"COMPARISON OF SKIN INCISION WITH ELECTRO SURGICAL CAUTERY VS SCALPEL IN ELECTIVE INGUINAL HERNIA SURGERY: A RANDOMIZED CONTROL STUDY"

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This is to certify that the dissertation entitled **"COMPARISON OF SKIN INCISION WITH ELECTRO SURGICAL CAUTERY VS SCALPEL IN ELECTIVE INGUINAL HERNIA SURGERY: A RANDOMIZED CONTROL STUDY"** is a bonafide research work done by **REG NO. BH0115003.**

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LIST OF ABBREVIATIONS USED

vs	–	Versus
cm	–	Centimeter
mm	–	millimeter
ESU	–	Electro Surgical Unit
Sl. No.	–	Serial Number
AC	–	Alternating Current
DC		Direct Current
°C	–	Degree Centigrade
Hrs	–	Hours
VAS	–	Visual Analogue Scale
VSS	–	Vancouver Scar Scale
MSS	–	Manchester Scar Scale
SBSES	–	Stony Brook Scar Evaluation Scale
POSAS	–	Patient and Observer Scar Assessment Scale
DM	–	Diabetes Mellitus
HTN	–	Hypertension
ASIS	–	Anterior Superior Iliac Spine
kHz	–	Kilo Hertz
MHz	–	Mega Hertz

ABSTRACT

Background and objectives

Surgical incisions are usually made with scalpel. Since its introduction in 1929, Electro surgery has been used extensively and has now become an indispensable tool in every operating room. The present study was designed to evaluate the use of electro surgery for making skin incisions in elective inguinal hernia surgery by comparing postoperative pain and cosmetic outcome.

Materials and methods

This one year randomized controlled trail was done in Department of General Surgery, KLES Dr.Prabhakar Kore hospital, Belagavi from January 2016 to December 2016. A total of 40 patients were divided into two groups of 20 each. Group A skin incision was made with electrosurgical cautery and Group B skin incision was made with scalpel.

Results

In the present study all the participants were males. In this study the commonest age group was 55 – 64 years in group A (40 %) and in group B (37.5%). The mean age of the participants in group A is 50.95 ±11.75 and the mean age of the participants in group B is 52.2 ± 11.443(p value of 0.0.741)

In the present study the postoperative pain between the two groups is compared at 24 hrs, 48 hrs and 72 hrs. The pain was assessed by Visual Analogue Scale on a scale of 1 to 10.

In the present study the mean pain scores at 24 hrs for group A is 3.7 ± 0.71 and that of group B is 4.85 ± 0.82 (p value 0.0004).

The mean pain scores measured at 48 hrs for group A is 2.9 ± 0.62 and for group B is 3.55 ± 0.589 (p value 0.009).

In the present study, the pain scores at 72 hrs between the two groups was not statistically significant (p value 0.262) group A mean is 2.2 ± 0.74 and group B mean is 2.55 ± 0.73.

The post operative pain scores are less when incision is made with electrosurgical cautery at 24 hrs and 48 hrs

The cosmetic outcome between the two groups was compared using Patient and Observer Scar assessment Scale (POSAS) , the scale has patient scale (60) and observer scale (60) and the total score (120) is assessed.

The mean scar score of group A is 37.4 ± 4.96 and that of group B is 36.05 ± 5.14 and there is no statistical difference between the two groups, p value = 0.415.

The incision length between the two groups was also compared, In group A the mean length of incision is 9.75 cm ± 0.825, in group B the mean length of incision is 9.811 cm ± 0.719 with a p value of 0.722, there is no statistically significant difference between the two groups.

Conclusion

Electro surgical cautery can be safely and effectively used for making skin incisions in surgical procedures and has the advantage of less postoperative pain when compared with incision made with scalpel.

Key words

Electro surgical cautery, scalpel, inguinal hernia

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INTRODUCTION

Incision is defined as a cut or slit made by a sharp instrument. Traditionally, scalpel is used for placing skin incisions and occasionally electro surgical cautery is used for making skin incisions.[1]

The Development of first surgical electrosurgical device is credited to Dr.William T Bovie and the first use of electrosurgical device in operating room is by Dr.Harvey Cushing in Brigham hospital. Since then the devices have become an indispensible tool in all operation theatres.[2]

Electrosurgical cautery has been widely used for hemostasis and underlying subcutaneous tissue dissection, but its use for making skin incision has been limited. This is because of the fear of scarring of skin, postoperative pain, poor wound healing and wound infection.[3]

Since the improvement in electrosurgical equipment and advent of oscillatory units, its use for making skin incisions has gained generalized acceptance. New oscillating units that deliver sinusoidal current via an electrode in cutting mode result in rapid cell vaporization along the tissue cleavage line thus minimizing damage to the surrounding area. Therefore, in absence of tissue charring, there is less inflammation and minimal scarring and hemostasis is instantaneous. The newer electrosurgical units deliver pure sinusoidal current which cause localized sensory nerve destruction with the subsequent disruption of transmission of nerve impulses resulting in lesser postoperative pain.[4,5]

This study was designed to compare skin incisions with electrosurgical cautery to that of scalpel incision in terms of postoperative pain and cosmetic outcome.

AIM OF THE STUDY

The aim of the present study is

- To compare the skin incision with electro surgical cautery vs scalpel in elective inguinal hernia surgery in terms of postoperative pain.

- To compare the cosmetic outcome of skin incision with electrosurgical cautery vs scalpel in elective inguinal hernia surgery.

REVIEW OF LITERATURE

Most surgeons refer the electrosurgical equipment or accessories as their "Bovie". This is because electrosurgery originated with Dr.William T. Bovie. The first use of the electro surgical generator in an operating room was on October 1, 1926, at Peter Bent, Brigham Hospital in Boston, by Dr. Harvey Cushing.[1]

Electrosurgery is the use of alternating current (AC) to raise intracellular temperature in order to achieve vaporization or the combination of desiccation and protein coagulation.[6] These effects can be translated into cutting or coagulation of tissue. Electrical energy has been used in the performance of surgical procedures since the late nineteenth century. However, it wasn't until the introduction of the first electro surgical generator or electrosurgical unit (ESU) by Bovie as reported in 1928 that the potential of electro surgery was popularized.[7]

Similar to any surgical procedure or instrument, electro surgery was found to have its own unique issues that resulted in unanticipated complications. Since then, much has been learned about the biophysics involved in the use of electricity, and both the devices and techniques have evolved to the point where the energy can be applied safely and effectively.[8]

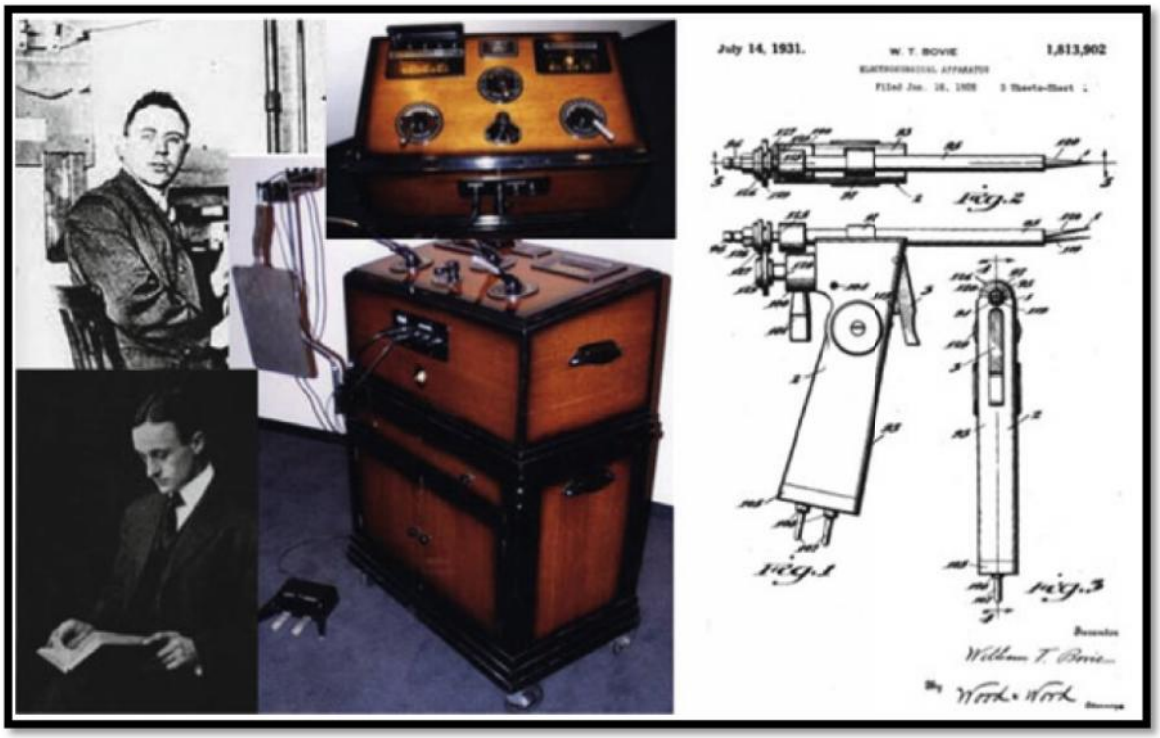


Fig 1: First electrosurgical unit

Principles of electro surgery [9-19]

In electrosurgery, the electromagnetic energy is converted in the cells first to kinetic energy then to thermal energy. The desired effect in the tissue is determined by a number of electrical properties as well as factors such as tissue exposure time and the size and shape of the surface of the electrode near to or in contact with the target tissue.

The three interacting properties of electricity that affect the temperature rise in tissue are current (I), voltage (V), and impedance or resistance (R). Current is a measure of the electron movement across or past a point in the circuit in a givenperiod of time. It is measured in amperes. Voltage describes the electrical differential created between two points in a circuit that determines with what pressure the electrons are "pushed" within the circuit, including the parts of the circuit that comprise tissue. It is

measured in volts. Resistance is measured in ohms, and is a reflection of the difficulty a giventissue presents to the passage of electrons.

Effect of Temperature on Cells and Tissue

Understanding the surgical applications of electricity requires a basic understanding of the effects of temperature on cells and tissue.The first is protein denaturation that occur secondary to the impact of temperature on the hydrothermal bonds that existbetween protein molecules. When the local temperature is as low as 60°C, these bonds are instantaneously broken but then quickly reform,as the local temperature cools. This ideally leads to a homogenous coagulum, a process that is typically called “coagulation.

The other effect is dehydration or desiccation as the cells lose water through the thermally damaged cellular wall which forma white, homogenous coagulum (white coagulation). Microscopically it has been demonstrated that protein bonds are formedcreating the homogenous, gelatinous structure. Such a tissue effect is useful for occluding tubular structures such blood vessels for the purpose of hemostasis.

If the intracellular temperature rises to 100°C or more, a liquid–gaseous conversion occurs as the intracellular water boils forming steam. The subsequent massive intracellular expansion results in explosive vaporization of the cell with a cloud of steam, ions, and organic matter.

When the local temperature reaches higher levels, 200°C or more, the organic molecules are broken down in a process called carbonization. This leaves the carbon molecules that create a black and/or brown appearance, sometimes referred to as “black coagulation.”

Effect of Alternating Current on Cells

The process called electrosurgery is based on the ability of the current to elevate cellular and consequently tissue temperature to attain the desired tissue effect. Understanding how this occurs starts with the knowledge of the impact of electro magnetic energy on intracellular components.

There are at least two basic mechanisms where by alternating current increases cellular and tissue temperature. The most important is by the conversion of electromagnetic energy to mechanical energy, which then is converted to thermal energy by frictional forces. A second, and likely less important mechanism is resistive heating.

Cellular cytoplasm contains electrically charged particles or ions in the form of atoms and molecules Cations are small, positively charged ions like sodium, potassium, and calcium, while the anionsinclude ions such as chlorine as well as large, negatively charged protein molecules. If a DC with its constant polarity is applied to the cell the cations tend to migrate toward the direction of the negativeelectrode while the anions orient to the positive electrode as unidirectional current flow is established. This is called the galvanic effect, and has no known medical purpose.

When an AC, with its continuously switching polarity, is applied to a cell, the anions and cations migrate to the positive and negative poles respectively but rather than maintaining an orientation within the cell, they oscillate in synchrony with the changing polarity of the output.

If the frequency of the AC is relatively low (20–30 kHz), the impact of the energy will incite depolarization of muscles and nerves and the creation of action potentials that result in muscle fasciculation and related pain, a process known as the Faradic Effect. It is thought that this depolarization is initiated through voltage-gated sodium and/or calcium ion channels that exist within neural and muscular cell membranes.

