into the scrotum, and its final obliteration are intimately linked to the descent of the testis from the abdominal cavity into the scrotum. These processes are initiated and controlled by the calcitonin gene - related peptide (CGRP) released by the genito-femoral nerve under the influence of fetal androgens. The presence of a patent processes vaginalis does not necessarily indicate that an indirect inguinal hernia is present, nor does it mean that one will necessarily develop in the future. Therefore, additional factors must be present to produce an indirect inguinal hernia besides a patent processes vaginalis.

➢ **Genetic Influence :** There exists a familial tendency to groin herniation. A study of 280 families with congenital indirect inguinal hernias in China indicated that transmission was autosomal dominant with incomplete penetrance of a preferential paternal factor. The hernia usually occurred on right side, consistent with later descent of testes on that side. Such herniation which is more common with prematurity has been ascribed to a delay in maturation.

➢ **Metabolic Factors :** Hydroxyproline content, and therefore collagen, which makes upto 80% of the rectus shealth, is found to be strikingly decreased in some hernia patients. This collagen shows altered salt precipitability and impaired hydroxylation with a decreased amount of mature, insoluble thick (polymeric) forms. Cultured fibroblasts proliferate less and show reduced uptake of radioactive proline.

On electron microscopy, collagen fibrils show irregular periodicity and variable width, with some intracellular fibrillar positioning.

The ability of fascia transversalis to withstand physiologic and pathologic elevations in the intra-abdominal pressure is dependant on the state of the collagen fibres that make up its tissues and give it its strength. Significantly lower levels and hydroxylated proline and lysine seem to be present in fascia samples from direct hernia patients.

- **Connective tissue disorders -** such as Marfan's Syndrome, Ehlers Danlos Syndrome, Hurler - Hunter syndrome and certain mesenchymal metabolic defects causing a deficiency of collagen and structural bnormalities of the collagen fibres, predispose to groin hernias.

B) Acquired weakness:

The ability of the abdominal wall in the groin to withstand the forces in favour of herniation may be reduced by the weakening of the muscle and fascia with,

- **Cigarette smoking:** Smoking, the most common cause of pulmonary emphysema which evokes a neutrophil - macrophage response. Priming of these white cells and their 5 to 10 fold concentration in the lungs, with release of elastase and collagenase, destroys the parenchyma of lung. It is proposed that the chronic inflammatory response in the lungs affects the circulating blood. Antiproteases and elastase in the blood stream bring about destruction of elastin and collagen of rectus sheath and fascia transverses and so cause their attenuation and pre-dispose to herniation.

- Old age
- Multiple pregnancies
- Lack of physical exercises
- Loss of weight and body fitness due to prolonged illness
- Certain "cosmetic" operative incisions, such as very low and unduly long transverse abdominal incisions for gynecologic or urologic procedures or "cosmetic" appendectomy, may be followed by appearance of groin hernia caused by cutting into the myoaponeurotic arch cutting across the motor or sensory nerves of the groin, causing, atrophy of the muscles.

C) Increased intra-abdominal pressure:

- Whooping cough in children / chronic bronchitis or TB in adults.
- Bladder neck obstruction or urethral stricture.
- Enlarged prostate.
- Powerful muscular effort or straining during lifting heavy weights.
- Pregnancy, obesity.
- Chronic constipation.

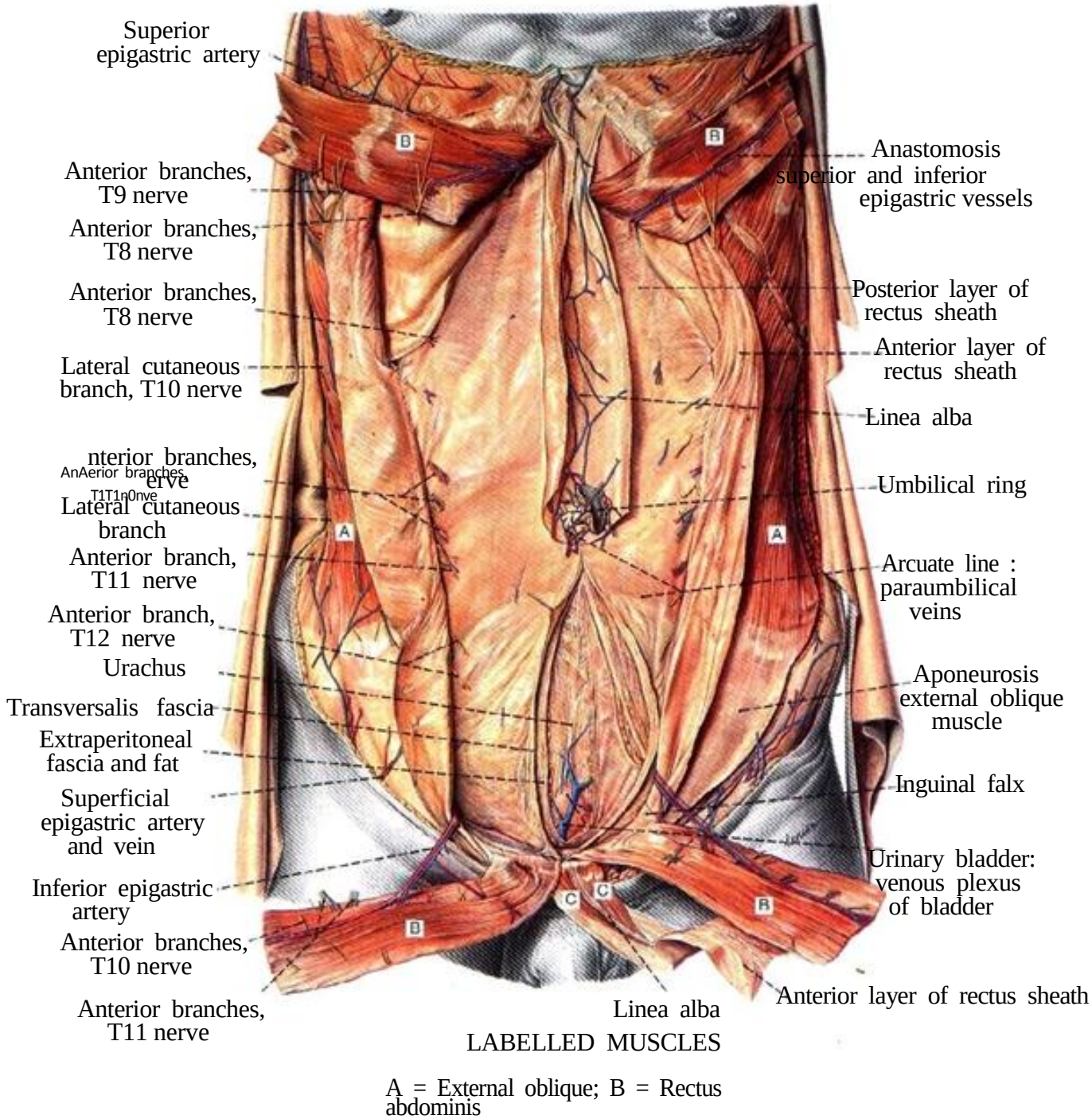


Fig 1 : Vessels and nerves of the anterior abdominal wall

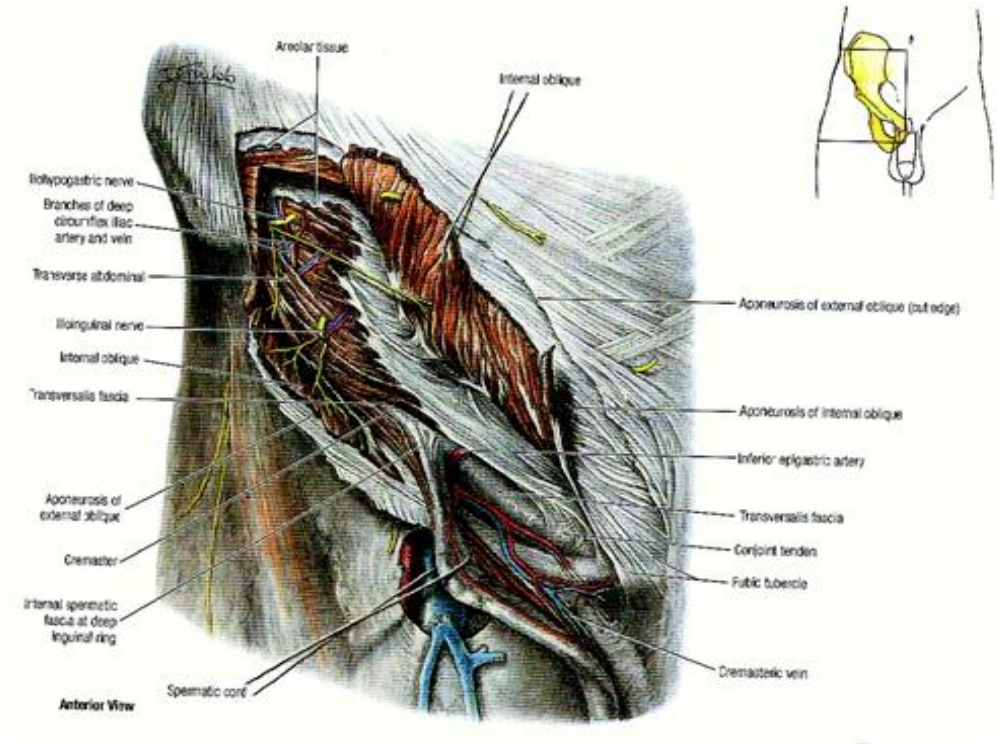


Fig.2 : Inguinal canal in the male

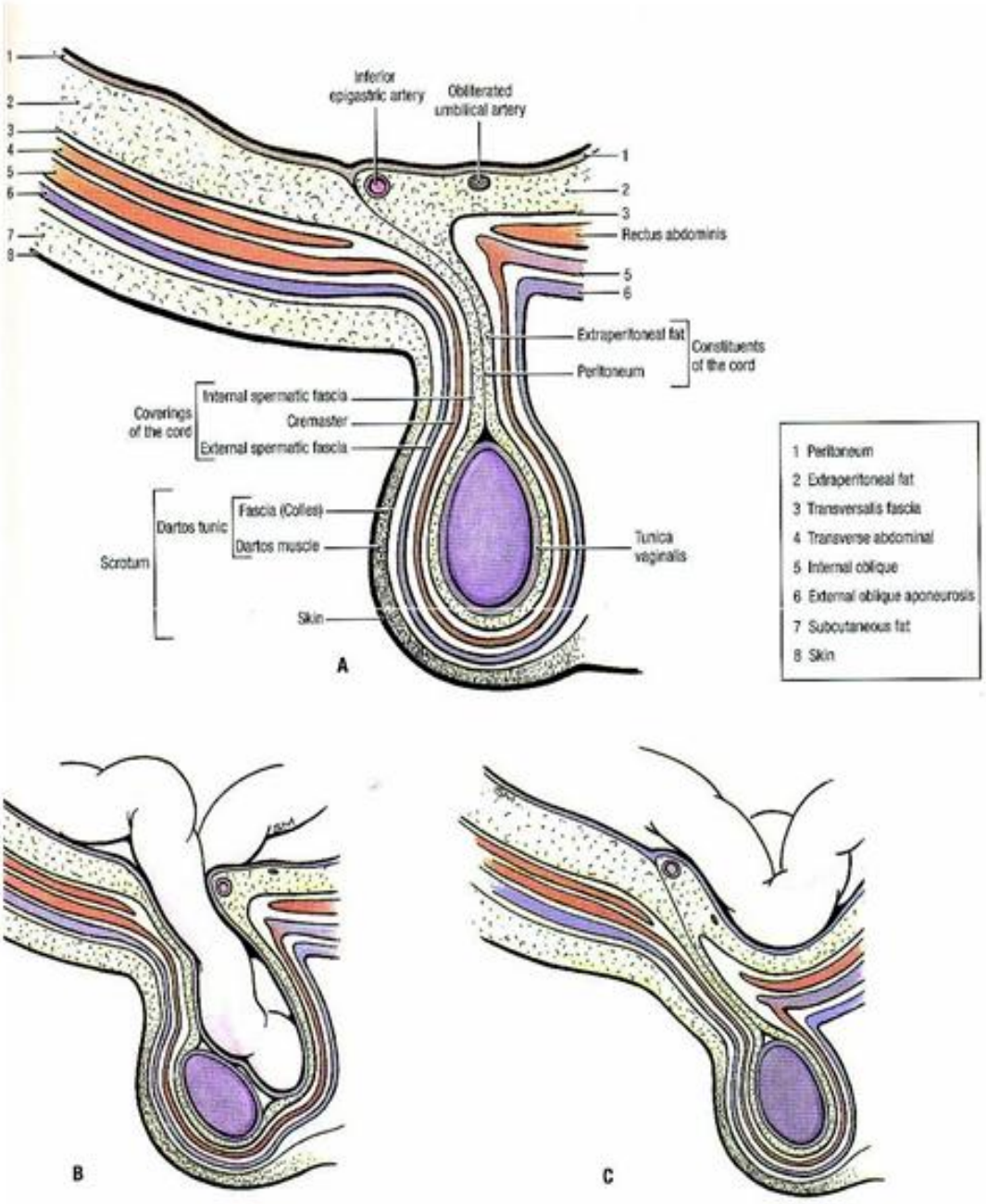


Fig. 4 : Continuity of different layers of anterior abdominal wall with coverings of spermatic cord

A = Coverings of spermatic cord and testes
B = Indirect inguinal hernia, C = Direct inguinal hernia.

COMPOSITION OF A HERNIA [15,16,17,18,19.]

A hernia consists of three parts:

➢**The sac** : It is a pouch of peritoneum which comes out through the abdominal musculature. The sac consists of mouth, neck, body and fundus. The mouth is the opening of the sac through which the contents enter the sac. The neck is usually well defined. It is the most constricted part. The body is the main portion of the sac and the fundus is the most redundant part of the sac.

➢**The covering** : They are derived from the layers of the abdominal wall through which the sac passes. In long standing cases, they become atrophied from stretching and so amalgamated that they are indistinguishable from each other.

➢ **The contents: Depending on the content, the hernia is variously named** :

- ❖ When the content is Omentum, Omentocele or Epiplocele.
- ❖ When intestine, Enterocele
- ❖ When a portion of the circumference of the intenstine - Richter's hernia.
- ❖ A portion of bladder may at times present as content of direct inguinal or sliding hernia.
- ❖ Ovary with or without fallopian tube.
- ❖ A Meckels diverticulum is sometimes found as content of sac, it is termed, Littre's hernia.
- ❖ A small amount of fluid is almost always present but it may be more if associated with ascites.

Coverings in case of an indirect inguinal hernia are, from inside out, as follows

- Extraperitoneal fatty tissue
- Internal spermatic fascia
- Cremasteric fascia
- External spermatic fascia
- Two layers of superficial fascia and Skin

Coverings in case of a direct hernia, from inside out, are as follows :

- Extraperitoneal fatty tissue
- Fascia transversalis
- Conjoint tendon
- External oblique aponeurosis
- Two layers of superficial fascia and skin

Differential diagnosis of Inguinoscrotal swellings :

- Encysted hydrocele of the cord
- Varicocele
- Lymph varix or lymphagiectasis
- Funiculitis
- Diffuse lipoma of the cord
- Inflammatory thickening of the cord
- Malignant extension of testis
- Torsion of testis
- Retractile testis

Protective mechanisms that maintain integrity of inguinal canal

The integrity of the normal inguinal canal depends upon :

1. Sphincter action of the transversus abdominis and internal oblique muscles acting at the internal ring.
2. Shutter action of the transversus abdominis aponeurosis, which forms the ransversus abdominis arch. This action reinforces the posterior wall of the canal. When the arch fails to reach the inguinal ligament area, the patient is a candidate for herniation.
3. Ball-valve action of cremaster muscle which pulls the spermatic cord into the canal and plugs it during rise in intra-abdominal pressure.
4. Obliquity of the inguinal canal - with rise in intra-abdominal pressure the posterior wall is apposed to the anterior wall and prevents the abdominal contents from entering in canal.

CLINICAL FEATURES[13, 16, 17,18, 19]

✓**HISTORY :**

❖ **Age:**

Inguinal hernias occur at all ages. They may be present at birth or appear suddenly in an 80 years old person. Indirect inguinal hernia is usually met within first few months of life, in late teens and young adults, whereas a direct inguinal hernia is mostly seen in older subjects.

❖ **Sex :**

Indirect inguinal hernia affects the males, 20 times more commonly than females. Direct inguinal hernia is rare in females.

❖ **Occupation :**

Heavy work, especially lifting, puts a great strain on the abdominal muscles. If there is any underlying weakness, the appearance of hernia may coincide with strenuous physical effort. Hard labour workers, sportsmen and weight lifters are more prone.

❖ **Associated diseases :**

Many a times hernia is due to disease causing weakness of anterior abdominal wall like obesity, previous lower abdominal operations, ascites and Malgaignes bulges. Certain diseases lead to increase in abdominal pressure such as prostatic enlargement, stricture urethra, chronic cough and chronic smoking. It should be remembered that appearance of a hernia in an adult may be a sign of intra abdominal malignancy. Peritoneal dialysis can cause the development of a hernia from a previously occult weakness or enlargement of a patent processus vaginalis.

❖ **Symptoms :**

- ✓ **Pain -** type of discomfort / dragging/ aching sensation may be the chief complaint, gets worse as the day passes. Pain may appear long before the lump is noticed and may continue so long as the hernia is progressing, but ceases when it is fully formed. Pull on the mesentery may cause pain in epigastrium.
- ✓ **Lump** - patient notices swelling in the groin in absence of pain, but usually he will have some sort of discomfort.
- ✓ **Systemic symptoms -** features of intestinal obstruction (colicky abdominal pain/vomiting / abdominal distension absolute constipation) may be present if the hernia is obstructing the lumen of the bowel.
- ✓ **Associated symptoms -** persistent coughing, constipation, dysuria due to be benign enlargement of prostate or stricture urethra.
- ✓ **Past history -** whether the patient had any previous abdominal operations especially appendectomy or any other operation confined to lower abdomen as incisions associated with these procedures may cause subcostal / ilioinguinal nerve division and that leads to weakness of the abdominal muscles. This usually predisposes to direct inguinal hernia.

✓**Signs :**

The patients should be first examined in the standing and then in the supine position. A majority of hernias are better examined in the standing position.

Two classical signs of an uncomplicated hernia are

- Impulse on coughing
- Reducibility

If a swelling descends into the scrotum, it is obviously an inguinal hernia. When it is confined to the groin, it should be differentiated from a femoral hernia.
Two anatomical structures are to be considered in this respect

a) The Pubic Tubercle

b) The Inguinal Ligament.

✓ **Position and extent:** If the swelling descends into scrotum / labia majora it is obviously an inguinal hernia. An inguinal hernia is positioned above the inguinal ligament and medial to the public tubercle whereas femoral hernia lies below inguinal ligament and lateral to public tubercle.

✓ **To get above the swelling :** In case of inguinal hernia one cannot get above the swelling .

✓ **Consistency :** If the hernia contains omentum the swelling feels doughy and granular. If it contains intestine (enterocele) it feels elastic. A strangulated hernia feels tense and tender.

✓ **Invagination test :** It is done to know size and patency of the superficial inguinal ring, to know tone of the ring, to differentiate direct from indirect hernias based on direction of finger and impulse on cough.

- ✓ **Ring occlusion test :** After reducing the hernia, a thumb is pressed on the deep inguinal ring and patient is asked to cough. A direct hernia will show a bulge and an indirect hernia will show no bulge.
- ✓ **Zeimann's technique :** When there is no obvious swelling or after the hernia has been reduced, the examiner places his corresponding index, middle and ring fingers on the indirect, direct and femoral hernial sites. The patient is asked to cough. A peculiar gliding motion of the walls of an empty sac or typical pushing sensation will be felt beneath the fingers, if a hernia is present in any one of these corresponding sites. A tympanic percussion note may be heard over an enterocele and impaired dull note in case of omentocele. Bowel sounds may be heard in cases where loops of bowel is present in the hernial sac.

Other relevant examinations include the complete external genital examination Scrotum for a thickened spermatic cord, absent or atrophic testis or presence of a hydrocele. Penis is examined for phimosis, pinhole meatus, presence of stricture urcthra, deviation of penisPer rectal examination is done to rule out benign prostatic enlargement and should be done routinely. The abdomen is examined to note the tone of abdominal muscles and respiratory system to rule out any cause of chronic cough (Tuberculosis / chronic bronchitis).

CLASSIFICATION SYSTEM OF INGUINAL HERNIAS[16,20,21]

➢ **Clinical classification :** Irrespective of site, a hernia can be classified into 5 different types.

❖ **Reducible hernia:** The hernia either reduces itself when the patient lies down or can be reduced by the patient / the surgeon. A reducible hernia imparts an expansile impulse on coughing.

❖ **Irreducible hernia :** In this case the contents cannot be returned to the abdomen but there is no evidence of other complications. It is usually due to adhesions between the sac and it's contents or overcrowding within the sac.

❖ **Obstructed (Syn. Incarcerated hernia):** Irreducible hernia + features of intestinal obstruction, but there is no interference to the blood supply of the bowel. The features are :

- Irreducible hernia.
- The sac is lax, not tender
- Cough impulse usually absent, may be present
- Features of intestinal obstruction (Abdominal distension / colicky abdominal pain / vomiting / constipation)

Usually there is no clear distinction clinically between obstruction and strangulation and the safe course is to assume that strangulation is imminent and treat accordingly.

❖ **Strangulated hernia :** Irreducible hernia + features of intestinal obstruction + when the blood supply of its contents is seriously impaired, rendering contents ischemic. Gangrene may ensue as early as 5-6 hrs after onset of first symptom. The features are :

- Irreducible hernia.
- Sac is tense, tender ; inflammed and edematous skin.
- Cough impulse absent .
- Features of intestinal obstruction.
- features of septicaemia.

❖ **Inflammed hernia** : A rare condition which mimics a strangulated hernia and occurs when its contents like a appendix / a salpinx / a meckel's diverticulum becomes inflamed. The features are :

- Overlying skin becomes red and oedematous.
- It is not tense and not associated with intestinal obstruction.
- Swelling becomes painful, swollen, tender.
- Cough impulse usually absent.

➢ **Gilbert's classification with additions by Rutkow and Robbins :**

Types 1, 2 and 3 are indirect hernias; types 4 and 5 are direct.

❖ **Type1** hernias have a peritoneal sac passing through an intact internal ring that will not admit 1 fingerbreadth (ie,<1 cm.); the posterior wall is intact.

❖ **Type2** hernias (the most common indirect hernia) have a peritoneal sac coming through a 1-fingerbreadth internal ring (ie, ≤2 cm.); the posterior wall is intact.

❖ **Type3** hernias have a peritoneal sac coming through a 2-fingerbreadth or wider internal ring (ie, >2 cm.), frequently are complete and often have a sliding component. They begin to break down a portion of the posterior wall just medial to the internal ring.

❖ **Type 4** hernias have a full floor posterior wall breakdown or multiple defects in the posterior wall. The internal ring is intact, and there is no peritoneal sac.

❖ **Type 5** hernias are pubic tubercle recurrence or primary diverticular hernias. There is no peritoneal sac and the internal ring remains intact.

❖ **Type 6** to designate double inguinal hernias

❖ **Type 7** to designate a femoral hernia.

➢ **Classification as per the contents of hernia :**

❖ Enterocele

❖ Omentocele

❖ Entero-omentocele

❖ Cystocele

❖ Meckel's diverticulum in Littre's Hernia

➢ **As per the patency of processes vaginalis :**

- ❖ Bubonocele : Hernia limited to the inguinal canal.
- ❖ Funicular : Processes vaginalis is closed just above the epididymis. The contents can be felt separately from the testis.
- ❖ Complete: Processes vaginalis patent upto bottom of scrotum. Testis appears to lie within the lower part of the hernia.

➢ **Lichtenstein's classification, 1987 :**

Indirect	Femoral
Direct	Combined
Whole floor	any 2 or more
Lateral ½ of floor	others
Medial ½ of floor	Diverticular

➢ **Nyhus classification, 1993 :**

Type I -Indirect, small, normal internal ring , sac in canal

Type II -indirect, enlarged internal ring , sac not in scrotum

Type III A. Direct - floor only

B .Combined - Indirect large Encroaching into direct floor C. Femoral

Type IV Recurrent A.Direct

B.Indirect

C.Femoral

D.Combination A-B-C

The Traditional classification of groin hernias is into direct, indirect and femoral. A majority of surgeons use this simple classification even today.

HISTORICAL PERSPECTIVE AND CURRENT LITERATURE:

HISTORY OF SURGICAL MESHES(VVS)[22, 23]

Father of modern herniorraphy, Edoardo Bassini did his first herniorraphy in 1884. He dissected the indirect sac and closed it off flush with the parietal peritoneum. He then isolated and lifted up the spermatic cord and dissected the posterior wall of the canal, dividing the fascia Transversalis down to the pubic Tubercle. He then sutured the dissected conjoined tendon consisting of the internal oblique, Transversus muscle and the vertical fascia of Cooper (or fascia Transversalis) to the posterior rim of Pouparts ligament.

EE. Shouldice devised a multilayer technique of inguinal repair in 1952. Shouldice technique uses a four layer overlapping repair of the posterior wall of the inguinal canal.

The essential steps are

1)Double breasting of Fascia Transversalis in order to tighten and narrow the deep ring

2) Approximation of conjoined tendon to inguinal ligament in two layers.

At the Shouldice Hospital, the recurrence rate for primary hernia repairs is <1%.

Billroth quotes “if we could artificially produce tissues of the density and toughness of fascia and tendon, the secret of radical cure of hernia would be discovered”.

Numerous material, were tried but they fell victim to the triple headed monster of - Infection, Rejection and Recurrence

Historically, the use of prosthesis to reinforce the posterior wall of the inguinal canal was first reported by McGavin in 1909 at the Greenwick Siamens hospital, London, who used silver filigree. Unfortunately, the filigree suffered stress fractures over the years and the successful application of prosthetic mesh had to await the introduction of an inert indestructible material such as polypropylene by Usher.

When Francis Usher introduced Marlex mesh in 1962 for technically challenging cases, a new era began during which this prostheses, when used in uncontaminated groin hernias, began to overcome the then current objections to mesh. However Usher was not in favour of using mesh for simple hernias.

In 1986, the tension free inguinal hernia repair with mesh was described by Lichtenstein. Lichtenstein repair has become the most popular open technique for inguinal hernia repair and has been shown to have superior recurrence rates, simplicity of repair, and the decreased post operative pain when compared with tissue based hernia repair.

He advocated this technique for all groin hernias large or small, complex or straight forward and maintained that essential components included local anesthesia, immediate ambulation, and same day discharge, each contributing to the overall success.

The long term results of the Lichtenstein technique have been reported over the last 10 years and in several recent series of over 10,000 cases, have shown recurrence rates of 0.2% and the infection rates of 0.03%.

The body generates an intense inflammatory response to the prosthetic that results in scar plate formation, increased stiffness of the abdominal wall, and shrinkage of the biomaterial.

The trend changed in the early and mid 1990's in parallel with increasing number of case reports reporting mesh related complications after heavy mesh based hernia repair such as seromas , discomfort, decreased abdominal wall mobility which are frequently observed post mesh hernioplasty. Serious complications such as recurrences, chronic and persisting pain as well as infection, including fistula formation are rare.

Reducing the density of polypropylene and creating a "light weight" mesh theoretically induces less foreign-body response, results in improved abdominal wall compliance, causes less contraction or shrinkage of the mesh, and allows for better tissue incorporation.

Some of the lightweight meshes being used are Vypro(polypropylene with PG910 ; 25g/m^2), VyproII (polypropylene with PG910; 30g/m^2) and Ultrapro (polypropylene with polyglecaprone ; 28g/m^2).

PROPERTIES OF IDEAL PROSTHETIC MATERIAL[24,25,26]

1. Possess good handling characteristics in the operating room,
2. Invoke a favorable host response,
3. Be strong enough to prevent recurrence,
4. Place no restrictions on post implantation function,
5. Perform well in the presence of infection,
6. Resist shrinkage or degradation over time,
7. Make no restrictions on future access,
8. Block transmission of infectious disease,
9. Be inexpensive and
10. Be easy to manufacture.

HOW DOES A PROSTHETIC MATERIAL WORK[26,27]

After any prosthetic is implanted, an extraordinarily complex series of events takes place Immediately after implantation:

- The prosthetic adsorbs proteins that create a coagulum around it. This coagulum consists of albumin, fibrinogen, plasminogen, complement factors, and immunoglobulins.

- Platelets adhere to this protein coagulum and release a host of chemo attractants that invite other platelets, polymorphonucleocytes (PMNs), fibroblasts, smooth muscle cells, and macrophages to the area in a variety of sequences.

- Activated PMNs drawn to the area release proteases to attempt to destroy the foreign body in addition to organisms and surrounding tissue. PMN's also further attract fibroblasts, smooth muscle cells, and macrophages.

- Macrophages then increasingly populate the area to consume foreign bodies as well as dead organisms and tissue. These cells ultimately coalesce into foreign body giant cells that stay in the area for an indefinite period of time, their role being unclear.

- The fibroblasts and smooth muscle cells subsequently secrete monomeric fibers that polymerize into the helical structure of collagen deposited in the extracellular space.

- There is a general net production of collagen for about 21 days, after which there is a net loss and a changing proportion of type III (immature) to type I (mature) collagen. The collagen helices also undergo crosslinking to increase strength. The overall strength of this new collagen gradually increases for about 6 months, resulting in a relatively less elastic tissue that has only 70% to 80% of the strength of the native connective tissue. It is for this reason that the permanent strength of a rosthetic is important for the best long-term success of hernia repair.

To understand what sort of properties a mesh should have, it is important to look at the tissues it is replacing and/or reinforcing. Klinge and colleagues described a mathematical model that calculated the force of the abdominal wall to be 16 N/cm.

This same group also examined the elasticity of the abdominal wall in human cadavers. They described the average male abdominal wall elasticity at 16 N to be 23 (+/- 7%) and 15 (+/- 5%) in the vertical direction and 15 (+/-5%) in the horizontal direction, while the average female abdominal wall elasticity at 16 N females was 32 (+/- 7%) in the vertical direction and 17 (+/- 5%) in the horizontal direction.

Properties of Standard Polypropylene mesh[22]

- Polypropylene ($-CH_2$ - CH (CH_3) - is a thermoplast based propane with molecular weight of 100,000. This material is readily available, strong and nonabsorbable. It is a monofilament that is inert, porous, thin and firm, but pliable.
- Polypropylene mesh is not rejected by the body and is able to withstand infection. A disadvantage is the high bending stiffness of the monofilaments. Nevertheless, most of the current meshes are built of monofilaments.
- Density of standard polypropylene mesh (heavy weight mesh) is 80-85g/m^2 with pore size of 100-600µm.
- Tensile strength is 89N/cm .
- Elasticitity is given by percentage stretch at 16N/cm tension is 6%.
- Prosthetics made from polypropylene induce biologic reactivity, which varies depending on the weight, filament size, pore size, and architecture of the prosthetic, as well as on the individual host response. The biologic response to PP begins with protein adherence that ultimately envelops the polypropylene in scar tissue.

In the clinical arena, there is concern that scar tissue and adhesions at the prosthetic-tissue interface cause chronic pain and discomfort. Additionally, direct contact of the polypropylene with the abdominal viscera can lead to the complications of bowel obstruction or fistula formation.

- The area of heavyweight polypropylene mesh has also been shown to contract up to 54% in experimental models , although all mesh types contract to some degree with acute wound-healing .

- The induction of an intense fibrosis entirely embedding the mesh into a scar plate is frequently followed by a restriction of the abdominal wall mobility.

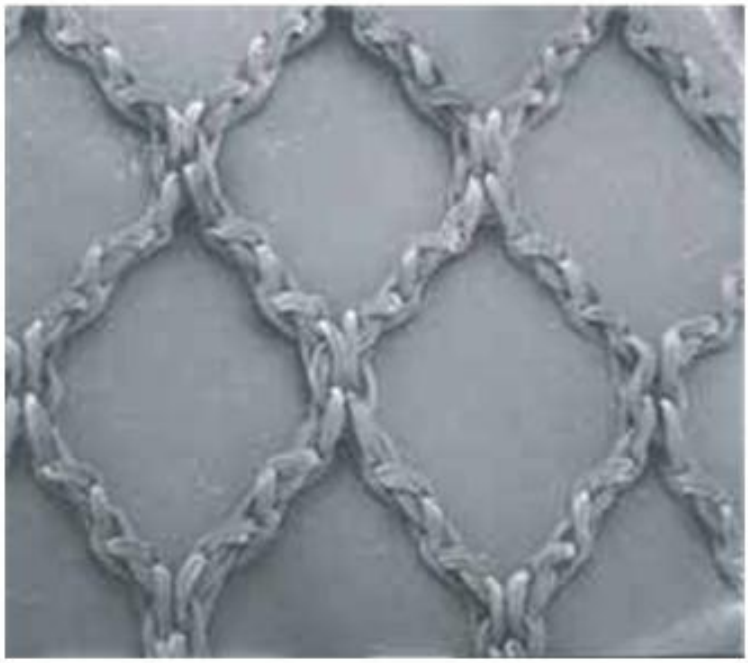


Fig.5 : Macroporous lightweight mesh

Fig.6 : Microporous heavyweight mesh

Fig.7 : Prolene mesh

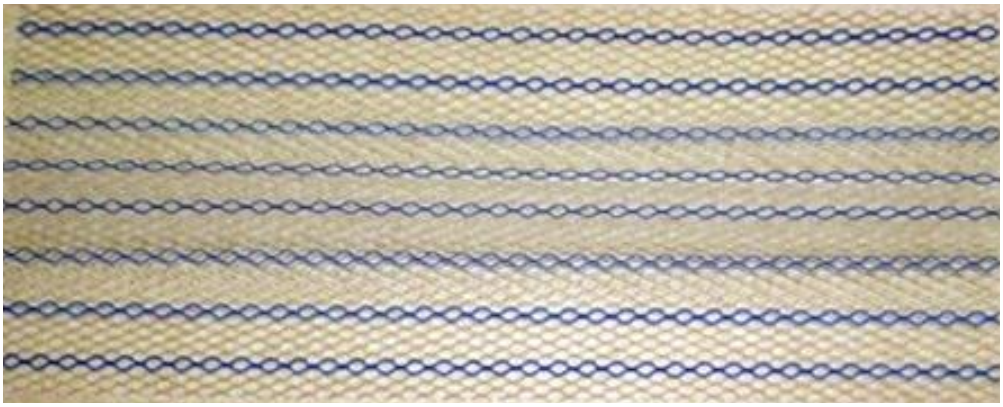


Fig.8 : Ultrapro mesh

Fig.9 : Mesh shrinkage as seen in prolene mesh

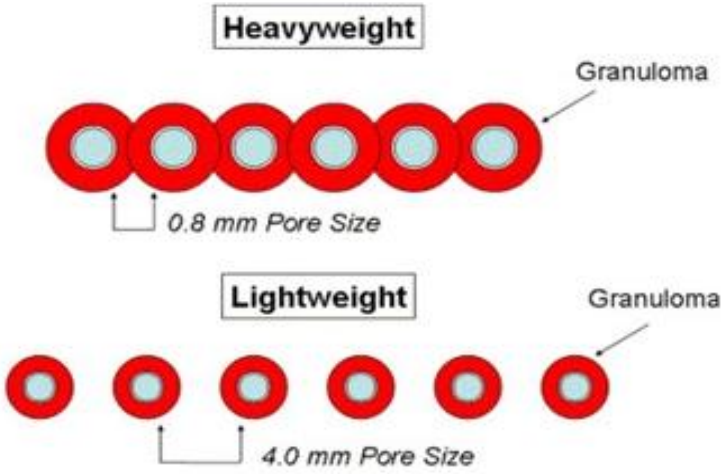


Fig.10 : Scar plate and scar mesh

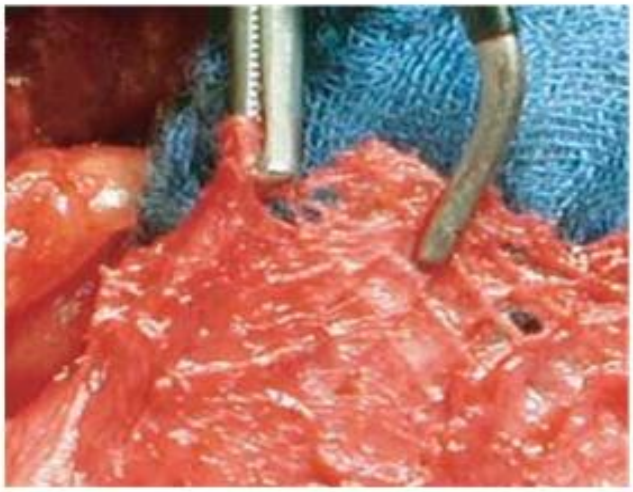


Fig.11 : Scar mesh

CONCEPT OF LIGHT WEIGHT MESH[26,27,28]

Methods to decrease the density of the prosthetic include reduction in fiber diameter (ie, strength) and number of fibers (ie, increase in pore size). Laboratory studies suggest that the prosthetic should have at least 16 N/cm strength to avoid disruption and maintain proper fixation to the tissues.