However, nerve and muscle membranes are not sensitive to very short duration "pulses" characteristic of the high-frequency electromagnetic energy. When AC (100 kHz–3.0 MHz) is applied across the cell, the pulse duration is so short that the sodium and calcium ionic channel gates do not open and cellular membrane depolarization doesn't occur. Instead, the electromagnetic energy is converted into mechanical energy as the cations and anions rapidly oscillate with in the cellular cytoplasm. Almost immediately, this mechanical energy, and especially that created by the large oscillating proteins, is converted, by frictional forces, into thermal energy that, in turn, results in elevation of intracellular temperature.

Tissue Effects of Electrosurgery

Cutting

Formation of a tissue incision with electricity is simply the process of linear vaporization. Vaporization of tissue is achieved with acontinuous, low-voltage waveform, using a unipolar instrument with a narrow, pointed or blade-shaped electrode held near to but not in contact with the tissue. The generator is activated, allowing the thin electrode to concentrate the current and therefore the power at its tip. The current then arcs between the electrode and the tissue, rapidly elevating the local intracellular temperature to more than 100°C causing focused cellular

vaporization and the creation of a local “plasma cloud”of steam, ions, and organic matter. To extend this zone of vaporization and form an incision, the electrode is advanced, keeping its tip or edge and the target tissue within the plasma cloud or “steam envelope” Because the voltage is low and the current dissipates rapidly with distance from the active electrode, the thermal damage on each sideof the cut zone is minimal.

Coagulation

Effective coagulation for the purposes of sealing vessels or other lumen-containing structures requires contact of the electrode with tissue.When a blunt or flat electrode is placed in contact with the tissue, all the energy on that electrode is made available for conversion to intra cellular heat by the processes

Fulguration

Fulguration is a process where by the tissue is superficially coagulated by repeated high-voltage electro surgical arcs that continue to elevate the temperature by resistive heating to beyond 100° reaching levels of 200°C and more. In addition to coagulation and desiccation, there is break down of the organic molecules into their atomic components including carbon that results in the addition of a dark hue to the coagulated tissue that is called“carbonization.” This process probably requires local temperatures of 400°C or more has also been described as spraycoagulation.

Monopolar Instruments and Systems

As with any electrical process electro surgery requires the creation of an electrical circuit that includes the two electrodes, the patient, the ESU, and the connecting wires

In Monopolar/unipolarinstruments only one electrode is mounted on the device and the entire patient is interposed between this “active electrode” and the large dispersive electrode that is also attached to the ESU, but located relatively distant from the target tissue, typically on the thigh or back.

The active electrode is designed to focus the current or power on the surgical target there by creating the desired tissue effect. The dispersive electrode is positioned on the patient in a location remote from the surgical site and is relatively large in surface area, a design that serves to defocus or disperse the current there by preventing tissue injury.

Active electrodes can have many designs, but those with a point, hook, narrow tip, or bladed edge are generally used to concentrate current and power, for the purpose of tissue vaporization and cutting. Dispersive electrodes are almost always designed with an adhesive to facilitate continuing contact with the patient and prevention of a clinically significant local thermal effect However, if there is partial detachment, the current or power density will increase, and the dispersive electrode can become “active” and capable of creating thermal injury.

Bipolar Instruments and Systems

Bipolar instruments have both electrodes mounted on the device, usually located at or near to the distal end so that only the tissue located between the two electrodes is included in the circuit. In simpler words put, bipolar systems are designed to use instruments designed with both electrodes positioned on the same surgical device, so instead of two wires connecting the ESU and the dispersive electrode and another linking the ESU to the “active” electrode, both are contained in one cable that joins the generator to the bipolar instrument. The fundamental concept being part of the patient involved in the circuit is the tissue interposed between the two electrodes, a design that prevents complications related to current diversion and provides more accurate measurements of local tissue parameters such as temperature and impedance. However, bipolar systems also havelimitations, as it is more difficult to include a method for electrosurgical vaporization and cutting into the design.

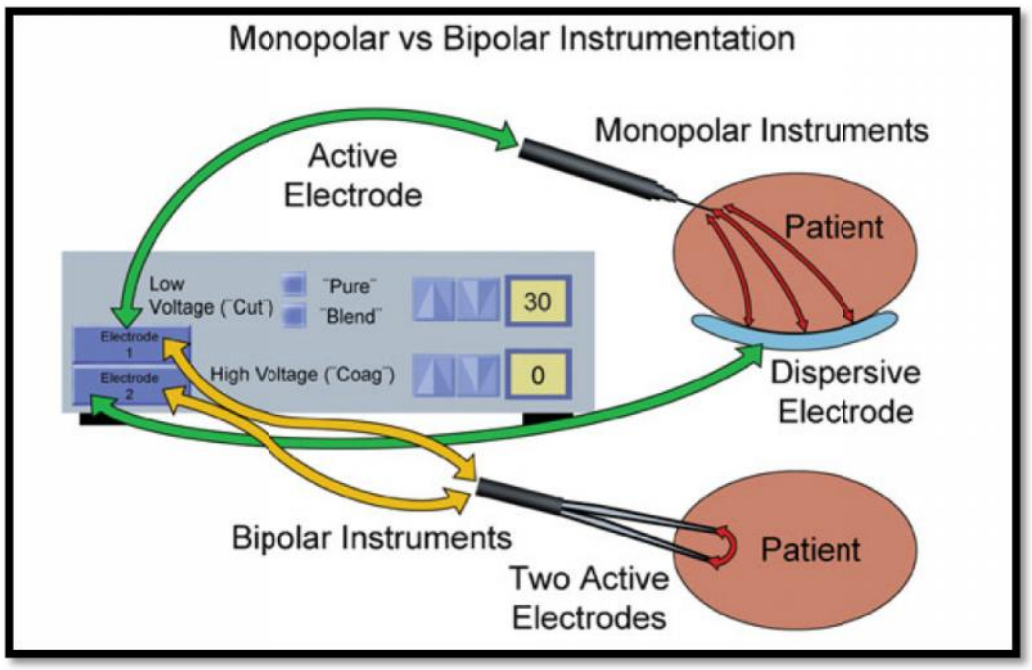


Fig 2:Monopolar and bipolar systems

Electrosurgery used appropriately allows the surgeon to perform a wide spectrum of procedures safely, effectively, and with minimal undesired tissue trauma.

Pain assessment[20-24]

Pain is defined as unpleasant sensory and emotional experience associated with actual or potential tissue damage.

Assessment of pain

Pain measurement is done by two methods

1) Type 1 methods

   These are objective methods done by the physician where he assigns numbers about the patient condition.It includes

Physiological indices

- Endocrinal
- Cardiovascular
- Respiratory

Neuro pharmacological

- Correlation with beta endorphin
- Thermography

Neurological

- Nerve conduction velocity

Behavioural

- Sighing , crying, shouting , trembling

Type 2 methods

It includes

Single dimension methods

- Visual analogue scale
- Graphic rating scale
- Numerical rating scale

Multi dimension methods

- Mc ill pain questionnaire
- Dartmouth pain questionnaire
- West haven yale pain questionnaire

Measurement of pain in clinical practice depends largely on verbal communication between patient and the doctor. A rating scale is mandatory in research projects where clinical data is being collected and compared.

Visual analogue scale

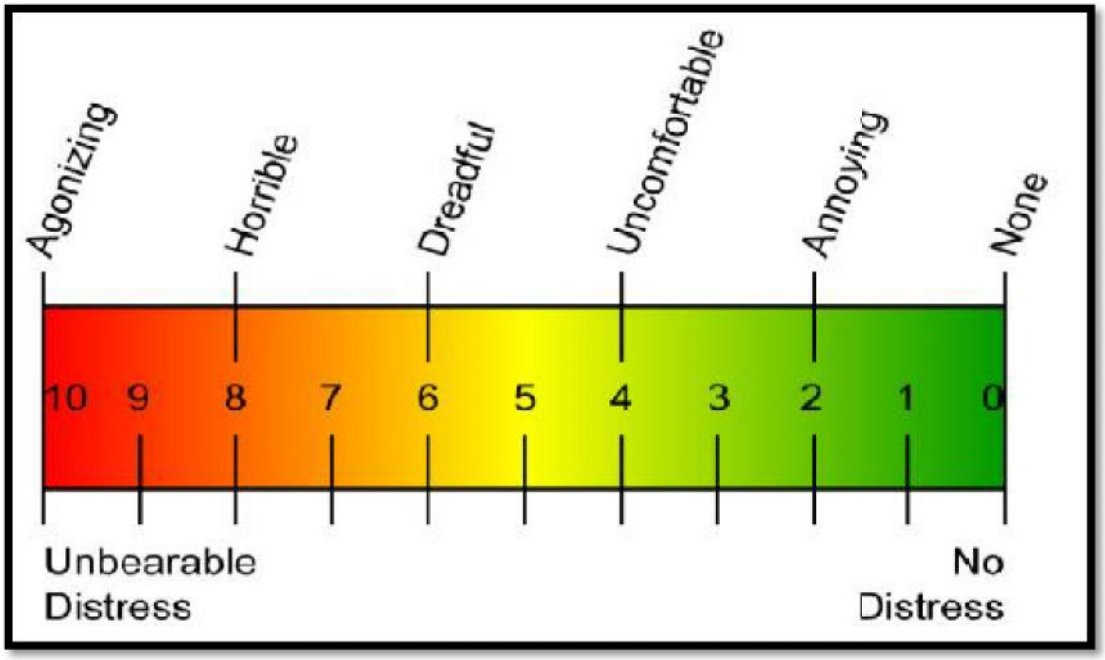
It is one the most commonly used single dimension method of pain scoring. This tool was first used in psychology by Freyd in 1923

The visual analogue scale uses a straight line with extremities of pain intensity at one end. The line is typically 10 cms long with one end defined as no pain and the other end being excruciating unbearable pain.

The patient is asked to place a mark on the line to describe the amount of pain that they are currently experiencing. The distance between the end labelled no pain and the mark placed by the patient is measured and rounded to nearest centimeter which gives the value of the scale.

Advantages of visual analogue scale

- Simple and fast
- Independent of language
- Easily understood and reproduced
- Is a ratio scale which has statistical significance



Scar assessment [25-29]

Surgical incisions invariably produce scar, several modalities have been devised to quantify scars for the purpose of determining response to treatments and interventions and evaluating the outcomes.

Scar-measuring devices should be non invasive, accurate, reproducible, and easy-to-use to facilitate objective data collection and have clinical utility. Usually parameters such as pliability, firmness, color, perfusion, thickness are assessed.

Vascularity: The increased vascularisation of the scar (erythema) is a good indicator for scar activity in the early maturation phase. On the long term scars frequently become pale.

Pigmentationis caused by variation in the concentration of melanocytes in the epidermal layer and their melanin production. Significant pigmentation disorders may remain in the long term.

Relief/texture: Irregularities of the scar surface (surface roughness or relief) are particularly seen after wound healing due to irregularities result from secondary healing of the interstices of skin.

Thickness: Scar tissue normally becomes thicker than the surrounding skin (hypertrophy) during the first months after which the thickness reduces. Normally the protruding part of the scar, compared to the surrounding skin, is judged.

Pliability: Scar tissue is normally less supple than normal skin mainly because the scar is thicker and has an inferior quality of collagen architecture. This may cause functional impairment, especially when scars are located at or around joints.

Surface area: The surface area of scars can either reduce or increase as a result of scar contraction or expansion respectively. Scar expansion or widening is often observed in linear scarring.

Pain: The patho physiology is still not well understood, but a strong relation with scar hypertrophy and pain has been reported.

Itching / Pruritus: This is an irritating cutaneous sensation that produces a desire to scratch. The impact of itching caused by scar tissue is frequently under estimated especially when large body surface areas are involved. Itching is often associated with hypertrophic scarring.

The most commonly used scar asessment scales are

Vancouver Scar Scale (VSS)

The VSS, first described by Sullivan in 1990, is perhaps the most recognized scar assessment method. It assesses 4 variables: vascularity, height/thickness, pliability,and pigmentation. Patient perception of his or her respective scars is not factored in tothe overall score.

Table 2. The Vancouver Scar Scale

	Scar characteristic	**Score**
Vascularity	**Normal**	**0**
	Pink	1
	Red	2
	Purple	3
Pigmentation	Normal	0
	Hypopigmentation	1
	Hyperpigmentation	2
Pliability	Normal	0
	Supple	1
	Yielding	2
	Firm	3
	Ropes	4
	Contracture	5
Height	Flat	0
	<2 mm	1
	2-5 mm	2
	>5 mm	3

Total score 13

Visual Analog Scale (VAS)

The multi dimensional VAS is a photograph-based scale derived from evaluating standardized digital photographs (pigmentation, vascularity, acceptability, andobserver comfort) plus contour. It sums the individual scores to get a single overall score ranging from “excellent” to “poor.” It has demonstrated high observer reliability and internal consistency when compared to expert panel evaluation, but it has shown only moderate reliability.