The tensile strength of surgical meshes for abdominal wall replacement in large hernia where mesh has to replace all structures of abdominal wall without fascia closure is 32N/cm at maximum. In small hernias where fascia can be closed tensile strength of mesh required is 16N/cm, therefore prolene (heavy weight polypropylene) is over engineered for their work. This excess prosthetic can lead to more complications, including decreased mesh flexibility, loss of abdominal wall compliance, inflammation, and scarring of surrounding tissues, potentially leading to pain, a sensation of feeling the mesh in the abdominal wall, and mesh contraction and wadding, which in turn may result in a recurrent hernia.

Lightweight meshes are designed to mimic the physiology of the abdominal wall and the inguinal region. Meshes in this group are produced with small polymer fibres, large pores (>1mm) and a high flexibility. Surface area in contact with the host tissue is low.

Average abdominal wall elasticity at physiological strain of 16N/cm is in between 11 and 32%. Textile analysis shows elasticity of lightweight meshes is in the physiological range i.e., (ultrapro-25%, vypro 28-31%) and that of heavy weight meshes in the range of 4-16% at 16N. Flexible lightweight mesh constructions with similar elasticity to the abdominal wall demonstrate their superiority with respect to a physiologic abdominal wall repair.

In abdominal wall augmentation in small hernias (where the fascia can be closed), the tensile strength of the mesh can be reduced to 16 N/cm . Tensile strengths of more than 100 N/cm of conventional heavyweight meshes are therefore disproportional and not required for an effective fascia closure or augmentation and lead to low flexibility with a subsequent restriction of the abdominal wall and discomfort of the patient.

However, the Foreign body reaction (FBR) depends not only on the polymer, but also the surface area in contact with the host tissues. The surface area again strongly depends on textile properties such as the pore size or the diameter and number of fibers used. The lightweight and large pore size meshes have less surface area than the heavyweight mesh group, consequently, the FBR in the lightweight mesh group is significantly reduced . In addition to this significantly decreased typical chronic inflammatory reaction, the fibrotic reaction around the mesh in total as well as around each single mesh fiber is greatly reduced . The fibrotic reaction as a result of the inflammatory response, however, considerably influences the long-term quality of the hernia repair. Today the tissue response to the mesh is understood as a chronic wound persisting over many years at the interface of the mesh and recipient tissues.

LIGHTWEIGHT MESH COMMONLY BEING USED ARE

➢**VYPRO :** The concept of lightweight large porous meshes for hernia repair was first realized in 1998 with the introduction of Vypro by Ethicon, Germany. The amount of remaining material was reduced to approximately 30% of common heavyweight meshes (Vypro 25 g/m^2 vs. Prolene 80-85 g/m^2) and the pore size was increased by up to 500-6 00% (Vypro 3-5 mm vs. Prolene <1 mm,). The nonabsorbable part is composed of multifilament PP combined with an absorbable part made of Vicryl (PG 910). Polypropylene part is $27g/m^2$ and polyglactin 910 part is $27g/m^2$. Vicryl part is absorbed in first 6 weeks after implantation. Tensile strength is 16N/cm. elasticity is 31 % when tension of 16N/cm is applied. Can be used for inguinal hernia repair where fascia can be closed.

❖ **VYPRO II :** in this composite mesh polypropylene part is $35g/m^2$ and polyglactin part is $45g/m^2$. density is $30g/m^2$. Tensile strength is 32N/cm. it can be used in larger hernias where fascia closure is not possible.

❖ **ULTRAPRO :** represents the newest member in the lightweight large porous mesh group. The mesh is constructed of a mono filament lightweight large porous PP mesh with pores of more than 3 mm. Its density is $28g/m^2$. Thickness is 0.5mm. An absorbable Monocryl (polyglecaprone 25) component is added to improve handling characteristics and to optimize implantation and increased tensile strength in the first weeks of the repair.

Monocryl (polyglecaprone 25) is a monofilament derived from a segmented copolymer of e-caprolactone and glycolide. This complex polymeric system contains soft segments of a random copolymer of e-caprolactone and glycolide, which provide good handling characteristics and hard segments of polyglycolide that provide high strength. Both hard and soft segments are combined in the same polymeric chain. Evaluating the toxicity potential of Monocryl sutures, no genotoxic, cytotoxic, teratogenic, irritating or allergic effects were found.

Monocryl is essentially absorbed without increased cellularity, inflammatory and fibrotic reaction within 84-140 days. Interestingly, the supplement of PP with Monocryl leads to significantly decreased FBR compared with simple lightweight large porous PP meshes with identical textile structure; an effect still under investigation. Overall, the Monocryl-PP-composite Ultra Pro is currently the member of the lightweight large porous mesh family with the lowest FBR and optimized handling. The first clinical studies produced encouraging results to move forward with this mesh concept.

MESH SHRINKAGE

It is not the mesh that shrinks, but the surface reduction is due to a simple retraction of the fibrotic scar tissues around the mesh. Retraction of the scar is a physiologic reaction of maturing scar started by a constant water loss and a subsequent surface-area decrease to an average 60% of the former wound region. It has been assumed that lightweight meshes with a notably decreased fibrotic tissue reaction demonstrate a lesser degree of shrinkage, a hypothesis that still has to be confirmed. Nevertheless, shrinkage is highly important for the repair technique. Sufficient longterm hernia repairs can only be performed with large meshes overlapping the hernia gap by a minimum of 5 cm each side.

Silvestre AC et al in their study of Shrinkage evaluation of heavyweight and lightweight polypropylene meshes in inguinal hernia repair concluded that there is significant differences between the two meshes when comparing the total area initially and on postoperative day 90 ($P = 0.001$). The HWM had significantly less area initial area, as compared with 90 days postoperatively ($P = 0.04$)[29].

FIBROTIC BRIDGING: SCAR PLATE AND SCAR MESH

Fibrotic bridging is a phenomenon closely associated with the occurrence of shrinkage. Bridging occurs in all mesh modifications with a granuloma size around each mesh fiber exceeding more than half of the pore size of the mesh.

Usually, the phenomenon of bridging is observed in all mesh modifications with pore sizes of less than 1 mm. In all of these cases a granuloma of one fiber starts to become confluent with granuloma formations of the adjacent fibers and thus eventually the whole mesh is incorporated into a larger area of granuloma side by side. Granulomas side by side, however, elicit a common outer fibrotic capsule joining each mesh fiber and forming a scar plate covering the whole mesh. The scar plate again results in the mesh becoming stiff and nonflexible. Conversely, stiff and non- flexible mesh repairs appreciably manipulate the abdominal wall function and quality of life. In contrast, lightweight meshes with large pores are con- structed in such a way that the granuloma is always notably smaller than half of the pore size. In some of these meshes, the pore size was increased more than six-times compared with the conventional heavyweight meshes, such that bridging is not possible. Lightweight large pore size mesh modifications are characterized by a localized fibrotic reaction around the mesh fibers, with small granulomas allowing the mesh to stay flexible and smooth after implantation.

RECURRENCE

In a meta-analysis of 6 randomized controlled trials that included 1936 hernia patients, comparing lightweight and heavyweight mesh for Lichtenstein inguinal hernia repair it was found that there was no difference in recurrence rate between lightweight mesh and heavyweight mesh patients[30].

CHRONIC PAIN

One of the most common sources of postoperative morbidity in surgical patients is the occurrence of post-herniorrhaphy chronic groin pain, defined as pain that persists after the normal healing process has occurred typically 3 months after surgery. Chronic groin pain is most often a result of nerve injury sustained during improper dissection.

When the groin is explored via the anterior approach, one may encounter the ilio-inguinal nerve, the genital branch of the genito-femoral nerve, and the ilio-hypogastric nerve . The ilio-inguinal nerve can usually be identified lateral to the internal ring. The genital branch of the genito-femoral can be identified in the lateral crus of the internal ring. Another possible anatomic location of this nerve is between the spermatic cord and inguinal ligament. The ilio-hypogastric nerve can be identified by separating the aponeurosis of the external oblique from the internal oblique muscle. The ilio-hypogastric nerve is the regional nerve that is at highest risk during tension-free repair because it can be trapped by the overlapping mesh in the scar tissue that forms between the mesh and the muscle plane along which the nerve runs.

The ilio-inguinal nerve is at the most risk for entrapment because it lies immediately beneath the divided external oblique fascia and can be included in sutures used for the hernia repair or to re-approximate the external oblique fascia.

Mesh placed atop the internal oblique fascia / muscle can adhere to the ilioinguinal and / or iliohypogastric nerves during healing. Several authors detail methods for prevention of nerve injury and stress the need for understanding inguinal anatomy and preservation of the nerves during hernia repair and inguinal incision closure.

The most crucial preventative step to reduce the incidence of postoperative groin pain is careful dissection and preservation of the ilio-inguinal, ilio-hypogastric, and genito-femoral nerves. It has been demonstrated that when all three nerves are identified and preserved, no cases of chronic pain were identified at 6-month follow- up.

In the post-retrieval study, most explants from all the patients with chronic pain in their medical history, indicate nerve fibers and fascicles in the interface of the mesh. Immuno histochemical stains allow the detection of even the smallest nerve structures that are mainly found in or around the foreign body granuloma. Due to the nature of the granuloma as a chronic inflammation, it may be speculated that these nerve structures are irritated by the inflammation and cause the sensation of pain. In some cases real traumatic neuroma can be found at the interface of the mesh-recipient tissues, an indicator of the mechanical destruction of the nerve by the mesh In total, all mesh modifications with small pores reveal unacceptably high rates of chronic pain in the retrieval study, in particular, all heavyweight PP meshes. Vypro, a light- weight large pore-constructed mesh, demonstrates a dramatically reduced surface area compared with heavyweight mesh. In combination with a favorable foreign body reaction, the small surface area leads to a minimum of nerve irritation and destruction.

Post S, et al, in their randomized clinical trial of lightweight composite mesh for Lichtenstein inguinal hernia repair on 122 hernia patients concluded that light weight mesh was associated with less pain on exercise after 6 months($P = 0.042$)[31].

Bringman S, et al, in their 3 year results of randomized controlled trial of lightweight or standard prolene mesh in Lichtenstein repair of hernia of 590 patients concluded that patients who had light weight mesh had less pain on examination, less pain on rising from lying to sitting position[32].

In a meta-analysis of 6 randomized controlled trials that included 1936 hernia patients, comparing lightweight and heavyweight mesh for Lichtenstein inguinal hernia repair it was found that Lightweight mesh was associated with reduced chronic pain ($P < 0.01$)[30] .

FOREIGN BODY SENSATION

Heavyweight meshes form Scar plate due to foreign body reaction and are less flexible and thus its presence can be felt on bending down. On the contrary lightweight mesh form scar mesh due to foreign body reaction and are flexible and thus felt less often.

Post S, et al, in their randomized clinical trial of lightweight composite mesh for Lichtenstein inguinal hernia repair on 122 hernia patients concluded that use of lightweight mesh reduced foreign body sensation after 6 months to less than half of incidence reported with use of conventional densely woven polypropylene mesh.[31]

TIME TO RERTURN TO NORMAL ACTIVITY

Convalescence and return to normal activities and work is very subjective at times and depends upon the nutritional state of the patient, age of the patient and type of work he does. Elderly patients and those who are undernourished are likely to have longer periods of convalescence. Some authors believe patients should be able to return to normal as soon as resolving pain permits. The major factors affecting return to activity are motivation and financial incentives.

O'Dwyer PJ et al in their randomized controlled trial and experienced that mean time taken to return to normal activities with lightweight mesh is 21days and standard prolene mesh is 26 days[33].

M. Smietanski et al in their randomized controlled trial comparing a polypropylene mesh with a polyglecaprone and polypropylene composite mesh for inguinal hernioplasty concluded that use of partially absorbable mesh reduced

postoperative pain at day 7 compared to heavy weight mesh and thus early return to normal activity[34].

IMMEDIATE POST OPERATIVE COMPLICATIONS

- **SEROMA**

S.Post et al, in their randomized controlled trial experienced seroma collection in 21 patients in lightweight mesh group compared to 20 patients in heavyweight mesh group (p-0.579) thus concluded there is no statistical difference between two mesh groups in terms of seroma formation.

- **WOUND INFECTION**

Due to the results of the retrieval study, all mesh modifications seem to have similar infection rates. Multifilament mesh constructions reveal no higher rates of infection as the reason for explantation. Further- more, scanning electron microscopy studies indicate that colonies of bacteria including biofilm-forming colonies of Staphylococcus epidermidis from skin, persisting at the surface of the polymer fibers may be responsible for late infection months or, in rare instances, years after the initial operation

M. Smietanski, et al, in their randomized controlled trial experienced no wound infection in both mesh groups.

- **HAEMATOMA**

S. Post et al and M. Smietanski et al in their randomized controlled trials did not find statistically significant difference in haematoma formation between two mesh groups with p - 0.673 and p - 0.279 respectively.

- **IMMEDIATE PAIN**

M. Smietanski et al in their randomized controlled trial experienced that The lightweight group reported less pain on day 7 (55.2 versus 36.2 per cent; $P < 0.001$) compared with heavyweight mesh group.

METHODOLOGY

This comparative study between Lightweight Mesh and standard prolene mesh in Lichtenstein's hernia repair for inguinal hernia was conducted from the patients admitted with the diagnosis of unilateral primary inguinal hernia in R. L. Jalappa Hospital & Research Centre and attached hospitals, Kolar from 1st January 2013 to 31st December 2014. The diagnosis of unilateral primary inguinal hernia was made on basis of history of reducible groin swelling and essentially on clinical examination.

Only those investigations were done which were relevant to obtain fitness for surgery. This included random blood sugar, blood urea, serum creatinine, ECG, hemoglobin percentage and routine urine analysis for sugar, albumin and microscopy, chest x-ray and ultra sound abdomen. If any patient was found to have any medical contraindication for surgery, he was first treated for these medical problems and then reevaluated for surgery.

All cases were done under Spinal anesthesia using 3 ml of bupivacaine 2% (Sensorcaine).

Inclusion criteria:

- ✓ Male patients aged 18years and above with unilateral primary inguinal uncomplicated direct or indirect hernia.

Exclusion criteria:

- ⌘ Patients with recurrent hernias .
- ⌘ Patients with strangulated / obstructed hernia .
- ⌘ Patients undergoing orchidectomy in the same procedure .

For Lightweight mesh a 2.4" x 4.3" (6cm x 11cm) polypropylene+polyglecaprone mesh was used. The mesh has pore size of more than 3mm and has a density of 28g/m^2. It is sterilized by Ethylene oxide gas by the manufacturer. Polypropylene 2-0 was used to suture the mesh in place.

Similarly for standard prolene mesh hernia repair, prolene mesh of 2.4" x 4.3" was used. The mesh has pore size of less than 1mm and has a density of 80-85g/m^2. It is sterilized by Ethylene oxide gas by the manufacturer. Polypropylene 2-0 was used to suture the mesh in place. A shot of inj. Ceftriaxone 1 g was given intravenously immediately before surgery.

The note was taken of the contents of the sac, duration of surgery and any technical difficulty encountered during the surgery.

Postoperatively patient was put on Inj. Ceftriaxone 1 g BD intravenously for five days and injection Diclofenac 75 mg im. BD for 3 days with one shot of Inj. Diclofenac being given 3 hrs after surgery (evening dose).

The patients were followed up for postoperative pain which was evaluated using Visual Analogue Scale, wound hematoma, wound seroma, wound infection.

Patients were assessed for postoperative pain using Visual Analogue Scale on 7 th day after surgery. Visual Analogue Scale consists of a 10 cm line anchored at one end by a label as no pain and at the other end by a label such a severest pain patient experienced in his life time. We translated this for documentation as 1-3 mild pain, 3-7 moderate pain, 7-10 severe pain.

Sutures were removed on the 7^{th} postoperative day and the patients discharged if there was no wound infection, were ambulatory, were taking orally and felt comfortable. Patients were called to the out patient department and follow up was done at 1, 6 and 12th month for complications like chronic groin pain (inguinodynia), foreign body sensation and recurrence. Time taken to return to normal activity was enquired during their follow up visit.

Time to return to normal activity :

All patients were encouraged to return to work as soon as possible, patient in both the groups were followed and the post operative time period that elapsed between day of surgery and the day of joining of duty at their work place was recorded and compared.

Recurrence :

Patients were followed for recurrence. Recurrence was defined as clinically manifest bulge or a protrusion exacerbated by valsalva manoeuvre in the operated groin.

Technique for Lichtenstein Hernioplasty :

After thoroughly painting with Betadine 5% v/v, drapes were put.

A 5 cm incision was made starting from the pubic tubercle medially to the position of the internal ring laterally. The skin incision was deepened. The External oblique aponeuroses was opened and its lower leaf freed from the spermatic cord. The upper leaf of External oblique was freed from the underlying Internal Oblique muscle and aponeuroses. The spermatic cord was mobilized by hooking an index finger around it near pubic tubercle. A thorough search was made for any direct sac. If present, the direct sac was inverted and imbricated using a non-absorbable suture (Prolene 2-0) to flatten the posterior wall. The cremasteric sheath was incised longitudinally and the cord structures separated out and a search for any indirect sac was made.

The indirect sac, if found, was freed from the cord to a point beyond the neck of the sac. The sac was opened. Any contents of peritoneal cavity present were reduced by twisting the sac. The sac was then transligated and excised. To minimize the risk of postoperative ischaemic orchitis, complete nonsliding scrotal hernia sacs were transected at the midpoint of the canal, leaving the distal section in place.

A sheet of 2.4"×4.3" polypropylene (prolene) or lightweight (ultrapro) onlay mesh was sutured with polypropylene 2-0 continuous sutures into place. The medial end of the mesh was cut out to the shape of the medial corner of the inguinal canal. The inferomedial border of the mesh was sutured to the soft tissues overlying Pubic Tubercle after obtaining 2-3 cm of overlap here. The periosteum of the bone was avoided.

The inferior border of the mesh was attached to the inguinal ligament with a loose continuous polypropylene suture. A slit was made at the lateral end of the mesh, creating two tails, a wider above and a narrower below. A 3 mm circular piece of mesh was removed at the medial end of the slit for positioning the cord. The wider upper tail was passed around the cord, and was sutured along with the narrower tail to the inguinal ligament with loose continuous suture. Similarly the upper end of mesh was sutured to conjoined tendon.

During the procedure every care was taken to prevent entrapment of ilio-inguinal as well as ilio-hypogastric nerves in the sutures.

The External Oblique aponeuroses was closed using Prolene 2-0 and skin closed by interrupted sutures with Ethylon 2-0.

Fig.12 : Exposure of External Oblique aponeuroses

Fig.13 : Exposure of Spermatic cord

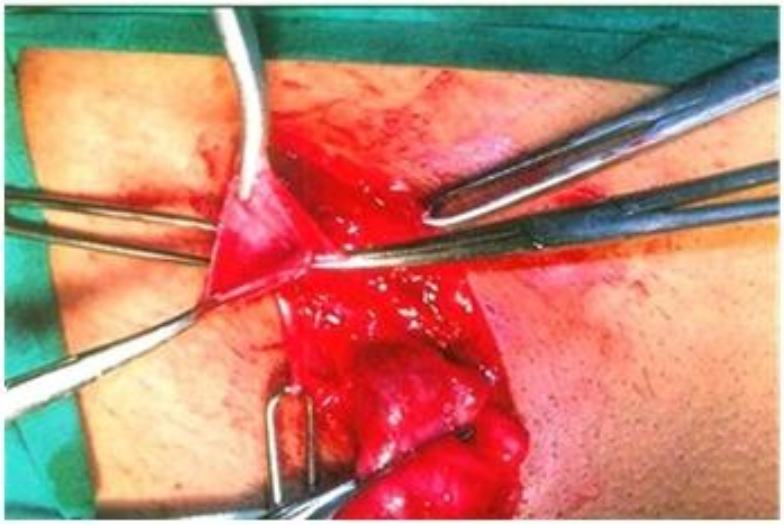


Fig.14 : Dissected and opened hernial sac

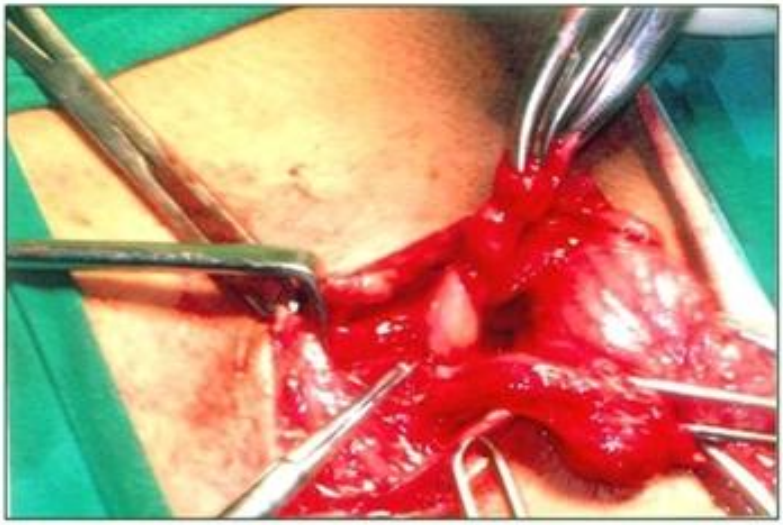


Fig.15 : Twisting to reduce contents of hernial sac

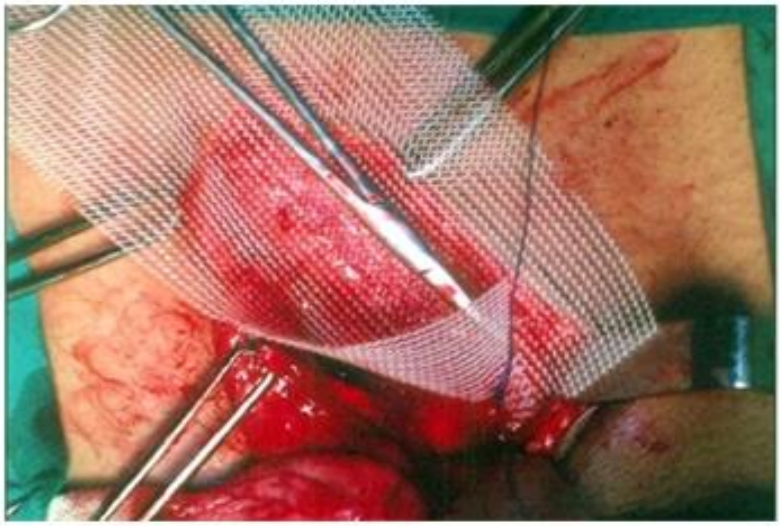


Fig. 16 : Fixing mesh to inguinal ligament and conjoint tendon

Fig. 17 : Standard prolene mesh insitu

Fig.18 : Ultrapro mesh insitu

RESULTS

The present study was carried out in the Department of Surgery in R. L. Jalappa Hospital and Research Centre and SNR General Hospital, Kolar. Sixty two cases of unilateral primary inguinal hernia were included in the study after taking their consent. They were subjected to Lightweight mesh or Standard prolene mesh Lichtenstein hernia repair. Evaluation of all the patients included in the study was done regarding the history, physical findings, operative findings and postoperative complications. Thirty one patients underwent repair with Lightweight mesh lichtenstein hernia repair and Thirty one patients underwent repair with standard Prolene mesh Lichtenstein hernia repair. All the cases in both the groups were followed for a period of one year. The patients were followed up at one month, six month and one year intervals for any complication or recurrence. Any recurrence of hernia was considered an end point.

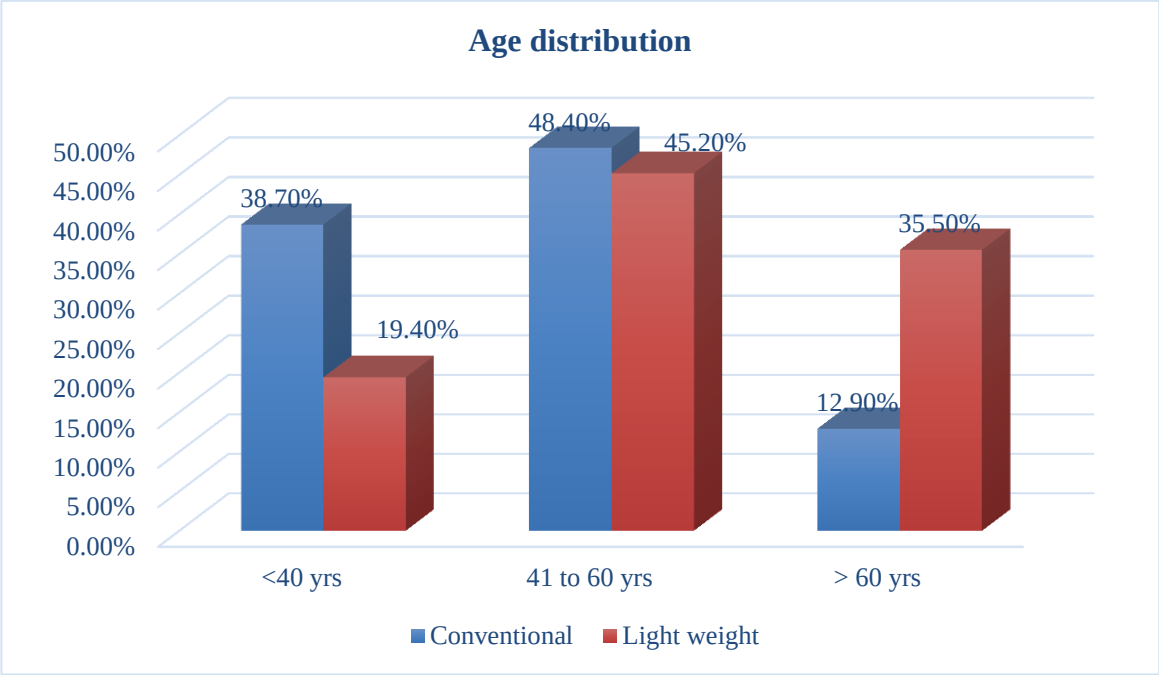
Statistical analysis:

Data was entered in to Microsoft excel data sheet and was analyzed using EPI info 7 version software. Categorical data was presented in the form of frequencies and proportions. Bar charts and pie diagrams was used to represent graphically. Chi-square test was the test of significance. Continuous data was represented in the form of Mean and Standard deviation. Independent ‘t’ test was the test of significance for Continuous variables. P value <0.05 was considered as statistically significant.

Table 1: Age distribution of subjects

		Groups		Total
		Conventional	**Light weight**	
Age	**<40 yrs**	12	6	18
	41 to 60 yrs	15	14	29
	> 60 yrs	4	11	15
Total		31	31	62

$\chi 2 = 5.301$, df = 2, p = 0.071



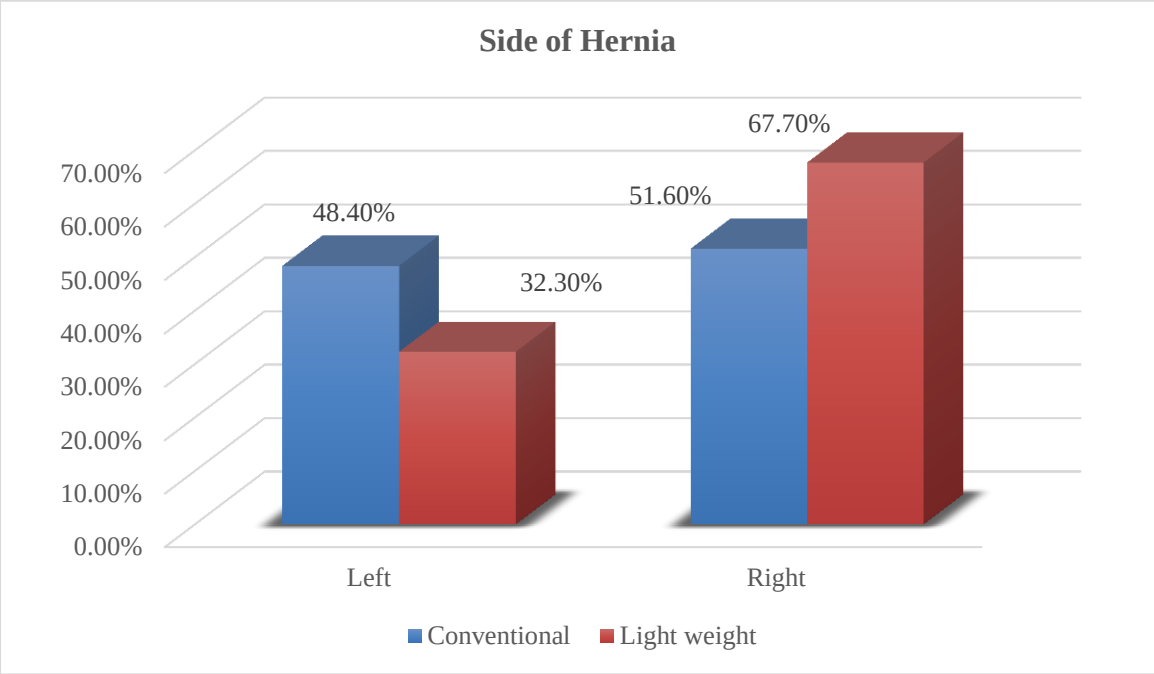
Graph1: Bar diagram showing age distribution of the subjects

Mean age of subjects in Conventional method was 45.55 ± 13.17 yrs and in Light weight mesh group mean age was 54.55 ± 13.26 yrs.

Table 2: Side of Hernia among subjects

		Groups		Total
		Conventional	Light weight	
Side	Left	15	10	25
	Right	16	21	37
Total		31	31	62

$\chi 2 = 1.676$, df = 1, p = 0.196



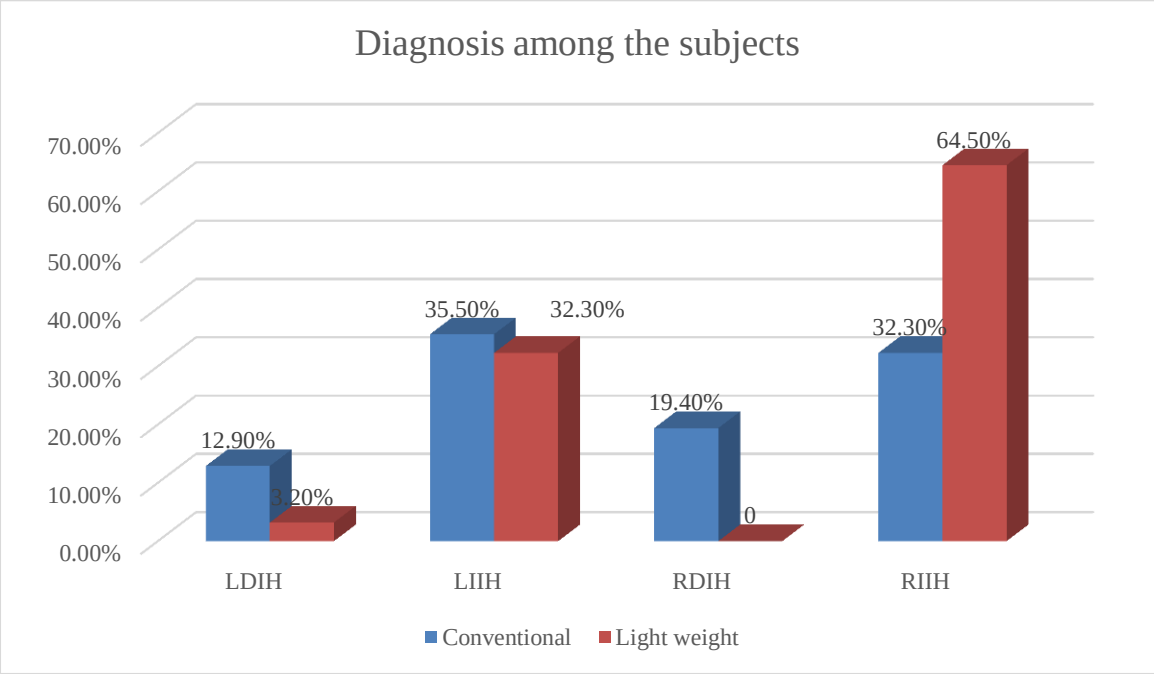
Graph2: Bar diagram showing side of hernia

In the Conventional method 48.4% hernia was on left side and 51.6% on right side and in light weight mesh method 32.3% on left side and 67.7% on right side. There was no significant association between side and methods.