Manchester Scar Scale (MSS)

The Manchester Scar Scale, proposed by Beausang et al in 1998, differs from the POSAS in that it includes an overall VAS that is added to the individual attribute scores. It assesses and rates 7 scar parameters.

Scores from the 2 scales are added together to give an overall score for the scar, with higher scores representing clinically worse scars.It is thus applicable to a wider range of scars and well-suited for post operative scars.

The MSS has not been used in research, however, perhaps because of the wide applicability of the VSS and POSAS.

The Stony Brook Scar Evaluation Scale (SBSES)

The SBSES was proposed in 2007 by Singer et al and is a 6-item ordinal wound evaluation scale developed to measure short-term cosmetic outcome of wounds 5 to 10 days after injury up to the time of suture removal. It incorporates assessments of individual attributes witha binary response (1 or 0) for each, as well as overall appearance, to yield a score ranging 0 (worst) to 5 (best). The SBSES has only

recently been proposed for use in research, as it was designed to measure short-term rather than long-term wound outcomes.

Patient and Observer Scar Assessment Scale (POSAS)

The POSAS includes subjective symptoms of pain and pruritus and expands on the objective data. It consists of 2 numerical numeric scales: The Patient Scar Assessment Scale and the Observer Scar Assessment Scale. It assesses vascularity, pigmentation, thickness, relief, pliability, and surface area, and it incorporates patient assessmentsof pain, itching, color, stiffness, thickness, and relief. The POSAS is the only scale that considers subjective symptoms of pain and pruritus.

Observer scale

1 2 3 4 5 6 7 8 9 10

- Vascularity
- Pigmentation
- Thickness
- Relief
- Pliability
- surface area

All items are scored on a scale ranging from 1 (‘like normal skin’) to 10 (‘worst scar imaginable’).

The sum of the six items results in a total score of the POSAS observer scale for a maximum score of 60.

Patient scale

1) Has the scar been painful the past few weeks?

2) Has the scar been itching the past few weeks?

3) Is the scar color different from the color of your normal skin at present?

4) Is the stiffness of the scar different from your normal skin at present?

5) Is the thickness of the scar different from your normal skin at present?

6) Is the scar more irregular than your normal skin at present?

Scale is from 1-10 for each parameter and maximum score is 60.

ANATOMY OF INGUINAL REGION[30-34]

It is a transitional area in which abdomen and thigh are joined.The inguinal region of the body, also known as the groin, is located on the lower portion of the anterior abdominal wall, with the thigh inferiorly, the pubic tubercle medially, and the anterior superior iliac spine (ASIS) superolaterally.

Superficial fascia of anterior abdominal wall

The superficial fascia of anterior abdominal wall is in single layer and contains fat and below the umbilicus it is divided in to

1) Superficial fatty layer – camper's fascia
2) Deep membranous layer – scarpa's fascia

a) Camper's fascia is thick, areolar in nature and contains variable amount of fat and is often greatly thickened in obese individuals. Inferiorly, it lies superficial to inguinal ligament and is continuous with superficial fascia of thigh, and the outer layer of fascia covering the perineum, penis and scrotum. In this region, it is generally thin with very little adipose tissue and in the scrotum contains smooth muscle fibres, which form the dartos muscle. In females, it continues from the supra pubic skin of the abdomen into the labia majora and perineum.

b) Scarpa's fascia contains more elastic fibres and is loosely connected by areolar tissue to the aponeurosis of external oblique muscle, but in the midline it is adherent to lineaalba and pubic symphysis. In males, it extends to form superficial ligament of the penis and continues medially and inferiorly over penis and scrotum where it becomes continuous with membranous layer of the superficial fascia of the perineum.

Transversalis fascia

It is a thin layer of connective tissue lying between the inner surface of transversus abdominis and extra peritoneal fat. In the inguinal region, it is thick and dense, and augmented by the aponeurosis of transversus abdominis muscle. Medial to the femoral vessels it is thin and fused to pubis behind conjoint tendon. Some fibres spread laterally towards the anterior superior iliac spine, some fibres run medially behind rectus abdominis, and some descend to pubis behind conjoint tendon, forming deep crural arch. The curved fibres of this arch thicken the inferomedial part of the rim of the deep inguinal ring. The spermatic cord in male, or the round ligament of uterus in female, pass through the transversalis fascia at the deep ring. The transversalis fascia spreads onto these structures as the internal spermatic fascia surrounding the testes and blends with areolar tissue on the parietal layer of tunica vaginalis.

Muscles of the anterior abdominal wall

The muscle bundles and fibrous tissue are arranged in layers and each muscle is covered by fascia. The flat lateral abdominal muscles are inserted via a laminated aponeurotic sheet. These laminae contribute to rectus sheath ultimately it inserts in the midline forming lineaalba. Major muscles of the abdominal wall are the external and internal oblique muscles, the transversus abdominus and the rectus muscles.

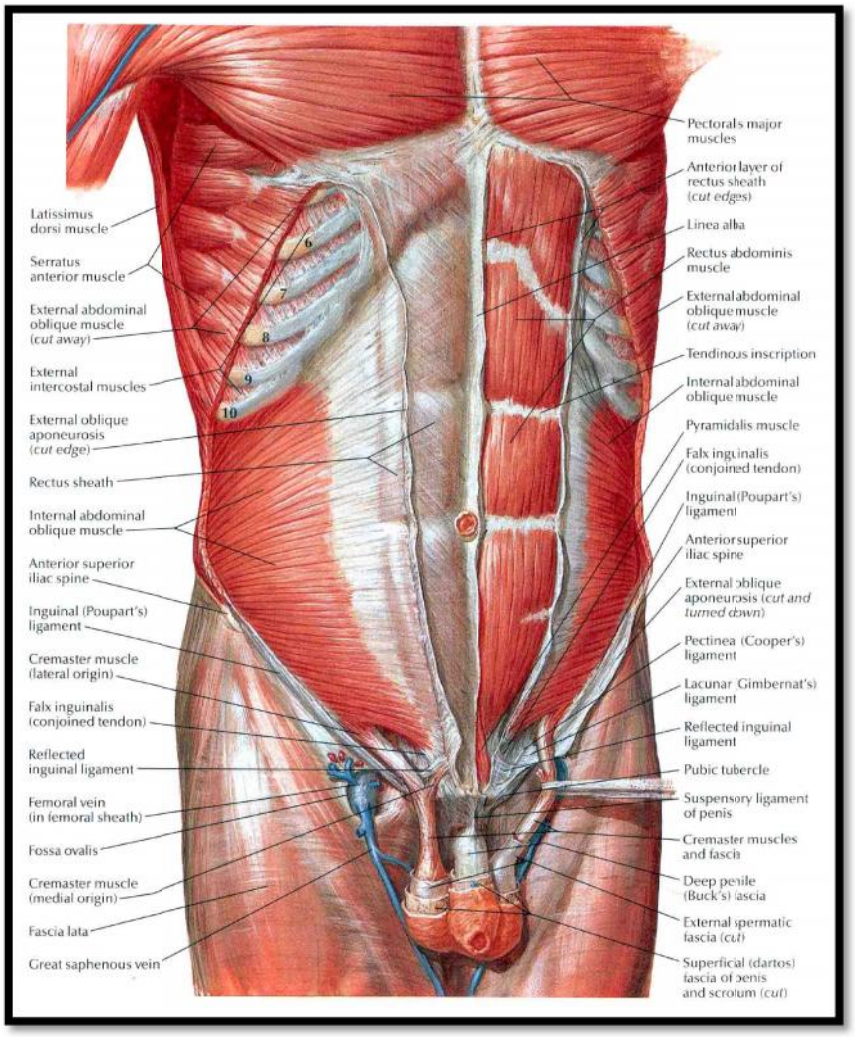


Fig 3:Muscles of the anterior abdominal wall

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.

The other vessels are the superficial circumflex iliac and external pudendal vessels which arise from femoral artery. All the arteries are accompanied by their respective veins and form tributaries to the femoral vein.

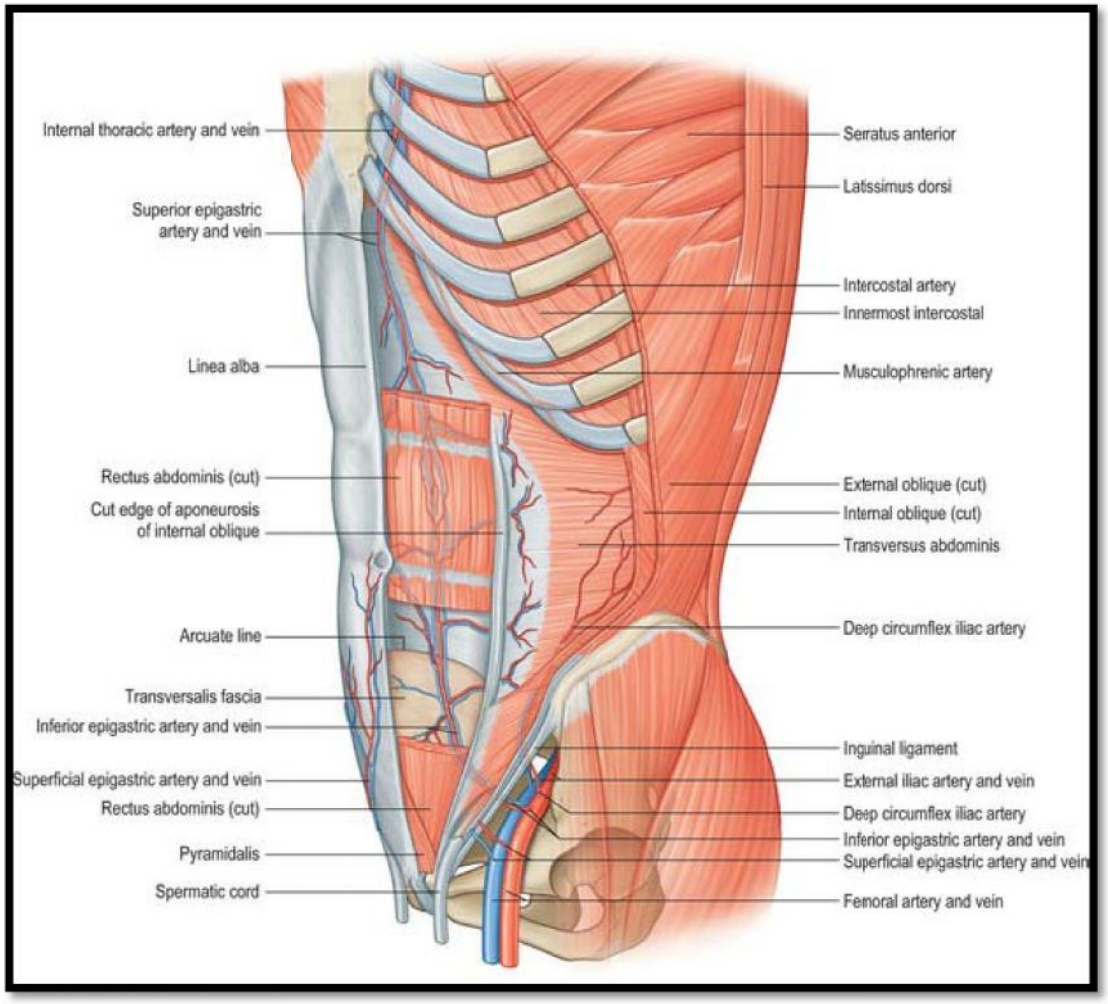


Fig 4:Blood Supply of the anterior abdominal wall

Innervation

The 7th to 12th lower thoracic ventral rami run anteriorly from the intercostal spaces into the abdominal wall. The rectus muscle and external oblique are supplied by lower intercostal and subcostal nerves (T7 – T12), and the internal oblique and transverses by those same nerves with the addition of iliohypogastric and ilioinguinal nerves (L1). The ilio-inguinal nerve accompanies the spermatic cord and runs through

the superficial inguinal ring, to supply the medial thigh proximal to the inguinal ligament, the root of the penis and upper anterior scrotum. In the female, the nerve exits the superficial ring to supply the mons pubis and labium majora. Iliohypogastric nerve has some fibres in common with subcostal and ilioinguinal nerve.