Table 3: Diagnosis among the subjects in both methods.

		Groups		Total
		Conventional	Light weight	
Diagnosis	LDIH (Left Direct Inguinal Hernia)	4	1	5
	LIIH (Left indirect inguinal hernia)	11	10	21
	RDIH (Right direct inguinal hernia)	6	0	6
	RIIH (Right Indirect Inguinal Hernia)	10	20	30
Total		31	31	31

$\chi 2 = 11.181$, df = 3, p = 0.011**



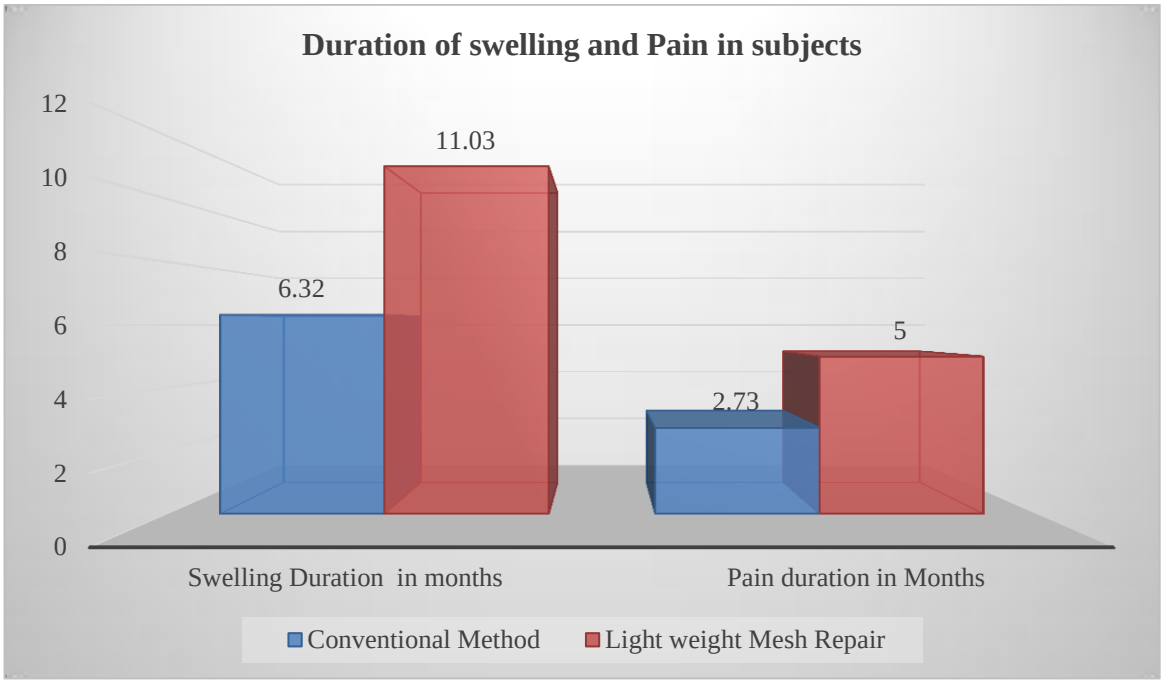
Graph3: Bar diagram showing diagnosis among the subjects

It was observed that majority of subjects who underwent Light mesh repair had Right Indirect inguinal hernia and majority of conventional repair subjects had equal no of Left indirect and Right indirect hernia. There was significant association between diagnosis and type of repair.

Table 4: Duration of symptoms among the subjects

	Groups	N	Mean	Std. Deviation	t value	p value
Swelling Duration in months	Conventional Method	31	6.32	2.561	-3.861	< 0.0001**
	Light weight Mesh Repair	31	11.03	6.290		
Pain duration in Months	Conventional Method	11	2.73	1.737	-2.160	0.040*
	Light weight Mesh Repair	18	5.00	3.199		

All the subjects presented with swelling as the main complaint and only 29 subjects presented with pain associated with swelling, of which 11 were in Conventional group and 18 were in light weight repair group. There was significant difference in duration of swelling and pain among both the groups.

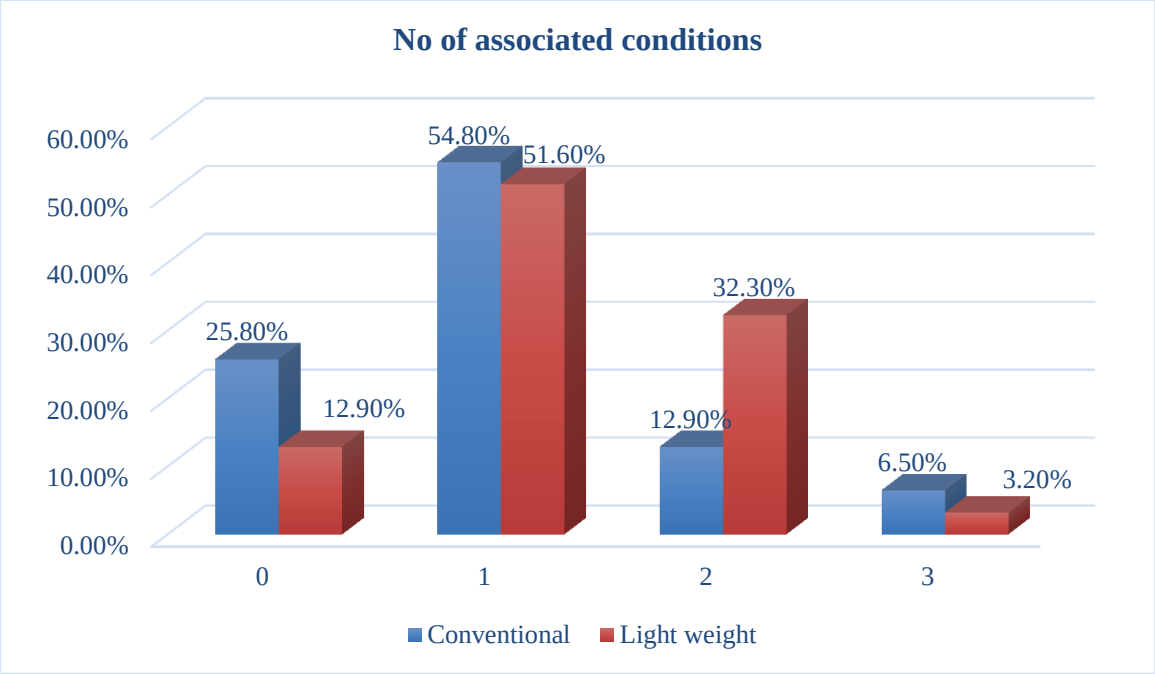


Graph4: Bar diagram showing duration of swelling and pain among the subjects

Table 5: No of associated condition among the subjects

		Groups		Total
		Conventional	Light weight	
No of Associated conditions	0	8	4	12
	1	17	16	33
	2	4	10	14
	3	2	1	3
Total		31	31	62

$\chi 2 = 4.26$, df = 3, p = 0.234

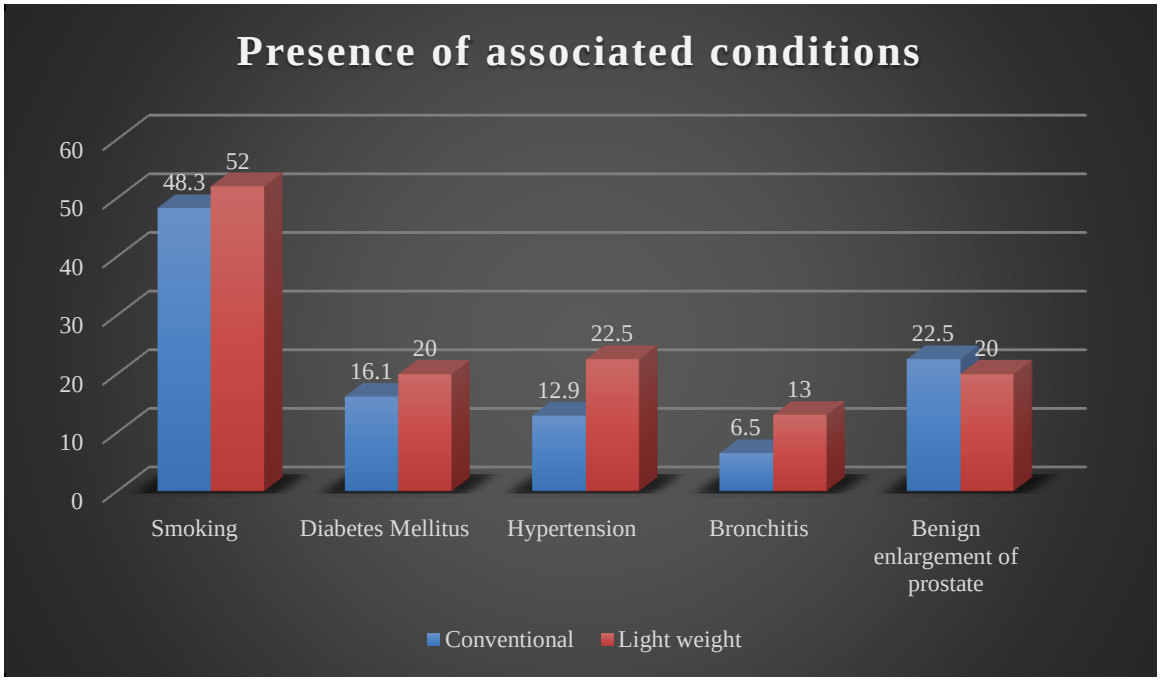


Graph5: Bar diagram showing associated conditions among the subjects

In the study it was observed that 33 (53.2%) subjects had at least one associated condition for hernia and only 19% of them did not have any predisposing factors

Table 6: Associated conditions among the subjects

Presence of Associated Conditions	Groups		Total	p value
	Conventional (n=31)	Light weight (n=31)		
Smoking	15	16	31	0.799
Diabetes Mellitus	5	6	11	0.740
Hypertension	4	7	11	0.319
Bronchitis	2	4	6	0.390
Benign enlargement of prostate	7	6	13	0.755



Graph6: Bar diagram showing presence of associated conditions among the subjects

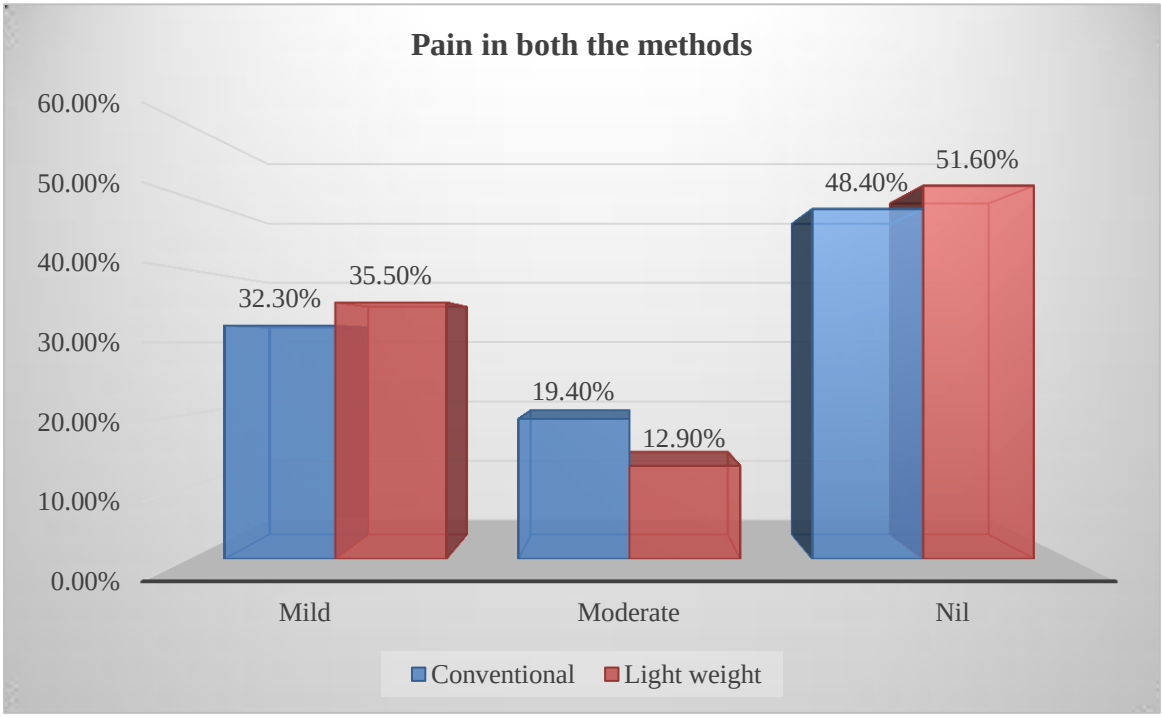
Majority of subjects in both the groups had smoking history, followed by Hypertension, diabetes and BEP. No significant association between the groups

Comparison of Immediate complications in both the methods

Table 7: Pain in both the procedures post operatively

		Groups		Total
		Conventional	Light weight	
Pain	Mild	10	11	21
	Moderate	6	4	10
	Nil	15	16	31
Total		31	31	62

$\chi 2 = 0.480$, df = 2, p = 0. 787

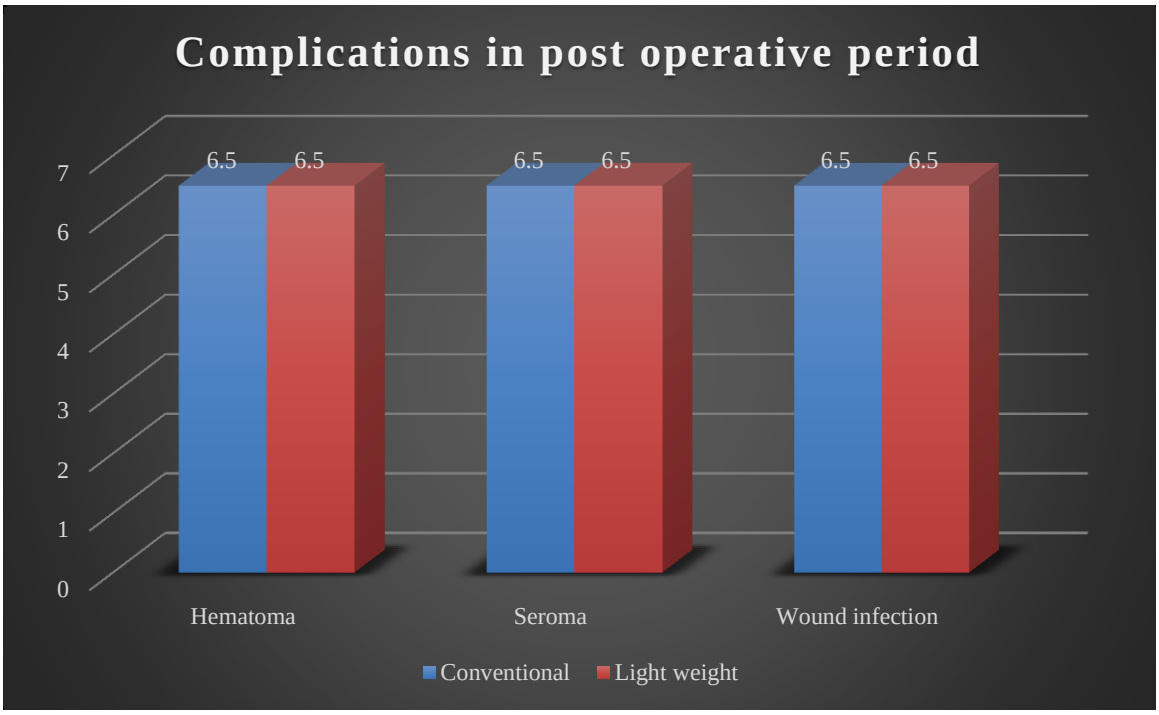


Graph7: Pain in both the methods post operatively

It was observed that both procedures had almost similar effect on pain. Mild to moderate pain was present in both the groups postoperatively. There was no significant association between the groups.

Table 8:Hematoma, Seroma and Wound infection in both the procedures post operatively

	Groups		Total	p value
	Conventional (n=31)	Light weight (n=31)		
Hematoma	2	2	4	1.00
Seroma	2	2	4	1.00
Wound infection	2	2	4	1.00



Graph8: Bar diagram showing immediate complications in both the groups

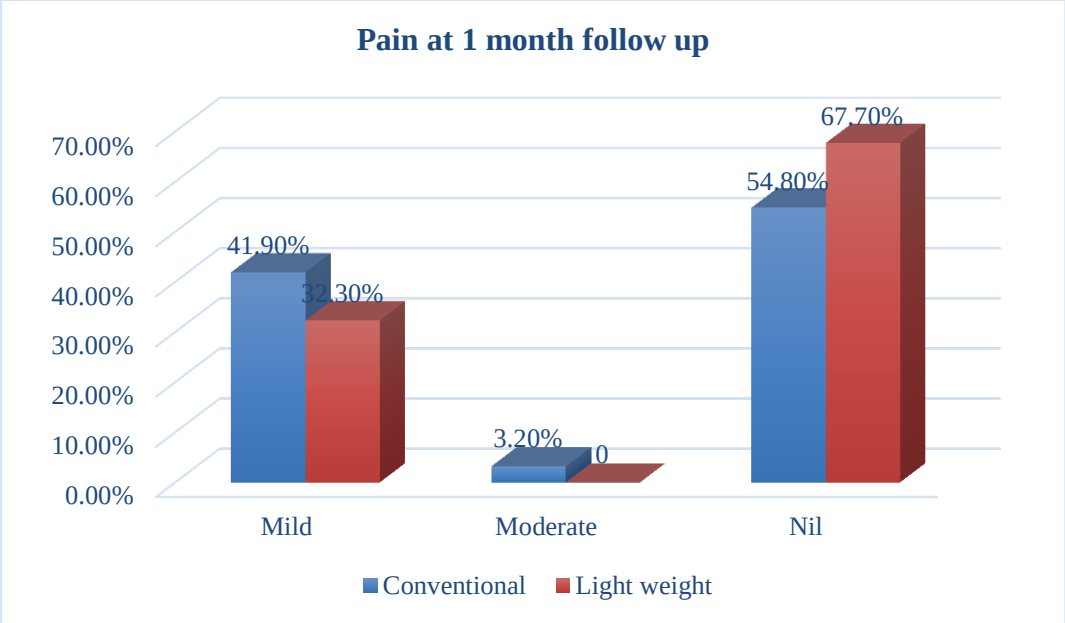
The immediate complications with respect to Hematoma, Seroma and Wound infection was same in both the procedures. There was no significant association between two procedures in the immediate complication rate.