The genitofemoral nerve emerges onto the anterior surface of psoas major muscle and its genital branch exits the pelvis via the deep inguinal ring and courses with the spermatic cord, supplying the cremaster muscle. The femoral branches of the genitofemoral nerves (L1, L2) pass under the inguinal ligament, travel across the thigh lateral to the saphenous opening, and then travel a short distance in the femoral sheath to supply the skin overlying it.

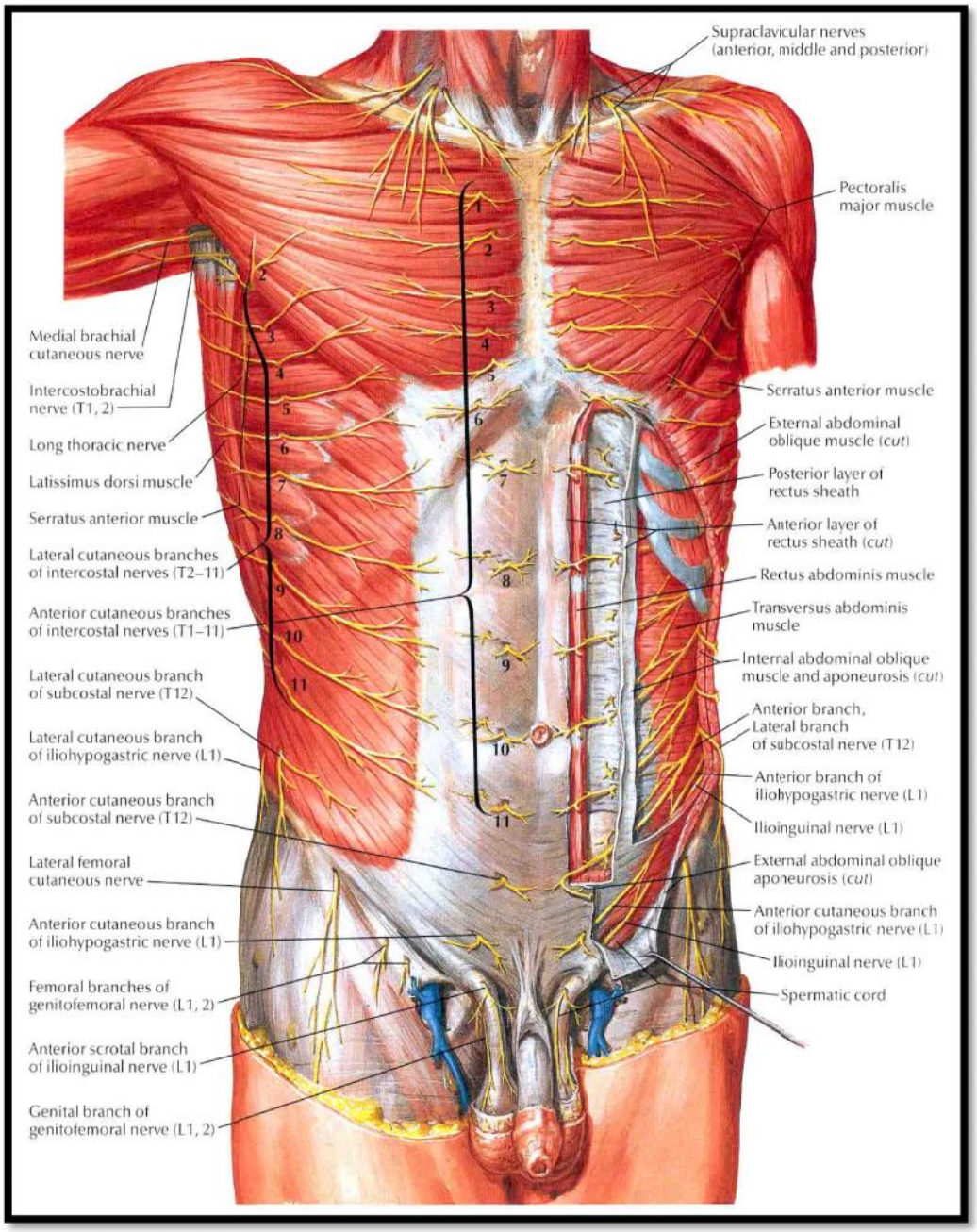


Fig 5:Nerve Supplyof the anterior abdominal wall

Inguinal canal

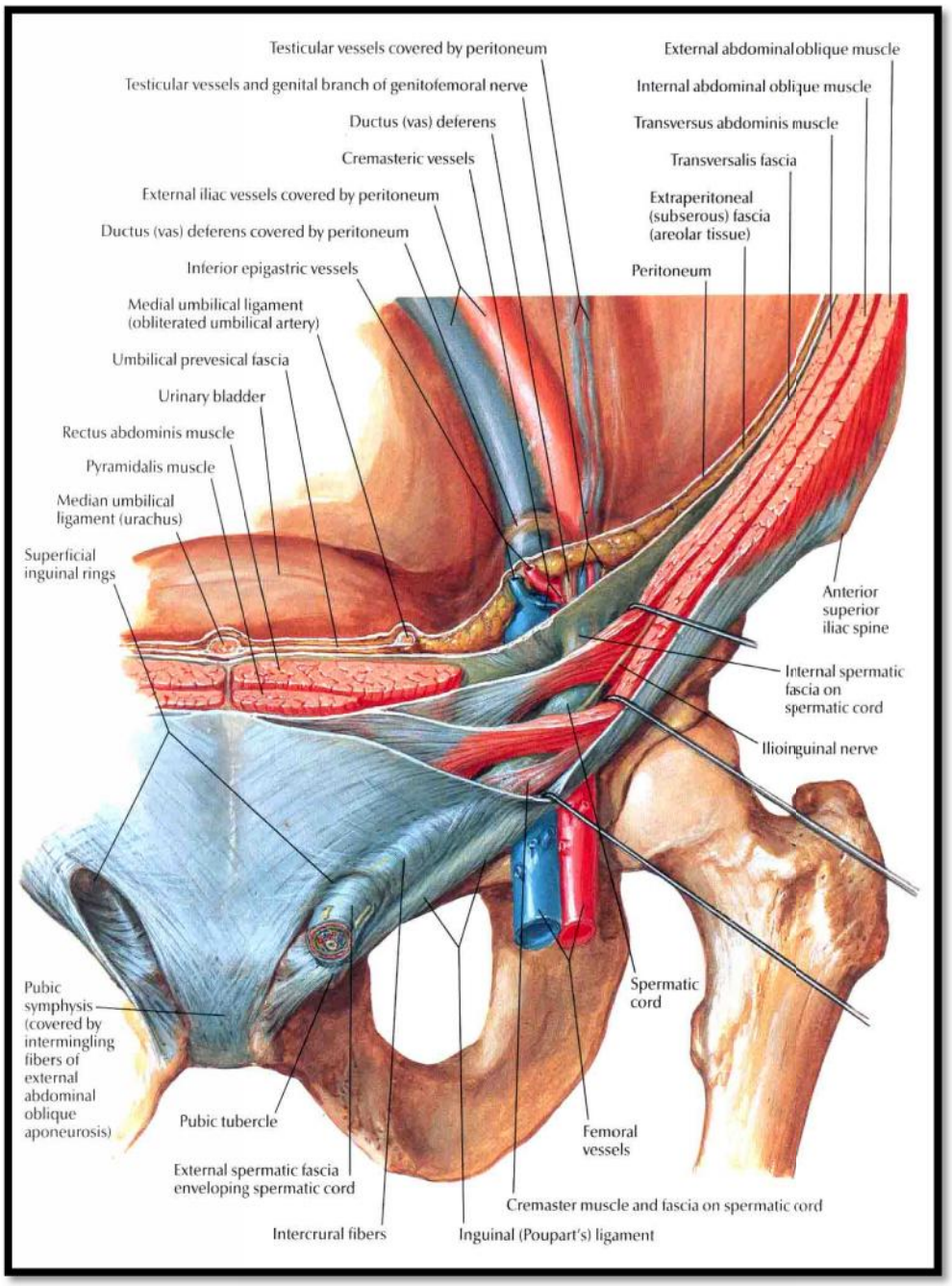


Fig 6:Anatomy of inguinal canal

Boundaries of the inguinal canal

Anterior wall

The inguinal canal is bounded anteriorly by the skin, superficial fascia and the aponeurosis of the external oblique. In the lateral one-third, the anterior wall is reinforced by the muscular fibres of internal oblique muscle just above the origin from the inguinal ligament.

Posterior wall

Medially the posterior wall consists of a strong conjoint tendon, formed by internal oblique muscle and transversus abdominis muscle. Lateral to the conjoint tendon, lies the transversalis fascia and reflected part of the inguinal ligament, which separate the inguinal canal from extra peritoneal connective tissue and peritoneum. Laterally the transversalis fascia in the posterior wall is strengthened by the tendinous muscle fibres derived from transverse abdominis muscle constituting the interfoveolar ligament.

Roof of the canal

This is formed by the arched fibres of internal oblique and transverse abdominis muscles. The fleshy fibres of internal oblique arise from lateral two thirds of the inguinal ligament. The fibres that arise from the inguinal ligament continues as aponeurosis that is attached to the crest of the pubic bone, and laterally, to the pectineal line.

Floor

Itis formed by the union of the transversalis fascia with the inguinal ligament and medially by the lacunar ligament. The lacunar ligament is a thick triangular band of tissue lying posterior to medial end of inguinal ligament. It is formed from fibres of medial inguinal ligament and fibres from the fascia lata of thigh. The inguinal fibres run posteriorly and laterally to the medial end of the pectineal line and are continuous with the pectineal fascia. The apex of the triangle is attached to the pubic tubercle.

A strong, fibrous band, the pectineal ligament of Astley Cooper extends laterally along the pectineal line. Fibres from the fascia lata join the inferior posterior border of the inguinal ligament; the latter, in combination with fibres from the transversalis fascia, fuses with the pectineal fascia as it joins the thickened periosteum of the pectineal line.

MATERIALS AND METHODS

The present study was conducted in the Department of General Surgery, KLES Dr.Prabhakar Kore hospital, Belagavi from January 2016 to December 2016.

Study design

The study design was a randomized control study.

Study period

The present study was conducted for one year from January 2016 to December 2016.

Source of data

Patients diagnosed with unilateral inguinal hernia and undergoing Lichtenstein tension free hernioplasty were included in the study.

Sample size

A total of 40 patients undergoing hernia repair divided in to two groups of 20 each were studied.

Sampling procedure

Based on previous studies the sample size was calculated according to formula.

$$N = \frac{2\,(z\,\alpha + z\,\beta)^2\,(S1+s2)^2}{(X_1 - X_2)^2}$$

Where N = sample size

α = type 1 error

β = type 2 error

$Z\alpha = 1.96$, $Z\beta = 0.84$

$X_1 = 6.18$, $X_2 = 4.93$

$S_1 = 0.92$, $S_2 = 0.36$ S = standard deviation

According to above formula sample size comes to 16 rounded of to 20 in each group.

Randomization

Patients were divided into Group A and Group B by sequentially numbered opaque sealed envelope and the patients were blinded to the intervention.

Selection

Inclusion criteria

- Patients diagnosed as inguinal hernia and willing for inguinal hernia surgery
- Age greater than 18 years

Exclusion criteria

- Age less than 18 years
- Complicated inguinal hernia
- Patients with cardiac pace makers

Ethical clearance

Prior to commencement, the study was approved from the Ethical and Research Committee, Jawaharlal Nehru Medical College, Belagavi.

Informed consent

The patients fulfilling selection criteria were informed in detail about the nature of study and a written informed consent was obtained before enrollment.

METHODOLGY

Method of collection of data

Patients were interviewed and demographic data and the presenting symptoms were noted. These patients were subjected to clinical examination and evaluated for clinical signs. The findings were noted on a predesigned proforma.

Investigations

The following investigations were done-

- Complete blood counts
- Serum creatinine
- Blood urea
- Urine routine and microscopy
- Ultrasound abdomen

The diagnosis of inguinal hernia was based on history and clinical examination correlated with investigations.

Patient positioning

All the patients were placed in supine position.

Anaesthesia

All the surgeries were performed under spinal anaesthesia.

Surgical procedure

Under aseptic precautions incision was placed 2 cms above and parallel to inguinal ligament in its medial two thirds and Lichtenstein tension free hernioplasty was performed on all patients.

Intervention

Group A

Skin incision is made using electrosurgical cautery set in pure cutting mode with voltage setting in electro surgical unit set at 60 watts.

Group B

Skin incision is placed with scalpel using 22 no surgical blade.

Post operative care

Post operative analgesia was standardized in both groups and both the groups received paracetamol 1000mg 8thhourlyfor post operative analgesia.

Diclofenac 50mg intra muscular (i.m) is used as rescue analgesia

Post operative pain was assessed using Visual Analogue scale at the operated site at 24 hrs, 48 hrs and 72 hrs respectively.

Both the groups were monitored for complications till discharge from hospital. The skin sutures were removed on postoperative day 7. Patients were followed up till one month after surgery.

Outcome variables

The following variables were evaluated

- Postoperative pain at 24 hrs, 48 hrs and 72 hrs using visual analogue scale.
- Wound cosmesis after one month was assessed using Patient and Observer Scar assessment Scale.

Statistical analysis

The data was entered in to Microsoft excel spread sheet. The data was analyzed using SPSS statistical software version 20.0. The categorical data was expressed as rates, ratios and percentages and comparison was done using fishers exact test and chi square test. Continuous data was expressed as mean ± standard deviation and the comparison was done using Mann Whitney U test and unpaired t test. Probability (P value) of less than or equal to 0.05 at 95% confidence interval was considered as statistically significant.

RESULTS

TABLE 1. SEX DISTRIBUTION

SEX	GROUP AN = 20		GROUP BN = 20	
	NUMBER	%	NUMBER	%
MALE	20	100	20	100
FEMALE	0	0	0	0
TOTAL	20	100	100	100

In the present study all the participants were males

GRAPH 1.SEX DISTRIBUTION

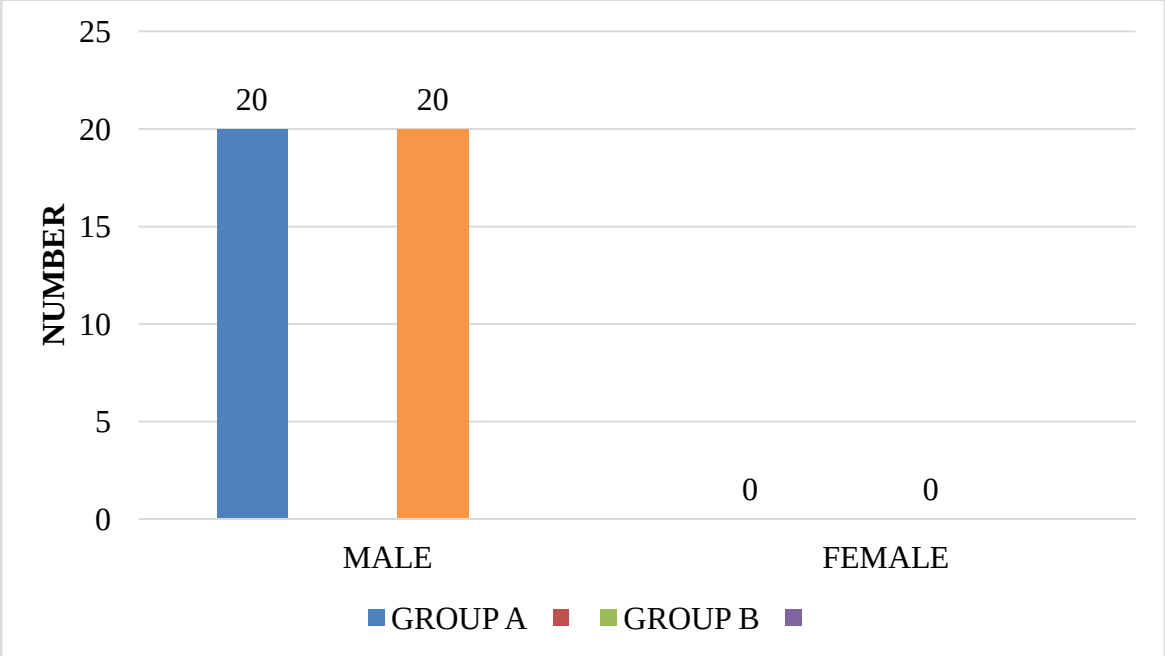


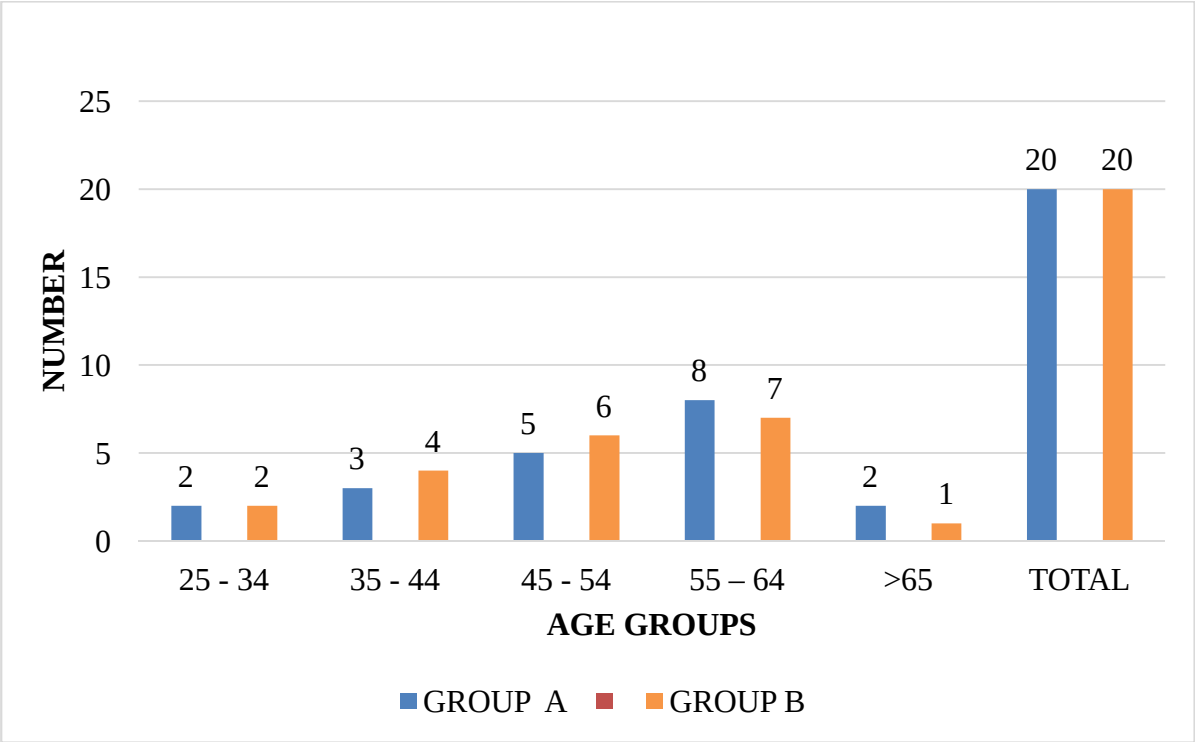
TABLE 2. AGE DISTRIBUTION

AGE GROUP	GROUP A	%	GROUP B	%	TOTAL	%
25 - 34	2	10	2	10	4	10
35 - 44	3	15	4	20	7	17.5
45 - 54	5	25	6	30	11	27.5
55 – 64	8	40	7	35	15	37.5
>65	2	10	1	5	3	7.5
TOTAL	20	100	20	100	40	100

TABLE 3. COMPARISION OF MEAN AGE OF GROUPS

	MEAN	SD	SE	t VALUE	p VALUE
GROUP A	50.95	11.753	2.27	-0.332	0.741
GROUP B	52.2	11.443	2.24		

GRAPH 2. AGE DISTRIBUTION



In the present study the mean age of the participants in group A is 50.95 ±11.75 and the mean age of the participants in group B is 52.2 ±11.443. There is no statistical difference between the two group with a p value of 0.741.

Most of the participants in both groups belong to age group of 55 – 64 yrs (37.5 %).

TABLE 4. COMPARISION OF CO MORBID CONDITIONS

CONDITION	GROUP A	GROUP B
DIABETES MELLITUS	10	8
HYPERTENSION	7	6

In the present study 10 participants in group A and 8 participants in grouo b has diabetes mellitus. Where as hypertension is found in 7 participants in group A and 6 participants in group B

GRAPH 3. COMPARISION OF CO MORBID CONDITIONS

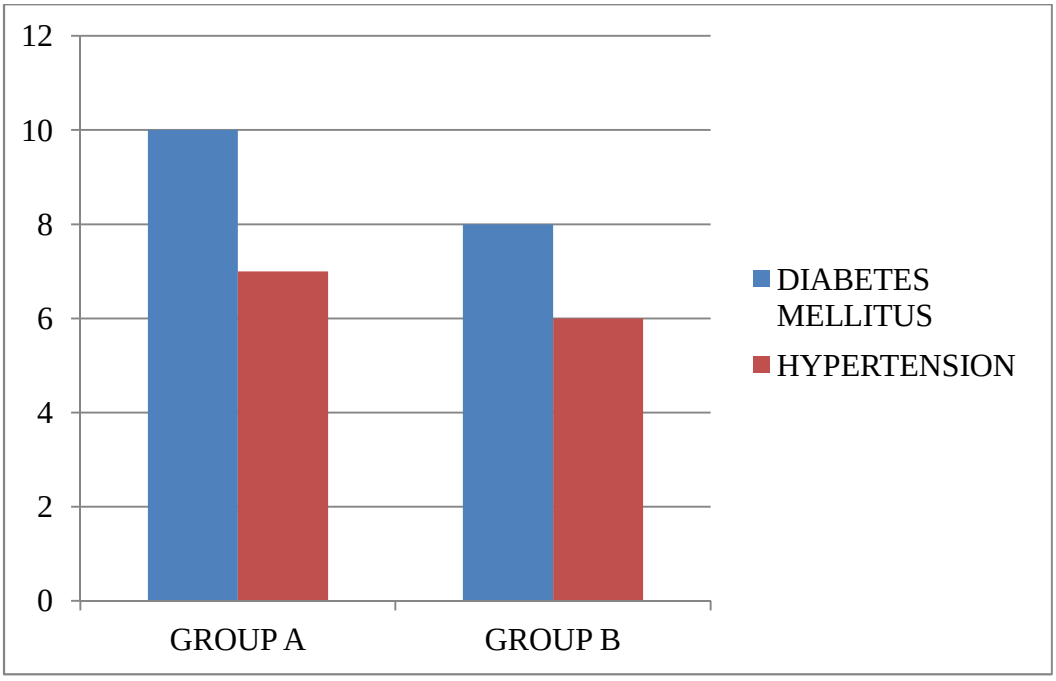


TABLE 5. COMPARISION OF GROUPS BY TYPE OF HERNIA

TYPE OF HERNIA	GROUP A	GROUP B
LEFT INDIRECT	6	8
RIGHT INDIRECT	8	7
LEFT DIRECT	2	4
RIGHT DIRECT	4	1

Indirect inguinal hernia is the most common type of hernia in both the groups (72.5%) and left sided hernia is present in 50 % of participants and right sided hernia in rest 50 %