Chronic pain in two procedures

Table 9: Pain in both the procedures at 1 month of follow up

		Groups		Total
		Conventional	Light weight	
At 1month of Follow up	Mild	13	10	23
	Moderate	1	0	1
	Nil	17	21	38
Total		31	31	62

$\chi 2 = 1.81$, df = 2, p = 0.404



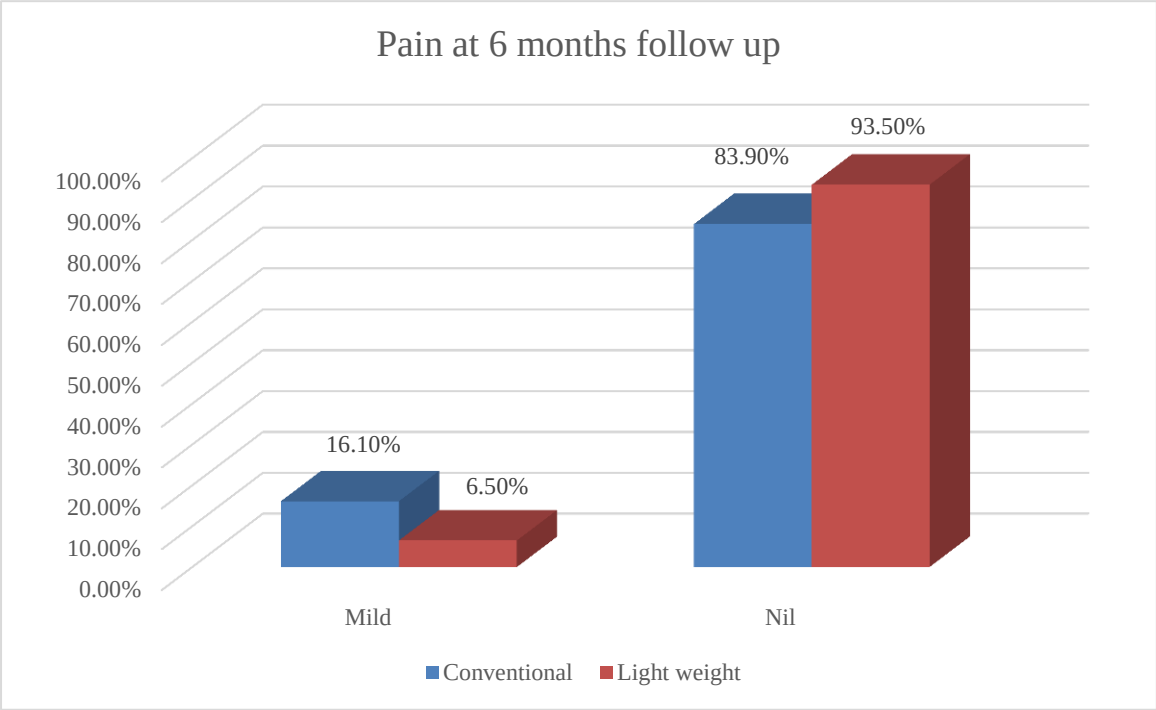
Graph9: Bar diagram showing chronic pain at 1 month follow up

At 1 month follow up 23 subjects had mild pain, 1 subject had moderate pain and 38 subjects had no pain. There was no significant difference in pain at 1 month follow-up in both the procedures.

Table 10: Pain in both the procedures at 6 month of follow up

		Groups		Total
		Conventional	Light weight	
At 6months of follow up	Mild	5	2	7
	Nil	26	29	55
Total		31	31	62

$\chi 2 = 1.449$, df = 1, p = 0.229



Graph10: Bar diagram showing chronic pain at 6 months of follow up

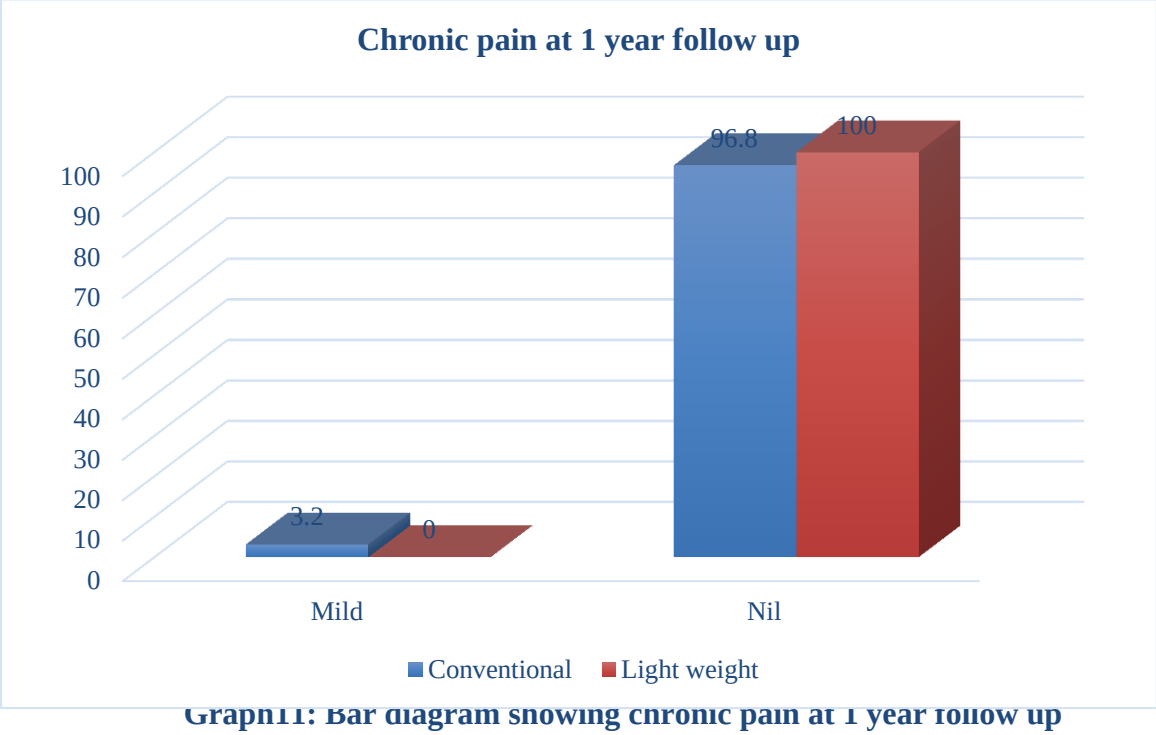
In the study at 6 months of follow up 7 subjects had mild pain, of which 5 subjects were from conventional group and 2 from Light weight mesh repair group. There was no significant difference in pain at 6 month follow-up in both the procedures.

Table 11: Pain in both the procedures at 1 year follow up

		Groups		Total
		Conventional	Light weight	
At 1year follow up	Mild	1	0	1
	Nil	30	31	61
Total		31	31	62

$\chi 2 = 1.016$, df = 1, p = 0.313

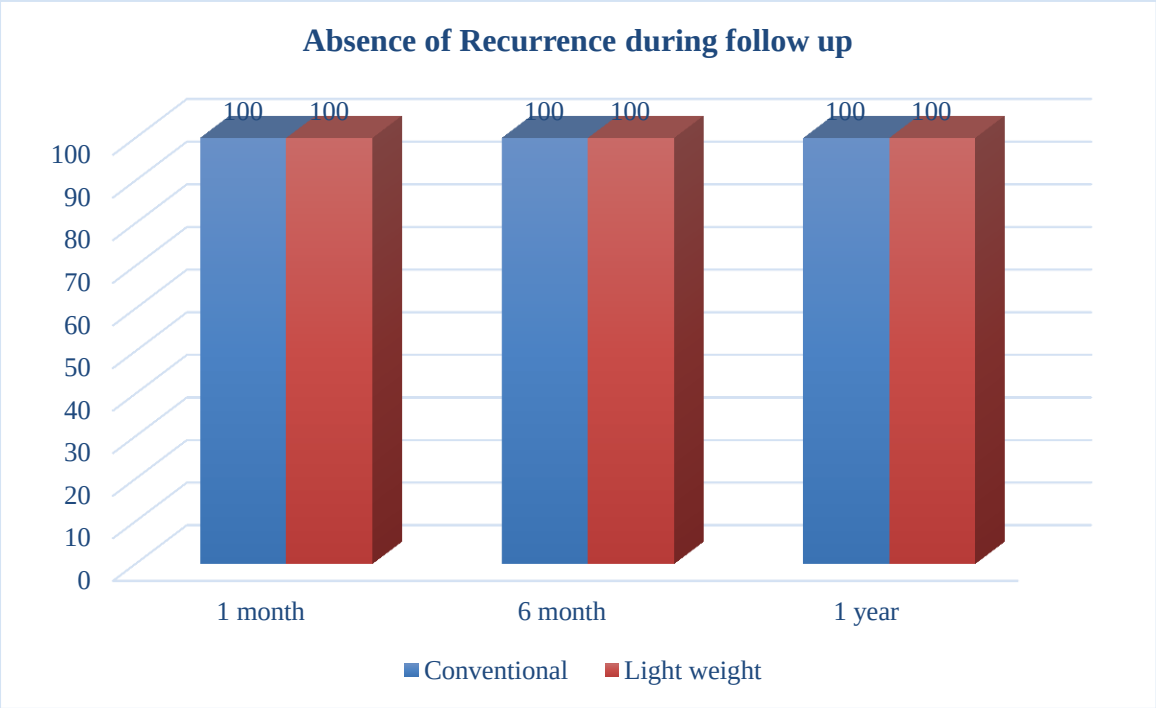
At 1 year only 1 subject from conventional group had pain. There was no significant difference in pain at 1 year follow-up in both the procedures.



Graph11: Bar diagram showing chronic pain at 1 year follow up

Table 12: Recurrence of Hernia in both the procedures at different intervals of follow up

Absence of Recurrence during follow up		Groups		Total
		Conventional	Light weight	
1month	**Nil**	31	31	62
6 month	**Nil**	31	31	62
1 year	**Nil**	31	31	62

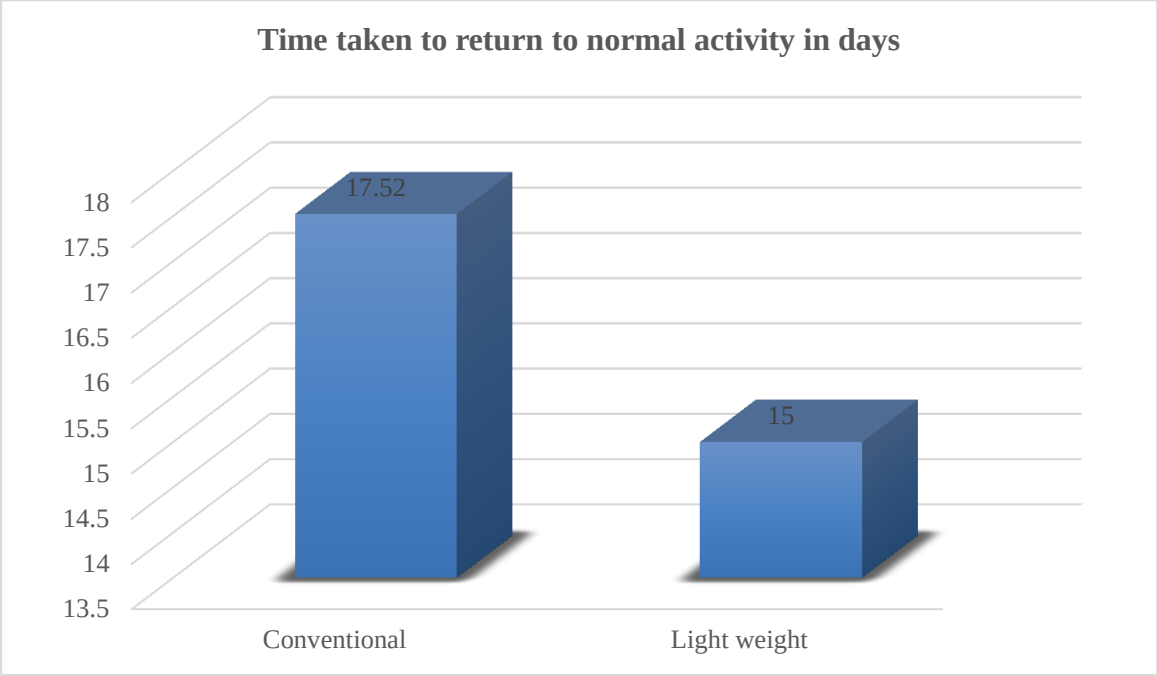


Graph12: Bar diagram showing absence of recurrence during follow up

There was no recurrence in any subject in both the groups at end of 1yr. Hence effectiveness of both the procedure was 100%.

Table 13:Time takento return to normal activity in daysamong both the groups

	Groups	N	Mean	Std. Deviation	t value	p value
Time taken to return to normal activity in days	**Conventional**	31	17.52	4.090	2.293	0.025**
	Light weight	31	15.00	4.539		



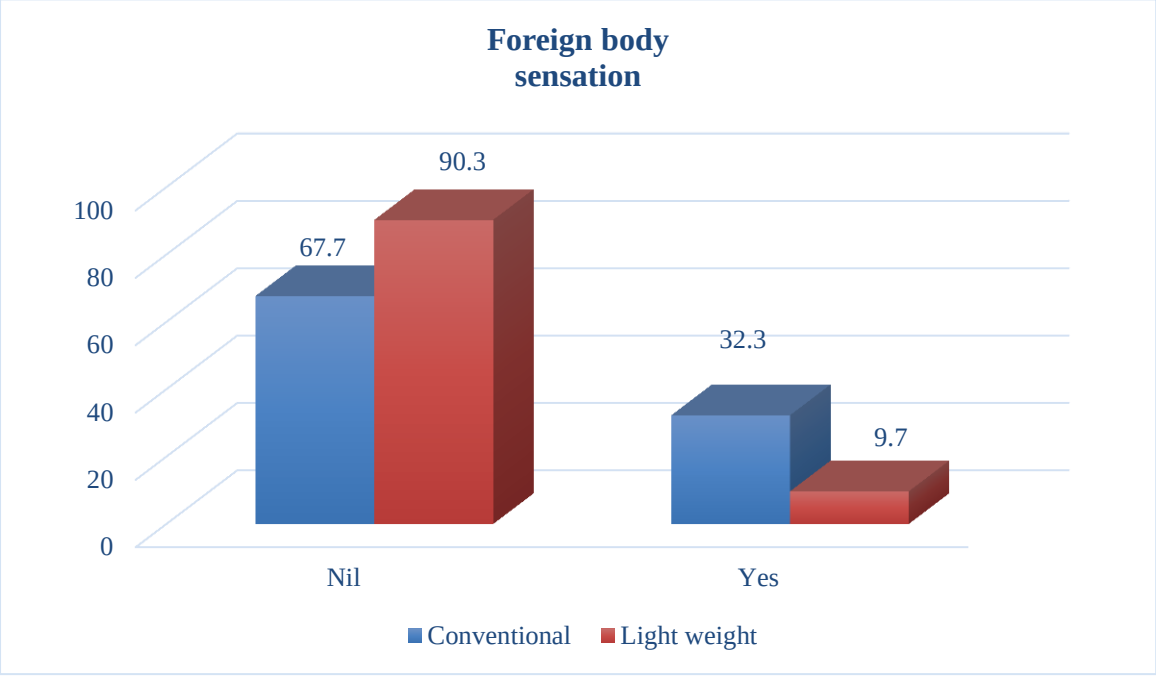
Graph13: Bar diagram showing mean time taken to return to normal activity

It can be inferred from the above table that mean time taken to return to normal activity was 17.52 days in conventional method and 15 days in Light weight method. This difference was statistically significant.