GRAPH 4. TYPE OF HERNIA

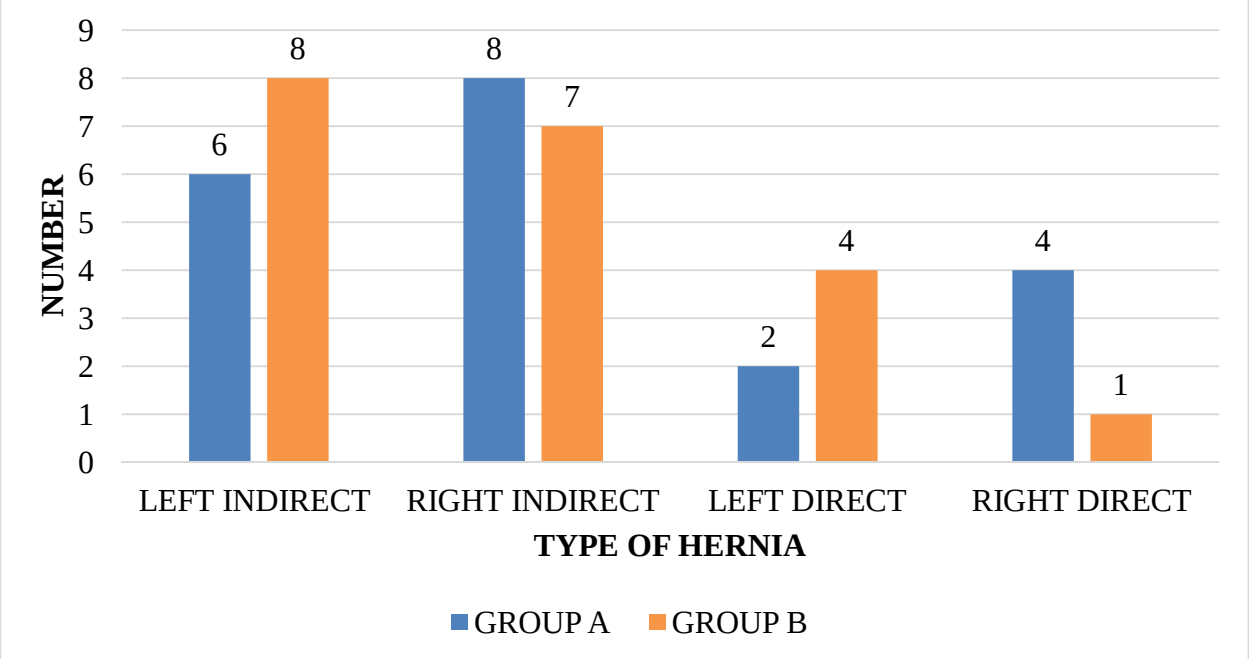
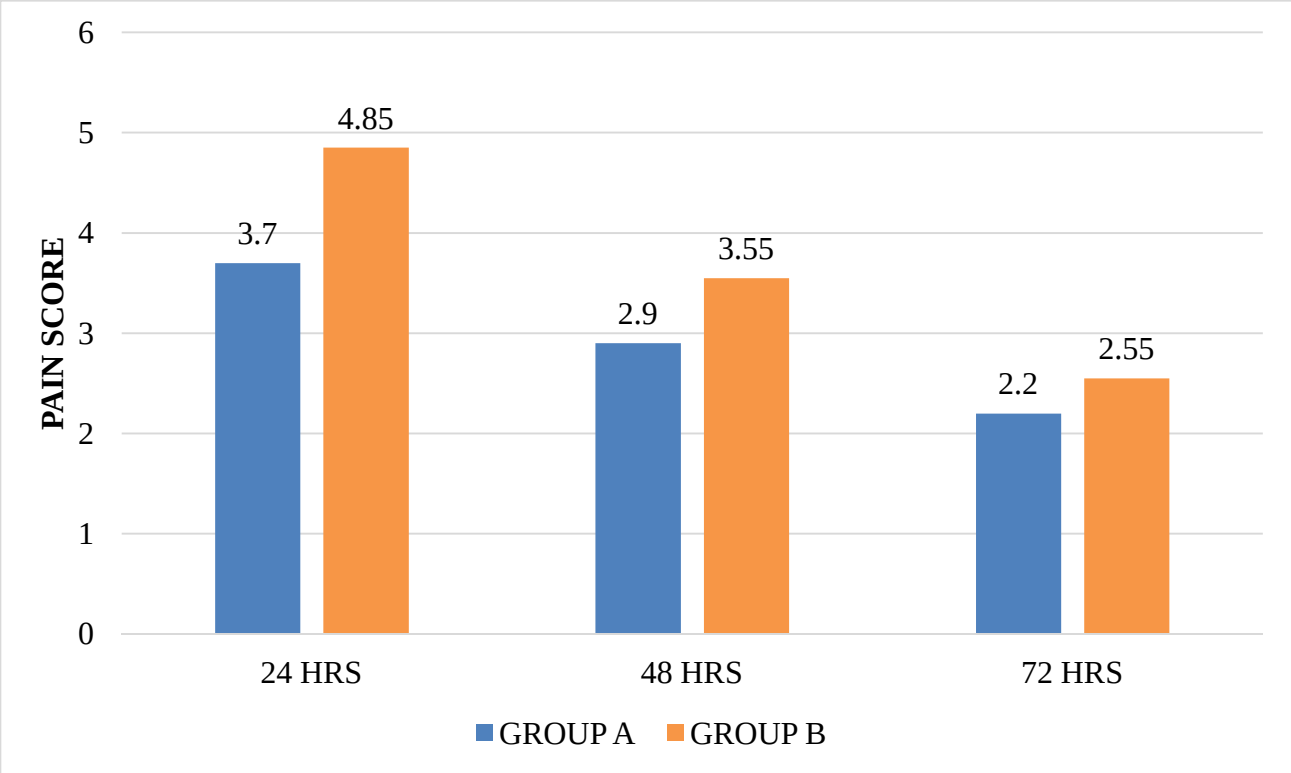


TABLE 6. COMPARISION OF PAIN SCORES

	GROUP A		GROUP B		Z VALUE	p VALUE
	MEAN	SD	MEAN	SD		
24 HRS	3.7	0.714	4.85	0.852	-3.53	0.0004
48 HRS	2.9	0.62	3.55	0.589	-2.59	0.009
72 HRS	2.2	0.74	2.55	0.739	-1.12	0.262

GRAPH 5. COMPARISION OF PAIN SCORES



In the present study the mean pain scores at 24 hrsof group A is 3.7 ± 0.71 and that of group B is 4.85 ± 0.82 with a p value of 0.0004.The difference in the pain score in first 24 hrs is statistically significant

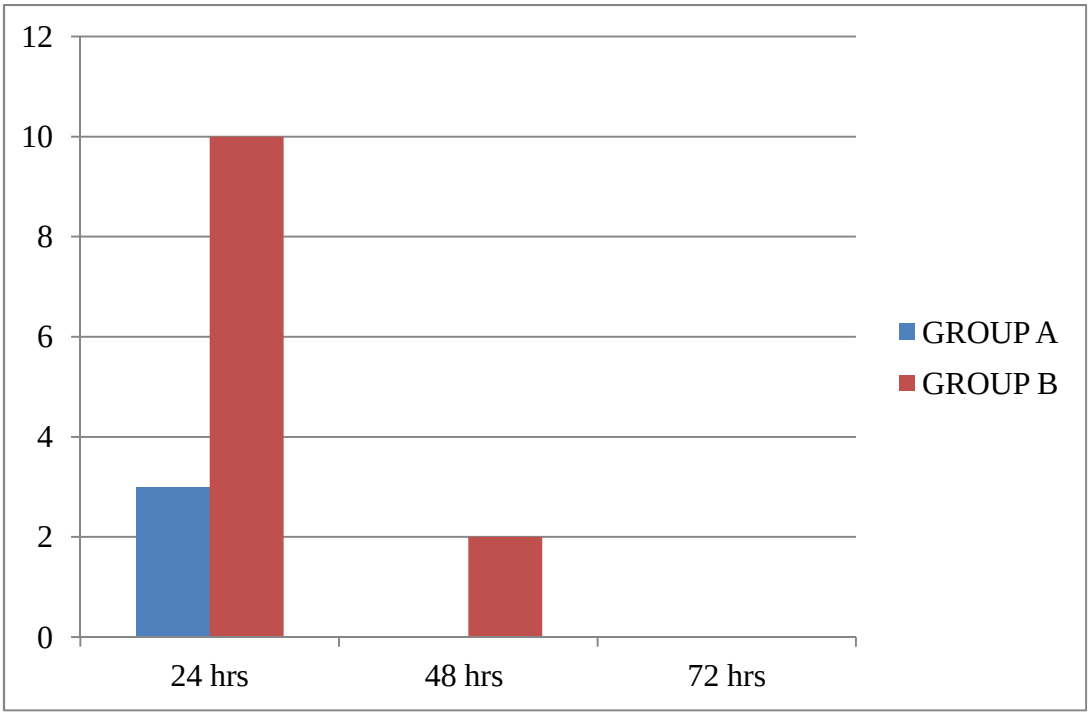
The mean pain scores measured at 48 hrs for group A is 2.9 ± 0.62 and for group B is 3.55 ± 0.589, the difference in the pain scores is statistically significant with a p value of 0.009.

There is no statistical difference between the pain scores at 72 hrs between the two groups (p value 0.262), group A mean 2.2 ± 0.74 and group B mean 2.55 ± 0.73

Table 7. Comparision of rescue analgesia

Rescue analgesia	GROUP A	GROUP B
24 hrs	3	10
48 hrs	0	2
72 hrs	0	0

Graph 6. Comparision of rescue analgesia



In the present study 3 participants in group A and 10 participants in group B required rescue analgesia in first 24 hours and 2 participant in group B required rescue analgesia. No participants required rescue analgesia in both the groups at 72 hours.

TABLE 8. COMPARISON OF SCAR

	GROUP A		GROUP B		p VALUE
	MEAN	SD	MEAN	SD	
SCAR SCORE	37.4	4.96	36.05	5.14	0.415

The mean scar score of group A is 37.4 ± 4.96 and that of group B is 36.05 ± 5.14 and there is no statistical difference between the two groups, p value 0.415

GRAPH 7. SCAR SCORE

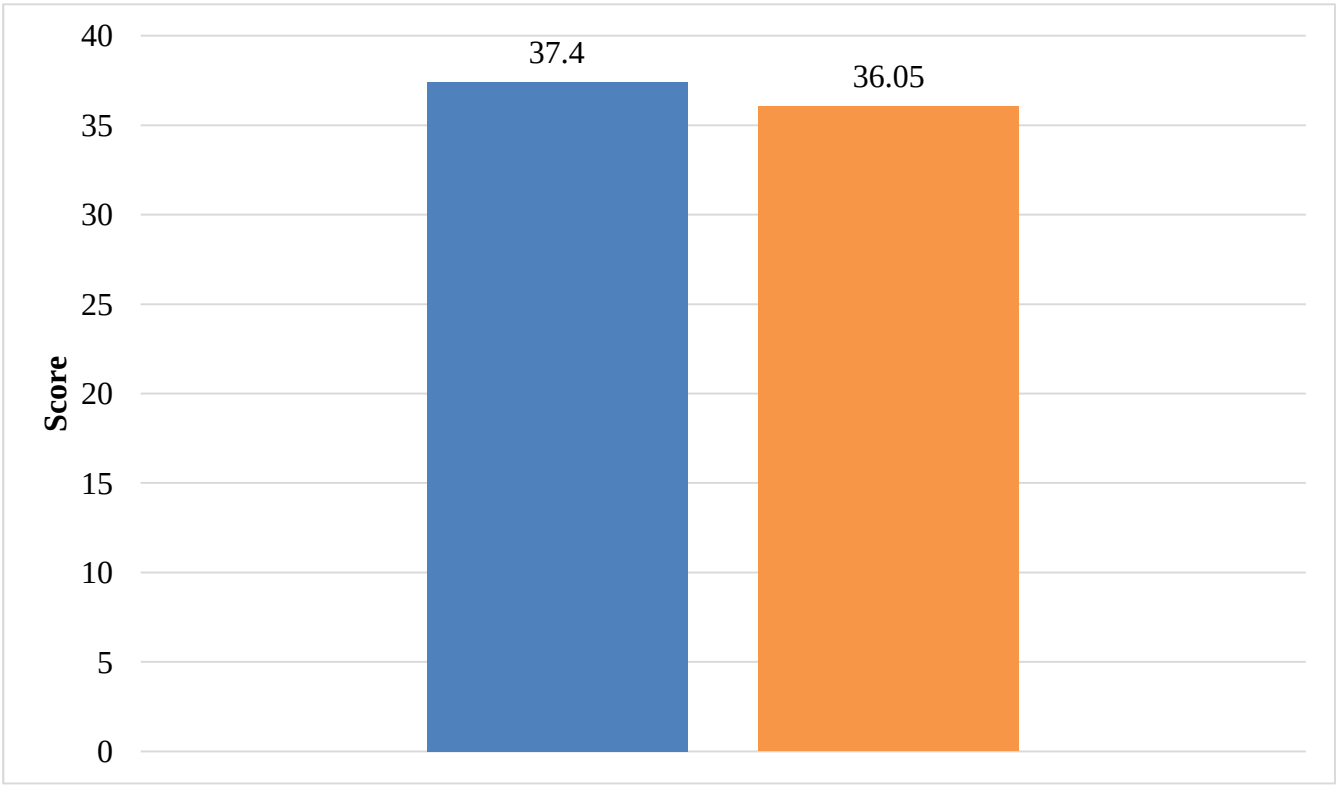
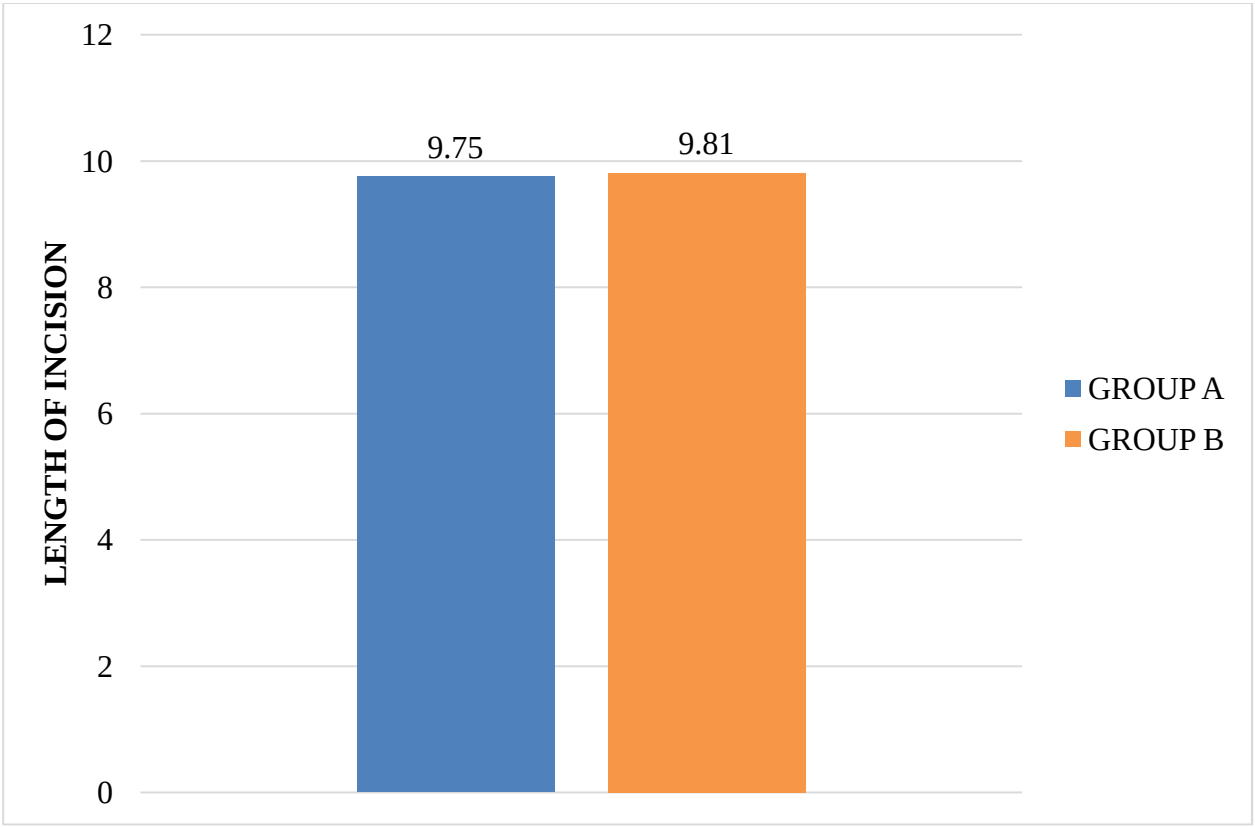