Table 14: Foreign body sensation among both the groups

		Groups		Total
		Conventional	Light weight	
Foreign body sensation	**Nil**	21	28	48
	Yes	10	3	14
Total		31	31	62

$\chi 2 = 4.769$, df = 1, p = 0.028**

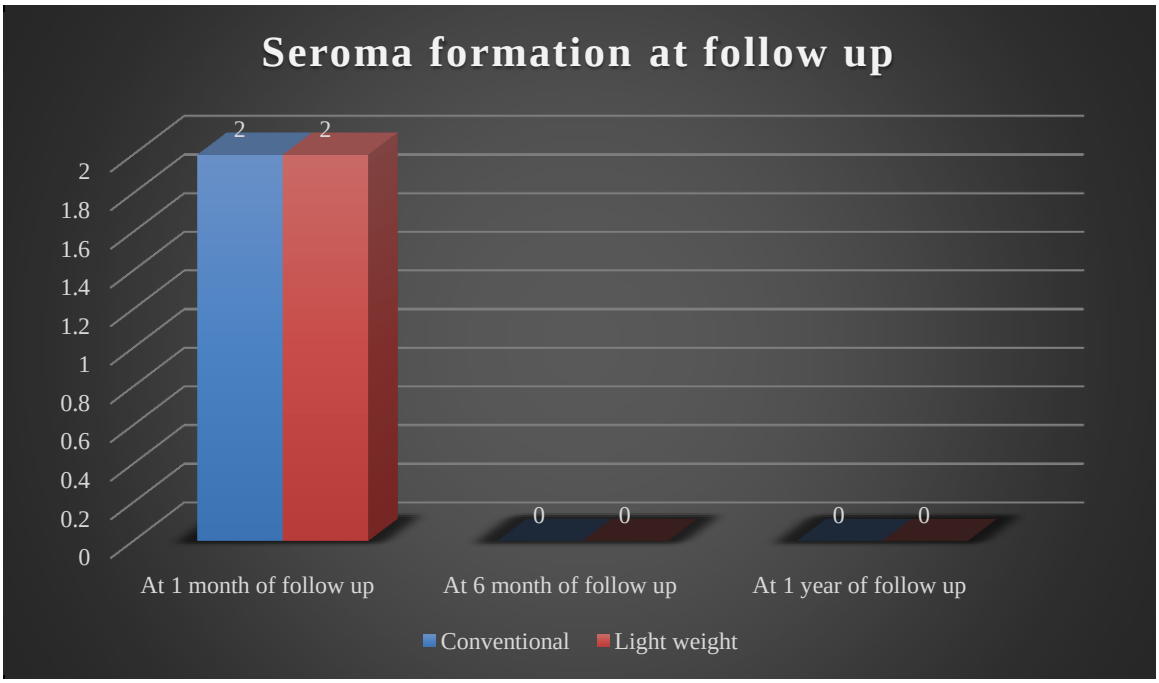


Graph14: Bar diagram showing foreign body sensation in both the procedures during follow up

It was observed that 32.3% of subjects who underwent conventional surgery had foreign body sensation compared to 9.7% in light weight mesh repair. This difference was statistically significant.

Table 15:Seroma formation among both the groups

		Groups		Total (n=62)
		Conventional (n=31)	Light weight (n=31)	
At 1month of follow up	Nil	29	29	58
	Yes	2	2	4
At 6 month of follow up	Nil	31	31	62
At 1 year of follow up	Nil	31	31	62



Graph15: Bar diagram showing Seroma formation during follow up

It was observed that at 1 month 2 subjects from both the procedure developed Seroma, at 6 months and 1 year follow up there were no Seroma cases in both the groups. There was no significant difference in Seroma occurrence between two procedures.

DISCUSSION

Inguinal hernia surgeries are one of the most frequently performed operations in general surgery and as such even minor changes in the outcome have appreciable impact. As surgeons we want techniques with short learning curves, but we still want to attain results comparable to the specialist hernia surgeons.

Our patients on the other hand want their period of convalescence and rehabilitation to be uncomplicated in both short and long term outcome so as to return to their normal daily activities. They need less pain and better quality of life post operatively with minimal surgical morbidity in the long term.

Currently, two major techniques of hernia repair exist Pure anatomical repairs and Tension free or mesh repairs

At present, tension-free preshaped mesh hernioplasties have become a gold standard for most operating surgeons and over the last decade several types of meshes have evolved, and are used as single flat meshes or used in conjunction with three dimensional plugs.

In 1984, Lichtenstein addressed the issue of tension by popularizing routine use of mesh (monofilament polypropyelene meshes) which was laid on posterior wall of the inguinal canal, and a slit made at the lateral end of the mesh, creating two tails, which pass around the cord as it emerges from the internal ring. Presently newer mesh concepts are the current interest which have less chronic pain, earlier return to normal activities without compromising on recurrence. Light weight mesh is one such concept which meets the above criteria.

The present comparative study is a small study and follow up is limited for period of one year. Therefore, this is a limitation of this study.

Chronic pain:

Pain is difficult to measure objectively. Chronic pain following inguinal hernia repair is becoming a significant clinical problem affecting the quality of life. The exact incidence of chronic pain remains to be elucidated, varying in different series and only a few studies presenting long term follow up and a sufficiently large study population.

In the present study, follow up of both group patients revealed that 23 patients had mild pain, 1 patients had moderate pain and 38 patients had no pain at 1 month.

At end of 6 months follow up 7patients had mild pain, of which 5patients were from conventional group and 2patients from light weight group.

At 1year follow up only 1patient from conventional group had pain and no patients had pain in light weight group

TABLE 16 : CHRONIC PAIN COMPARED WITH OTHER STUDIES

Study	Standard prolene mesh		Study	Light weight mesh	
	Followup	% having pain		Followup	% having pain
S.Bringman et al[32]	3 year	3.3%	S.Bringman et al[32]	3 year	0.8%
P.J.O'Dwyer et al[33]	1 mon 3 mon	81.8% 56.6%	P.J.O'Dwyer et al[33]	1 mon 3 mon	82.1% 56.8%
M.Smietanski et al[34]	7 days 3 mon 6 mon 12 mon	55.2% 17.1% 9.9% 6.2%	M.Smietanski et al[34]	7 days 3 mon 6 mon 12 mon	36.2% 9.8% 10.7% 3.8%
Present study	7 days 1 mon 6 mon 12 mon	51.61% 45.2% 16 % 3.2%	Present study	7 days 1 mon 6 mon 12 mon	48.38% 32.2% 6.4% 0 %

Time to return to normal activity:

Return to normal activities and work can be dependent on nutritional status of the patient. Malnourished patients are likely to have longer periods of convalescence.

In the present study conventional group patients with mean of 17.52 days and Light weight mesh group with mean value 15 days.

It should be noted that desk workers will usually return to work earlier than manual workers.

Time taken to return to work may also be dependent on financial incentives a patient gets at place of work.

TABLE 17 : TIME TAKEN TO RESUME NORMAL ACTIVITIES (CONVALESCENCE PERIOD) COMPARED WITH OTHER STUDIES

Study	Standard prolene mesh (T)	Study	Light weight mesh (T)
P.J.O'Dwyer et al[33]	26 days	P.J.O'Dwyer et al[33]	21 days
Present study	17.52 days	Present study	15 days

Time taken to resume normal activities in the present study are comparable with the other study.

Foreign body sensation:

It is understood that light weight mesh with less amount of foreign body causes less foreign body reaction and thus lesser foreign body sensation.

In this study 32.3% patients in the standard prolene mesh group had foreign body sensation compared to 9.7% people in the light weight mesh group.

TABLE 18 : FOREIGN BODY SENSATION COMPARED WITH OTHER STUDIES

Study	Standard prolene mesh (%)	Study	Light weight mesh (%)
S.Bringman et al[32]	55 (22.6%)	S.Bringman et al[32]	37 (14.7%)
S.Post et al[31]	21 (43.8%)	S.Post et al[31]	10 (17.2%)
Present study	10 (32.3%)	Present study	3 (9.7%)

Foreign body sensation is in the present study is comparable to other studies.

Recurrence :

In this study during the period of one year follow up there was not even a single case of recurrence in both mesh repair groups.

TABLE 19 : RECURRENCE RATE COMPARED WITH OTHER STUDIES

Study	Standard prolene mesh		Study	Light weight mesh	
	Followup	Recurrence (%)		Followup	Recurrence (%)
S.Bringman et al[32]	3 year	9 (3.7)	S.Bringman et al[32]	3 year	9 (3.6)
P.J.O'Dwyer et al[33]	1 year	1 (0.7)	P.J.O'Dwyer et al[33]	1 year	8 (5.6)
M.Smietanski et al[34]	1 year	1 (0.6)	M.Smietanski et al[34]	1 year	4 (1.9)
S.Post et al[31]	6 months	2 (4.2)	S.Post et al[31]	6 months	2 (3.4)
Present study	1 yr	0	Present study	1 yr	0

The recurrence rate in the present study is comparable with the other studies.

CONCLUSION

Light weight mesh and standard prolene mesh usage in Lichtensteins repair of inguinal hernia are both comparable and effective.

Light weight mesh with lesser amount of foreign body causes less foreign body reaction and thus less chronic pain, lesser foreign body sensation and earlier return to normal activities where as recurrence is similar in both the groups. Seroma formation, immediate pain, wound infection, hematoma is not affected by the type of mesh used.

Light weight mesh is an ideal choice in Lichenstein's hernioplasty whenever it is feasible.

SUMMARY

This was a comparative study comprising sixty two patients having primary unilateral inguinal hernia. Half of them were subjected to Lichtenstein's hernia repair using either light weight mesh or standard prolene mesh.

The patients presented with swelling in the groin with duration ranging from 2 months to 3 years. Highest numbers of patients were in the age group 40-49years in the standard prolene mesh group. Similarly highest numbers of patients were in the age group 50-59 in the light weight mesh group.

Smoking was the most common associated factor present in 31patients in both the groups.

Chronic pain among patients in standard prolene mesh group at 1 month, 6 month, and 1 year follow up was seen in 45.2%, 16% and 3.2% of the patients respectively, in light weight mesh group patients at 1 month, 6 month and 1 year follow up was 32.2% , 6.4% and none at one year respectively.

Light weight mesh group of patients took on an average 15 days to return to normal activities, whereas patients in standard prolene mesh group took 17.52 days on an average to return to normal activities.

Foreign body sensation seen in 10 (32.3%) of the patients in standard prolene mesh group and 3 (9.7%) patients in light weight mesh group.

No recurrence was noted in any of the patients in both groups.

BIBLIOGRAPHY

1.Benjamin Woods, Leigh Neumayer. Open repair of Inguinal hernia : Evidence based review In Surgical Clinics of North America Volume 88 February 2008. P144-146.

2. Stephen.H.G, Mary.T.H, Kamal.M.F.I. Surgical progress in Inguinal and Ventral Incisional Hernia repair. In Surgical Clinics Of North America Volume 88 February 2008. P 18.

3. Skandalakis JE, Gray SW, Ricketts R, Skandalakis LT. The Anterior Abdominal Wall. In Skandalakis JE, Gray SW, Editors. Embryology for Surgeons - The Embryological Basis for the treatment of congenital anomalies: Maryland, USA: Williams and Wilkins 1994.p54.

4. Snell RS. Clinical Anatomy for Medical Students. 3rd ed. Boston : Little, Brown and Company; 1986.

5.Quinn TH. Anatomy of the Groin : A view from the Anatomist. Chapter 6. In : Fitzgibbons R, Greenberg G, editors. Nyhus and Condon's Hernia : Philadelphia USA: Lippincott Williams and Wilkins, 2002.p 55.

6. Kux M. Anatomy of the Groin : A view from the surgeon. Chapter 5 in : Fitzgibbons R, Greenberg G, editors. Nyhus and Condon's Hernia : Philadelphia USA: Lippincott Williams and Wilkins, 2002.p.45.

7.Fitzgibbons RJ. Jr, Flipi CJ and Quinn TH, Inguinal Hernias. Chapter 36 In : Brunicards FC, Anderson DK, Billiar TK, Dunn DL, Hunter JG, Pollock RE, editors. Schwartz's Principles of Surgery : USA : McGraw-Hill , 2005.p. 1353.

8. Last RJ. The anterior abdominal wall. In : McMinn RMH, Editor, Last's Anatomy Regional and Applied 9th edition London. Churchill Livingstone; 1994.

9. Boffard KD. The Groin and Scrotum. In : Decker GAG, du Plessis DJ. Lee McGregor's Synopsis Of Surgical Anatomy, Bristol, Great Britain: John Wright and Sons Limited;1986. p 118-137.

10. Madden JL, Hakim S, Agrorogianuis AB. The Anatomy and Repair of Inguinal Hernias. Surg Clin N Am 1971; 51(6):1269-1292.

11. Read RC. Why do Human Beings Develop Groin Hernias ? Chapter 1 : In Fitzgibbons R, Greenberg G, editors. Nyhus and Condon's Hernia : Philadelphia USA: Lippincott Williams and Wilkins, 2002.p 3.

12. Schofield PF. Inguinal Hernia : Medicolegal Implications. Ann R Coll Surg Engl 2000; 82: 109-110.

13. Das S. A Concise Textbook of Surgery. 1st ed. Calcutta: Dr. S. Das:1994.

14. Abrahamson J. Etiology and pathophysiology of primary and recurrent groin herniaformation. Surg Clin North Am 1998;78(6):p.953.

15. Read RC. Why do Human Beings Develop Groin Hernias ? Chapter 1 : In Fitzgibbons R, Greenberg G, editors. Nyhus and Condon's Hernia : Philadelphia USA: Lippincott Williams and Wilkins, 2002.p 3.

16. Kingsnorth AN, Bennet DH, Hernias, Umbilicus and abdominal wall. Chapter 73; in Russell RCG, Williams NS and Bulstrode CJK, editors: Bailey and Love's Short Practice of Surgery, 25th edn. London: Arnold, 2008.p968.

17. Das S. A. Manual on Clinical Surgery. 6th ed. Calcutta : Dr. S. Das; June 2004.

18. Das S. A. A Textbook on Surgical Short Cases. 1st ed. Calcutta : Dr. S. Das: Sept1990.

19. Gupta RL, Textbook of Surgery. 2nd ed. New Delhi: Jaypee Brothers Medical Publishers; 2003.

20. Zollinger RM, Jr. Classification of ventral and Groin Hernias, Chapter 7 in : Fitzgibbons R, Greenberg G, editors. Nyhus and Condon's Hernia : Philadelphia USA: Lippincott Williams and Wilkins, 2002.p 71.

21. Zollinger RM, Jr. Classification Systems for Groin Hernias. Surg Clin of N Am 2003; 83: 1053.

22. Debord JR. The historical development of prosthetics in Hernia surgery. Surg Clin North Am 1998;78(6):973.79.

23. Schumpehck V, Klinge U, Klosterhalfen B. Biomaterials for the repair of abdominal wall hernia; structural and compositional considerations. Chapter 47, In : Fitzgibbons R, Greenberg G, editors. Nyhus and Condon's Hernia, 5th edn., Philadelphia USA: Lippincott Williams and Wilkins, 2002.p 551-565.

24. Martin K, Belsham PA, Klark AE. The Lichenstein's repair. Surg Clin North Am 1998;78(6):1025-1046.

25. Klinge U. Mesh for hernia repair. Br J Surg 2008;95:539-540.

26. David.B.E, Lisa.A.M. Prosthetic Material in Inguinal hernia Repair : How do I choose? In Surg Clinics of North America 88 (2008) p179-201.

27. Sharon.B, Bruce.R. Prosthetic Material in Ventral Hernia repair: How do I choose? Surg Clin N Am 88 (2008) p101-112.

28. Klosterhalfen.B, Karsten.J, Klinge.U. The Lightweight and Large porous Mesh concept for Hernia repair In www.future-drugs.com . .

29. Silvestre AC, de Mathia GB, Fagundes DJ, Medeiros LR, Rosa MI. Shrinkage evaluation of heavyweight and lightweight polypropylene meshes in inguinal hernia repair: a randomized controlled trial. In Hernia. 2011 Dec;15(6):629- 34.

30. Uzzaman MM, Ratnasingham K, Ashraf N. Meta-analysis of randomized controlled trials comparing lightweight and heavyweight mesh for Lichtenstein inguinal hernia repair. Hernia. 2012 Oct;16(5):505-18.

31. S.Post, B.Weiss, M.Willer, T.Neufang and D.Lorenz. Randomised controlled trial of light weight composite mesh for Lichtenstein inguinal hernia repair. In British Journal of Surgery 2004; 91 :44-48.

32. Bringman S, Wollert S, Osterberg J, Smedberg S, Granlund H, Heikkinen TJ. Three-year results of a randomized clinical trial of lightweight or standard polypropylene mesh in Lichtenstein repair of primary inguinal hernia. In Br J Surg. 2006 Sep;93(9):1056-9.

33. P.J.O'Dwyer, A.N.Kingsworth, R.G.Molloy, P.K.Small, B.Lammers and G.Horeyseck. Randomized clinical trial assessing impact of a lightweight or heavyweight mesh on chronic pain after inguinal hernia repair. In British Journal of Surgery 2005; 92:166 - 170.

34. M.Smietanski for the Polish Hernia study group. Randomised clinical trial comparing polypropylene with a poliglecaprone and polypropylene composite mesh for inguinal hernioplasty. In British Journal Of Surgery 2008; 95 : 1462-1468.