TABLE 9. COMPARISION OF INCISION LENGTH

	GROUP A		GROUP B		p VALUE
	MEAN	SD	MEAN	SD	
INCISION LENGTH	9.75	0.825	9.81	0.719	0.722

In group A the mean length of incision is 9.75 cm ± 0.825, in group B the mean length of incision is 9.811 cm ± 0.719 with a p value of 0.722 there isno statistically significant difference between the two groups

GRAPH 8. INCISION LENGTH



DISCUSSION

Since the introduction of electro surgical cautery by William T Bovie, it has been used extensively in operation theatres for various effect, most notably for haemostasis. With the recent advances in electro surgical units, the scope of its usage has widened.[1]

Before the advent of non explosive anesthetic agents, electrosurgical units had limited application. Following the introduction of halothane, electro surgery was used to achieve hemostasis and, to a lesser extent for cutting.[35]

Early studies with primitive diathermy machines suggested that electrosurgical incisions were associated with charring and poor wound healing. Recent studies conducted show many advantages of electro surgical cautery in terms of reduced postoperative pain, less operative time and decreased blood loss.[36]

In this study, we evaluate the use of electro surgical cautery for making skin incisions when compared to traditional scalpel in terms of postoperative pain and cosmetic outcome.

The present study is one year randomized controlled trail conducted in the Department of General Surgery KLES Dr.Prabhakar Kore hospital, Belagavi from January 2016 to December 2016. A total of 40 patients diagnosed with inguinal hernia scheduled for Lichtenstein tension free hernioplasty were studied. Based on the method used for making skin incision these participants were divided in to two groups of 20 each. Group A (skin incision with electrosurgical cautery) and Group B (skin incision with scalpel). The participants were evaluated for post operative pain and cosmetic outcome

In the present study all the participants were males. In this study the commonest age group was 55 – 64 yrs in group A (40 %) and in group B (37.5%). The mean age of the participants in group A is 50.95 $\pm$ 11.75 and the mean age of the participants in group B is 52.2 $\pm$ 11.443 (p value of 0.741).

Over all the demographic characteristics of the study population were comparable between the two groups. The comparison of anthropometric variables (height and weight) vitals (pulse rate, blood pressure, temperature) were also comparable between the two groups. Most of the participants in this study had indirect inguinal hernia group A (70%) and group B (75%).

In the present study the postoperative pain between the two groups is compared at 24hrs, 48 hrs and 72 hrs. The pain was assessed by visual analogue scale on a scale of 1 to 10.

In the present study the mean pain scores in the 24 hrs for group A is 3.7 + 0.71 and that of group B is 4.85 + 0.82 (p value 0.0004) .

The mean pain scores measured at 48 hrs for group A is 2.9 + 0.62 and for group B is 3.55+ 0.589 (p value 0.009).

The post operative pain scores are less when incision is made with electrosurgical cautery at 24 hrs and 48 hrs these findings are similar to other studies where electro surgical cautery is used for skin incision.

Shekhar UP et al compared skin incision in inguinal hernioplasty in terms of early post operative pain and concluded that there is significant pain reduction when skin incision is made with cautery.[37]

Similar study conducted by Ali Q, Siddique Ket al for skin incision in inguinal hernia showed reduced use of analgesics in the post operative period.[38]

In the systemic review conducted by Lisa N.F aird et al it is concluded that skin incisions with electro surgical cautery has less post operative pain and required lesser doses of analgesics at post operative day 1 and 2.[39]

Although some studies show no difference in post operative pain scores there is reduced requirement of analgesics which in shown in a study conducted by Stolz AJ, Schutzner J, Lischke R et al comparing diathermy incision versus scalpel incision in thoracotomy.[40]

Hussain SA, Hussain Set al conducted a similar study comparing skin incision with diathermy vs scalpel in elective midline laparotomy and results of the study show lower post operative pain scores in first 48 hrs and overall decrease in the use of analgesics.[41]

In a study conducted by Gilmore M, McCabe JP comparing diathermy versus scalpel for hemi arthroplasty compared blood loss and concluded that incision with diathermy is associated less blood loss compared to scalpel.[42]

Siraj A, Dar MF, Gilani et al conducted a study comparing diathermy and steel scalpel in abdominal incisions in terms of post operative pain, incision time, post operative wound infection rates and scar character concluded that incision with diathermy is associated with less postoperative pain on day 1 and day 2 post operative period these findings are similar to findings of our study.[43]

Razia Bano, Farhan Ahmed Majeed conducted similar study for skin incision in inguinal hernia surgery and found decreased pain scores in immediate post operative period at 12 hrs and 24 hrs.

In the present study, the pain scores at 72 hrs between the two groups (p value 0.262), group A mean 2.2 + 0.74 and group B mean 2.55 + 0.73 was not statistically significant.

In the present study 3 participants in group A and 10 participants in group B required rescue analgesia in first 24 hours and 2 participant in group B required rescue analgesia at 48 hours. No participants required rescue analgesia in both the groups at 72 hours.

The cosmetic outcome between the two groups was compared using patient and observer scar assessment scale (POSAS), the scale has patient scale (max 60) and observer scale (max 60) and the total score (120) is assessed.

The mean scar score of group A is 37.4 +4.96 and that of group B is 36.05 + 5.14 and there is no statistical difference between the two groups, p value 0.415.

In a similar study conducted by 45. Arsalan S, Athar A et al comparing cutting diathermy versus scalpel for skin incision using both Vancouver scale and POSAS scale concluded that there is no significant difference in scar cosmetic outcome measured with two scales.[45]

Earlier skin incision with electro surgical cautery is associated with charring of skin edges and delayed wound healing due to de vitalization of edges leading to poor scar and increased wound infections but with recent advances in electro surgical units which deliver pure sinusoidal current there is no charring of the edges and many

studies have shown similar outcomes in the scar assessment of skin incisions with electro surgical cautery.

Many studies compared infection rates and wound healing period in skin incisions performed with electro surgical cautery vs scalpel, Soballe PW, Nimbkar et al found that electro surgical cautery reduces the threshold for infections in laparotomy incisions [46], similar studies done by Sheikh B in patients where skin incision is made by cautery in neuro surgery found reduced infection rates [47]

In a Systematic review by Ly J, Mittal A, Windsor J showed reduced early post operative pain and reduced infection rates with no significant difference in wound healing.[48,] similar study comparing effects of electro cautery on midline laparotomy wound by Kumagai SG, Rosales RF, Hunter concluded reduced infection rates and lesser post operative pain compared with incision with scalpel.[49]

In a study conducted by Ayandipo OO, Afuwape OO et al in Nigerian teaching hospital showed less post operative pain at 24hrs and 48 hrs and reduced doses of post operative analgesia which is in agreement with our study.

The incision length between the two groups was also compared, In group A the mean length of incision is 9.75 cm $\pm$ 0.825, in group B the mean length of incision is 9.811 cm $\pm$0.719 with a p value of 0.722, there is no statistically significant difference between the two groups.

The results in this study suggest that skin incision with electrosurgical cautery is safe and associated with less post operative pain with no difference in cosmetic outcome.

CONCLUSION

In the present study of skin incision with electro surgical cautery vs scalpel, the skin incision made by electrosurgical cautery has less postoperative pain and no difference in scar outcome when compared to scalpel incision

Other parameters including blood loss and local wound complications need further evaluation with a larger sample size.

SUMMARY

Skin incision is traditionally made with scalpel, with the technical advances in electro surgery it is being employed in making skin incisions.

The present study was an attempt to evaluate the use of electro surgical cautery in making skin incision compared to scalpel in terms of post operative pain and cosmetic outcome.

This one year randomized controlled trial was done in the Department of General Surgery, KLES Dr. Prabhakar Kore hospital, Belagavi from January 2016 to December 2016. A total of 40 patients undergoing Lichtenstein hernioplasty were randomized in to two groups of 20 each. Group A skin incision with electro surgical cautery and group B skin incision with scalpel.

In the present study all the participants were males .The mean age of the participants in group A is 50.95 $\pm$ 11.75 and the mean age of the participants in group B is 52.2 $\pm$ 11.443(p value of 0.28). Other variables including demographic data, clinical presentation, anthropometric variables, vitals and clinical signs were comparable.

In the present study the mean pain scores in the 24 hrs for group A is 3.7 + 0.71 and that of group B is 4.85 + 0.82 (p value 0.0004). The mean pain scores measured at 48 hrs for group A is 2.9 + 0.62 and for group B is 3.55+ 0.589 (p value 0.009). The pain scores at 72 hrs between the two groups (p value 0.262), group A mean 2.2 + 0.74 and group B mean 2.55 + 0.73.

The mean scar score of group A is 37.4+4.96 and that of group B is 36.05±5.14 and there is no statistical difference between the two groups, p value 0.07.

In group A the mean length of incision is 9.75 cm±0.825, in group B the mean length of incision is 9.811 cm±0.719 with a p value of 0.1 there is no statistical difference between the two groups .There were no wound complications in both the groups.

Based on the results it may be concluded that skin incision with electro surgical cautery is advantageous in terms of less postoperative time with no difference in scar outcome and can be safely used as an alternate to scalpel.

However studies with larger sample size are required to further establish the efficacy of using diathermy for skin incision

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ANNEXURE I– CONSENT FORM

Title of the research study –

COMPARISON OF SKIN INCISION WITH ELECTRO SURGICAL CAUTERY VS SCALPEL IN ELECTIVE INGUINAL HERNIA SURGERY: A RANDOMIZED CONTROL STUDY

Principal investigator: Co-investigator:

Dr ********** Dr **********

Professor post graduate

Department of general surgery Department of general surgery

Dear Mr/Mrs _____ , you are kindly requested to enroll yourself in a research study titled "COMPARISON OF SKIN INCISION WITH ELECTRO SURGICAL CAUTERY VS SCALPEL IN ELECTIVE INGUINAL HERNIA SURGERY : A RANDOMISED CONTROL STUDY" being conducted by Dr._____ post graduate student in department of general surgery and the study will be carried out under direct supervision and guidance of Dr._____ professor , department of general surgery , Jawaharlal Nehru medical college, Belagavi.

You have been asked to participate in this study as you fit into the laid out criteria for a study participant.