ANNEXURE I

"PROSPECTIVE OBSERVATIONAL STUDY COMPARING LIGHT WEIGHT MESH WITH CONVENTIONAL PROLENE MESH IN LICHTENSTEIN INGUINAL HERNIA REPAIR"

PROFORMA

Name	:	Age	:
Sex	:	IP No.	:
Surgical unit	:	Occupation	:
Unit chief	:	Diagnosis	:
Address :		D.O.A.	:
		D.O.S.	:
		D.O.D.	:

COMPLAINTS :

1) Swelling in the groin (Right / Left)
2) Pain in swelling / Groin
3) Others

I) HISTORY OF PRESENTING ILLNESS :

1) Swelling in the groin (Duration)
    a. Onset - Spontaneous
        - Following lifting heavy weights
    b. Site and size when it was first noticed
    c. Rate of progress
    d. Reducibility - Spontaneous / Manual / Not reducible /
        Not reducible and painful
2) Pain in swelling (Absent / Present)
    a. Duration
    b. Nature

c. Relation to appearance of swelling

d. Aggravating and relieving factors

3) Other : Colicky abdominal pain / Vomiting / Abdominal distension / Constipation / Fever

4) History of straining : Chronic cough / Chronic constipation / Straining at micturition

II) PAST HISTORY :

1) Previous abdominal surgery :

(Notably appendicectomy by extended grid iron incision, hernia repair on opposite side)

2) History of any associated medical condition -

(Diabetes / Hypertension / Pulmonary TB)

III) FAMILY HISTORY :

H /o hernia in the family members

IV) PERSONAL HISTORY :

1) Nature of work : Sedentary / Moderate / Heavy (requires lifting heavy weights)

2) Smoking :

V) GENERAL PHYSICAL EXAMINATION :

1) Built and nutrition : Well built / Moderate / Poor
2) Anemia / Cyanosis Jaundice / Clubbing / Dependent edema / Lymphadenopathy

3) Vital signs :

Temperature : Pulse :

Respiration : B.P. :

VI) LOCAL EXAMINATION :

(Patient in standing position / Patient in lying position)

1) Inspection :

   a. Swelling : Unilateral / Bilateral

   b. Site size shape :

   c. Position and extent :

   d. Surface, skin over the swelling :

   e. Expansile impules on cough : Yes / No

2) Palpation :

   a. Size, position and extent

   b. Tenderness

   c. To get above swelling : Possible / Not possible

   d. Consistency : Doughy / Granular / Elastic / Tense

   e. Reducibility : Partial / Complete / Gurgling felt during reduction / Not reducible

   f. Invagination test :

   g. Internal ring occlusion test :

   h. Zieman's technique :

   i. Examination of tone of abdominal muscles

      malgaignes bulges : Present / Absent

3) Percussion : Dull / Tympanitic

4) Auscultation : Bowels sounds heard / Not heard over the swelling

5) External genitalia :

   Phimosis : Yes / No

   Meatal stenosis : Yes / No

   Stricture urethra : Yes / No

6) P.R.

Prostatic enlargement : Yes / No

Anal stensois / Growth Yes / No

VII) EXAMINATION OF OTHER SYSTEMS :

1) Abdominal examination (Presence of ascites / Abdominal mass)
2) Respiratory system - Breath sounds,

- Rhonchi / Crepts in upper zone : Present / Absent
- Rhonchi / Crepts in lower zone : Present / Absent

3) CVS

VIII) DIAGNOSIS :

IX) INVESTIGATIONS :

1) Blood Hb : TC : DC :

ESR : BT : CT :

2) Urine complete exdamination
3) FBS : S. Creatinine : Blood urea :
4) ECG :
5) Chest x-ray :

X) TREATMENT :

1) Preoperative :
    a. Medical treatment for precipitating factors
    b. Fitness for surgery

2) Type of mesh used in Lichtenstein's operation

   a. Light weight mesh

   b. Standard prolene mesh

3) Operative findings

   a. Type of anaesthesia

   b. Contents of sac

   c. Duration of surgery

   d. Any technical difficulty encountered

XI) POSTOPERATIVE PERIOD :

1) Immediate

   a. Pain assessment (VAS)

   b. Dosage and frequency of analgesics used

   c. Haematoma / Seroma

   d. Wound infection

XII) FOLLOW-UP :

	1 week	1 month	6 month	1 year
Chronic pain				
Time taken to return to normal activity				
Foreign body sensation				
Wound infection				
Recurrence				
Seroma formation				

ANNEXURE II

CONSENT FORM

FOR OPERATION / ANAESTHESIA

I _____ Hosp No. _____ in my full senses here by give my complete consent for _____ or any other procedure deemed fit which is a / and diagnostic procedure / biopsy / transfusion / operation to be performed on me / my son / my daughter / my ward _____ age _____ under any anaesthesia deemed fit. The nature and risks involved in the procedure have been explained to me to my satisfaction. For academic and scientific purpose the operation / procedure may be televised or photographed.

Signature / Thumb impression of
Patient / Guardian

Date :

Name :

Designation :

Guardian :

Relationship:

Full Address :

KEY TO MASTER CHART

BA	-	Bronchial asthma
BEP	-	Benign enlargement prostate
Br	-	Bronchitis
D	-	Day
DM	-	Diabetes mellitus
g	-	groin
H	-	Hematoma
h	-	hour
HTN	-	Hypertension
L	-	Left
LDIH	-	Left direct inguinal hernia
LIIH	-	Left indirect inguinal hernia
Lo	-	Lost
m	-	mild
M	-	Moderate
mon	-	months
N	-	Nil
P	-	pain
R	-	Right
RDIH	-	Right direct inguinal hernia
RIIH	-	Right indirect inguinal hernia
S	-	Seroma
S	-	Severe
S	-	Swelling
Sm	-	Smoker
T	-	Time taken to return to normal activity
US	-	Urethral structure
Yr	-	year
Y	-	Yes

Sl.no	Groups	Groupscoded	Age	Sex	Complaints	Over all Complaints	Side	Swelling Duration in months	Pain duration in Months	Diagnosis	No of Associated conditions	Associated condition	Smoking	DM	HTN	Bronchitis	BEP	Immediate Complications	Pain	Hematoma	Seroma	Wound inf.	Chronic pain	1mon	6mon	1year	Recurrence	1mon	6mon	1year	Time taken to return to normal activity in days	Foreign body sensation	Seroma formation	1mon	6mon	1year
1	Conventional	1	32	M		S L g 7mon	L	7		LIIH	1	Sm	P	A	A	A	A		m	N	N	N		m	m	N		N	N	N	24	Y		N	N	N
2	Conventional	1	50	M		S R g 6mon	R	6		RDIH	1	HTn	A	A	P	A	A		m	N	N	N		m	N	N		N	N	N	15	N		N	N	N
3	Conventional	1	35	M		S L g 6mon	L	6		LIIH	1	Br	A	A	A	P	A		N	N	N	N		N	N	N		N	N	N	16	Y		N	N	N
4	Conventional	1	44	M		S L g 7mon P 3mon	L	7	3	LIIH	2	Sm+DM	P	P	A	A	A		M	N	Y	N		m	m	N		N	N	N	20	N		Y	N	N
5	Conventional	1	53	M		S L g 7mon	L	7		LDIH	2	Sm+BEP	P	A	A	A	P		N	N	N	N		N	N	N		N	N	N	14	N		N	N	N
6	Conventional	1	60	M		S L g 9mon P 3mon	L	9	3	LIIH	1	BEP	P	A	A	A	P		M	N	N	N		M	m	N		N	N	N	28	N		N	N	N
7	Conventional	1	55	M		S R g 7mon	R	7		RIIH	3	Sm+DM+BEP	P	P	A	A	P		M	Y	N	N		m	N	N		N	N	N	22	N		N	N	N
8	Conventional	1	45	M		S L g 6mon	L	6		LIIH	0	N	A	A	A	A	A		N	N	N	N		N	N	N		N	N	N	16	N		N	N	N
9	Conventional	1	35	M		S L g 5mon	L	5		LDIH	1	Sm	P	A	A	A	A		m	N	N	N		m	m	m		N	N	N	21	Y		N	N	N
10	Conventional	1	30	M		S R g 4mon P 1mon	R	4	1	RIIH	0	N	A	A	A	A	A		m	N	N	N		N	N	N		N	N	N	17	N		N	N	N
11	Conventional	1	28	M		S L g 2mon	L	2		LIIH	0	N	A	A	A	A	A		N	N	N	N		N	N	N		N	N	N	16	N		N	N	N
12	Conventional	1	27	M		s L g 5mon P 1mon	L	5	1	LIIH	1	Sm	P	A	A	A	A		m	Y	N	N		m	N	N		N	N	N	14	Y		N	N	N
13	Conventional	1	65	M		S R g 9mon P 3mon	R	9	3	RIIH	1	BEP	P	A	A	A	P		N	N	N	N		N	N	N		N	N	N	16	N		N	N	N
14	Conventional	1	42	M		S R g 2mon	R	2		RDIH	1	Sm	P	A	A	A	A		N	N	N	N		N	N	N		N	N	N	13	N		N	N	N
15	Conventional	1	70	M		S L g 2yr 6mon	L	6		LDIH	3	DM+HTn+BEP	A	P	P	A	P		m	N	N	Y		m	N	N		N	N	N	18	Y		N	N	N
16	Conventional	1	51	M		S L g 7mon	L	7		LDIH	1	Sm	P	A	A	A	A		m	N	N	N		m	m	N		N	N	N	15	Y		N	N	N
17	Conventional	1	37	M		S R g 5mon	R	5		RIIH	0	N	A	A	A	A	A		m	N	N	N		N	N	N		N	N	N	18	N		N	N	N
18	Conventional	1	52	M		S R g 7mon P 2mon	R	7	2	RIIH	0	N	A	A	A	A	A		N	N	N	N		N	N	N		N	N	N	17	N		N	N	N
19	Conventional	1	28	M		S R g 4mon	R	4		RIIH	1	Sm	P	A	A	A	A		M	N	N	N		m	N	N		N	N	N	16	Y		N	N	N
20	Conventional	1	39	M		S R g 3mon P 1mon	R	3	1	RIIH	0	N	A	A	A	A	A		M	N	N	N		m	N	N		N	N	N	19	N		N	N	N
21	Conventional	1	60	M		S R g 8mon	R	8		RIIH	2	HTn+BEP	A	A	P	A	P		N	N	N	N		N	N	N		N	N	N	18	N		N	N	N
22	Conventional	1	68	M		S L g 1yr3mon P 7mon	L	15	7	LIIH	1	DM	A	P	A	A	A		N	N	N	N		N	N	N		N	N	N	16	N		N	N	N
23	Conventional	1	57	M		S R g 11mon P 4mon	R	11	4	RIIH	1	Dm	A	P	A	A	A		N	N	N	N		N	N	N		N	N	N	14	Y		N	N	N
24	Conventional	1	70	M		S L g 8mon	L	8		LIIH	2	HTn+BEP	A	A	P	A	P		M	N	N	Y		m	N	N		N	N	N	28	N		N	N	N
25	Conventional	1	43	M		S R g 5mon	R	5		RDIH	1	Sm	P	A	A	A	A		m	N	Y	N		m	N	N		N	N	N	24	N		Y	N	N
26	Conventional	1	32	M		S L g 6mon	L	6		LIIH	0	N	A	A	A	A	A		N	N	N	N		N	N	N		N	N	N	16	N		N	N	N
27	Conventional	1	46	M		S R g 5mon	R	5		RDIH	1	Sm	P	A	A	A	A		N	N	N	N		N	N	N		N	N	N	12	N		N	N	N
28	Conventional	1	27	M		S R g 6mon P 2mon	R	6	2	RIIH	0	N	A	A	A	A	A		m	N	N	N		m	N	N		N	N	N	18	Y		N	N	N
29	Conventional	1	40	M		S R g 4mon	R	4		RDIH	1	Sm	P	A	A	A	A		N	N	N	N		N	N	N		N	N	N	13	N		N	N	N
30	Conventional	1	50	M		S R g 8mon P 3mon	R	8	3	RDIH	1	Br	A	A	A	P	A		N	N	N	N		N	N	N		N	N	N	15	N		N	N	N
31	Conventional	1	41	M		S L g 6mon	L	6		LIIH	1	Sm	P	A	A	A	A		N	N	N	Y		N	N	N		N	N	N	14	Y		N	N	N
32	Light weight	2	66	M		S R g 10mon P 4mon	R	10	4	RIIH	2	DM+Sm	P	P	A	A	A		m	N	N	N		N	N	N		N	N	N	13	N		N	N	N
33	Light weight	2	60	M		S R g 1yr4mon	R	16		RIIH	2	Br+BEP	A	A	A	P	P		m	N	N	N		m	N	N		N	N	N	16	N		N	N	N
34	Light weight	2	35	M		S R g 6mon	R	6		RIIH	1	Sm	P	A	A	A	A		N	N	N	N		N	N	N		N	N	N	11	N		N	N	N
35	Light weight	2	50	M		S L g 8mon	L	8		LIIH	0	N	A	A	A	A	A		m	N	N	N		N	N	N		N	N	N	13	N		N	N	N
36	Light weight	2	65	M		S L g 2yr3mon P 8mon	L	25	8	LIIH	2	Dm+BEP	A	P	A	A	P		m	N	N	N		m	N	N		N	N	N	11	Y		N	N	N
37	Light weight	2	45	M		S L g 7mon	L	7		LIIH	2	Br+Sm	P	A	A	P	A		N	Y	N	N		N	N	N		N	N	N	22	N		N	N	N
38	Light weight	2	75	M		S R g 1yr9mon P 1yr	R	21	12	RIIH	2	DM+HTn	A	P	P	A	A		M	N	N	N		m	m	N		N	N	N	18	Y		N	N	N
39	Light weight	2	62	M		S R g 11mon	R	11		RIIH	0	N	A	A	A	A	A		N	N	N	N		N	N	N		N	N	N	12	N		N	N	N
40	Light weight	2	48	M		S R g 7mon	R	7		RIIH	1	HTn	A	A	P	A	A		N	N	N	N		N	N	N		N	N	N	11	N		N	N	N
41	Light weight	2	82	M		S R g 2yr6mon P 1yr	R	30	12	LIIH	2	Sm+BEP	P	A	A	A	P		M	Y	N	N		m	N	N		N	N	N	21	N		N	N	N
42	Light weight	2	42	M		S R g 4mon	R	4		RIIH	1	Sm	P	A	A	A	A		m	N	N	N		N	N	N		N	N	N	14	N		N	N	N
43	Light weight	2	50	M		S L g 8mon	L	8		LIIH	1	Br	A	A	A	P	A		N	N	N	N		N	N	N		N	N	N	16	N		N	N	N
44	Light weight	2	40	M		S R g 7mon P 3mon	R	7	3	RIIH	1	Sm	P	A	A	A	A		m	N	N	Y		m	N	N		N	N	N	28	N		N	N	N
45	Light weight	2	65	M		S L g 1yr4mon P 6mon	L	16	6	LIIH	1	Htn	A	A	P	A	A		N	N	N	N		N	N	N		N	N	N	11	N		N	N	N
46	Light weight	2	44	M		S R g 7mon	R	7		RIIH	1	Sm	P	A	A	A	A		N	N	N	N		N	N	N		N	N	N	13	N		N	N	N
47	Light weight	2	65	M		S R g 1yr6mon P 8mon	R	18	8	RIIH	1	HTn	A	A	P	A	A		N	N	N	N		N	N	N		N	N	N	12	N		N	N	N
48	Light weight	2	60	M		S L g 9mon P 4mon	L	9	4	LIIH	1	DM	A	P	A	A	A		m	N	N	Y		m	N	N		N	N	N	22	N		N	N	N
49	Light weight	2	60	M		S R g 1yr2mon P 6mon	R	14	6	RIIH	1	DM	A	P	A	A	A		N	N	N	N		N	N	N		N	N	N	14	N		N	N	N
50	Light weight	2	65	M		S R g 1yr P 6mon	R	12	6	RIIH	2	HTn+BEP	A	A	P	A	P		M	N	Y	N		m	N	N		N	N	N	20	N		Y	N	N
51	Light weight	2	35	M		S L g 6mon	L	6		LIIH	1	Sm	P	A	A	A	A		N	N	N	N		N	N	N		N	N	N	11	N		N	N	N
52	Light weight	2	35	M		S R g 4mon	R	4		RIIH	1	Sm	P	A	A	A	A		m	N	Y	N		m	N	N		N	N	N	24	N		Y	N	N
53	Light weight	2	41	M		S R g 9mon	R	9		RIIH	0	N	A	A	A	A	A		N	N	N	N		N	N	N		N	N	N	11	N		N	N	N
54	Light weight	2	52	M		S R g 7mon	R	7		RIIH	2	Sm+Br	P	A	A	P	A		N	N	N	N		N	N	N		N	N	N	13	N		N	N	N
55	Light weight	2	70	M		S R g 6mon P 2mon	R	6	2	RIIH	1	Sm	P	A	A	A	A		m	N	N	N		m	m	N		N	N	N	18	Y		N	N	N
56	Light weight	2	63	M		S R g 3mon P 3mon	R	3	3	RIIH	0	N	A	A	A	A	A		N	N	N	N		N	N	N		N	N	N	10	N		N	N	N
57	Light weight	2	60	M		S L g 11mon P 3mon	L	11	3	LDIH	2	Sm+BEP	P	A	A	A	P		N	N	N	N		N	N	N		N	N	N	14	N		N	N	N
58	Light weight	2	73	M		S R g 8mon P 2mon	R	8	2	RIIH	1	HTn	A	A	P	A	A		m	N	N	N		N	N	N		N	N	N	13	N		N	N	N
59	Light weight	2	60	M		S R g 1yr6mon P 4mon	R	18	4	RIIH	3	DM+Sm+BEP	P	P	A	A	P		m	N	N	N		m	N	N		N	N	N	16	N		N	N	N
60	Light weight	2	40	M		S L g 1yr2mon P 2mon	L	14	2	LIIH	2	Sm+HTn	P	A	P	A	A		N	N	N	N		N	N	N		N	N	N	14	N		N	N	N
61	Light weight	2	45	M		S R g 8mon P 3mon	R	8	3	RIIH	1	Sm	P	A	A	A	A		M	N	N	N		N	N	N		N	N	N	12	Y		N	N	N
62	Light weight	2	35	M		S L 1yr P 2mon	L	12	2	LIIH	1	Sm	P	A	A	A	A		N	N	N	N		N	N	N		N	N	N	11	N		N	N	N