Your participation in this study is voluntary. During the study you will be asked some questions and you are supposed to answer to the best of your knowledge. Your decision to whether or not to participate in the study will not affect your treatment in

any form during the hospital stay. Even if you decide to participate you are free to withdraw at any time.

Title of the study:

COMPARISON OF SKIN INCISION WITH ELECTRO SURGICAL CAUTERY VS SCALPEL IN ELECTIVE INGUINAL HERNIA SURGERY: A RANDOMIZED CONTROL STUDY

Purpose of study:

To compare the post operative pain and cosmetic outcome in skin incision with electro surgical cautery vs scalpel

Procedure involved:

If you agree to enroll yourself in my study, you will be interviewed regarding your present , past and family history then you will be clinically examined in detail and investigated accordingly.

You will be randomly allocated in to two groups, Group A - skin incision with electro surgical cautery , Group B – skin incision with scalpel

Surgery will be done by a consultant general surgeon under spinal anaesthesia and skin incision is placed 2 cms above and parallel to inguinal ligament in its medial two thirds, postoperative analgesia is standardized in both groups tab paracetamol 1000 mg 8^{th} hourly. Diclofenac 50mg intra muscular (i.m) is used as rescue analgesia

Postoperative pain was assessed with visual analogue scale ranging from 0 – 10, considering zero as no pain and ten as maximum pain at operated site at 24 hrs , 48

hrs and 72 hrs intervals by the assessor who is blinded to the intervention. Cosmetic outcome is compared by patient and observer scar assessment scale.

Risks and benefits:

The potential risks involved with the procedure are same as that of scalpel incision and anaesthesia related risks

Benefits of taking part in this research:

May cause lesser post operative pain

May have better cosmetic outcome

Voluntary participation/ with drawl from this study:

Taking part in this study is voluntary. You may choose not to enroll yourself in this study and may choose to leave at anytime

Privacy and confidentiality:

All data collected or disclosed by you during the course of participation of study will be kept fully confidential. If however during the course of study it becomes necessary for the progress of study to disclose the identity it would be so done so only after your informed and written consent.

Authorization to publish the result:

The results of the study may be used to publish an article, when the results are published or discussed in a conference no information will be displayed that would disclose your identity. Any information obtained in connection with this study and that can be identified with you will remain confidential.

Financial incentives for participation:

No additional costs shall be incurred upon you for the purpose of the study. It is purely being done with the idea of research and all the cost of study will be borne by the investigator

Compensation:

In the event you become injured as a result of taking part in this study, treatment will be offered to you at KLES Dr.Prabhakar kore hospital, Belagavi or you will be given information about where to receive medical care in which case you will responsible for the costs.

Questions and contact details

You shall be free to contact below mentioned any time during the study period for any clarification or help you may desire.

Principal investigator : Co-investigator :

Dr ********** Dr **********

Professor post graduate

Department of general surgery Department of general surgery

Ph no _____ Ph no _____

Consent to participate in the study

I Mr/Mrs _____ have been explained about the research study titled "COMPARISON OF SKIN INCISION WITH ELECTRO SURGICAL CAUTERY VS SCALPEL IN ELECTIVE INGUINAL HERNIA SURGERY : A RANDOMIZED CONTROL STUDY" , the need for the study the intervention, their risks, benefits and alternatives available in my own vernacular language.

I voluntarily agree to participate in this study by signing up this form below. I understand that I may withdraw at any time from this study. I have been given time to clarify my doubts about the study and my rights as a study participant

My signature and thumb impression below indicate that I have read or the information in the consent have been read to me including the risks and benefits and have cleared my doubts

Name of the participant signature/LTI

Date :

Place:

Name of the witness signature/LTI

Date :

Place:

Name of the investigator signature/LTI

Date :

Place:

ANNEXURE II: PROFORMA

Proforma of clinical examination of each patient

Name :

Age/sex:

IP no :

Address:

Occupation:

Date of admission:

History

When did you notice the swelling:

Size of the swelling :

Associated features :

Other complaints :

Past history :

Personal history :

Family history :

General physical examination

Built and nourishment :

Weight :

Pallor : Icterus : Cyanosis : Clubbing:

Vitals

Pulse Rate :

blood pressure :

respiratory rate :

temperature :

local examination

inspection : size and extension

shape

cough impulse

palpation : reducibility

cough impulse

consistency

ring occlusion test

genital examination

percussion :

auscultation :

systemic examination :

central nervous system :

cardio vascular system :

respiratory system :

per abdomen :

diagnosis :

investigations :

surgery done :

Evaluation of pain : visual analogue scale

	Score
24 hrs	
48 hrs	
72 hrs	

Cosmetic outcome assessment: patient and observer scar assessment scale

Objective scale :

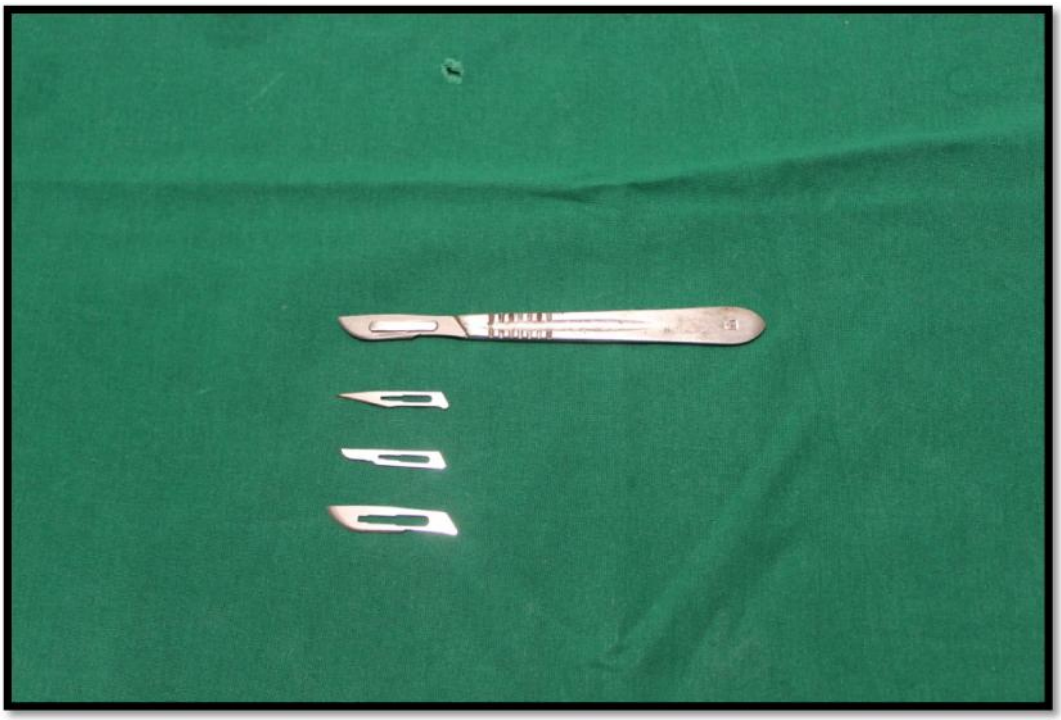
	Score
Vascularity	
Pigmentation	
Thickness	
Relief	
Pliability	
surface area	

Subjective scale:

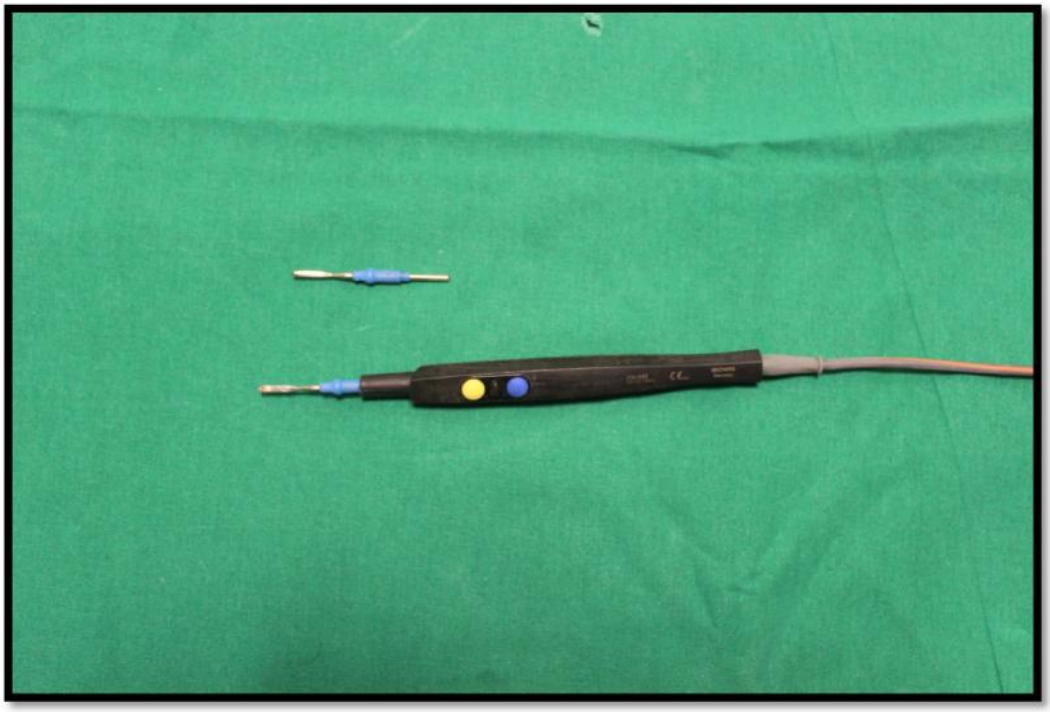
	Score
Has the scar been painful the past few weeks?	
Has the scar been itching the past few weeks?	
Is the scar color different from the color of your normal skin at present?	
Is the stiffness of the scar different from your normal skin at present?	
Is the thickness of the scar different from your normal skin at present?	
Is the scar more irregular than your normal skin at present?	

Total score of cosmetic outcome:

ANNEXURE III: PHOTOGRAPHS

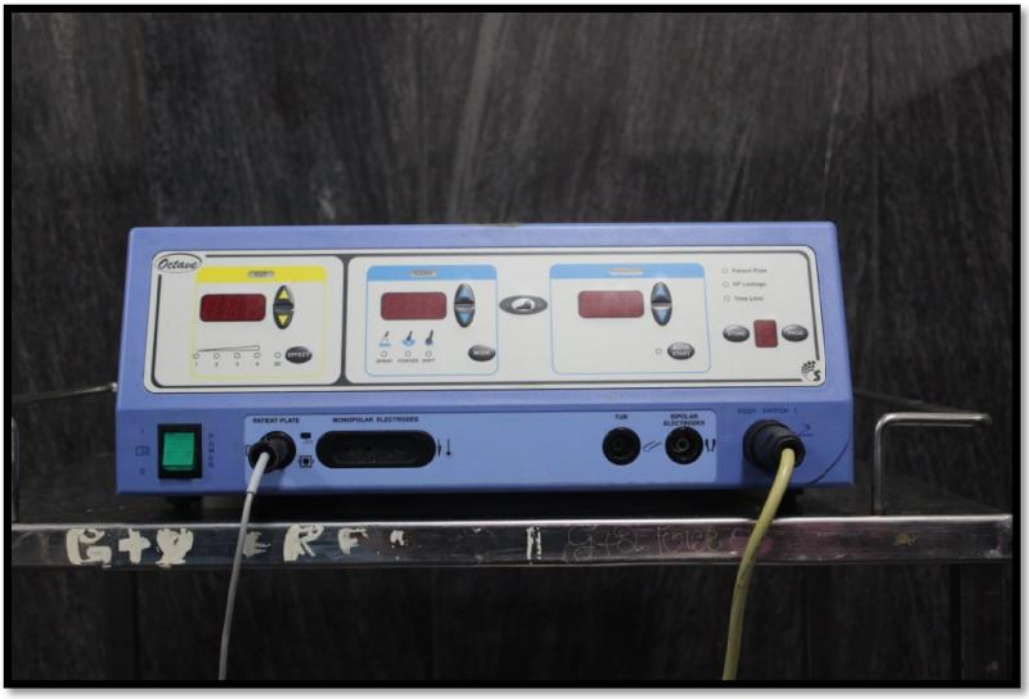


Photograph 1: **Scalpel with blades**



Photograph 2: **Mono polar electrosurgical device**

Photograph 3:**Bi polar electrosurgical device**



Photograph 4:**Electro surgical unit**

Photograph 5:**Placing skin incision with electrosurgical cautery**

Photograph 6:**Placing incision with scalpel**

Photograph 7:**Skin incision with electrosurgical cautery**

Photograph 8:**Skin incision with scalpel**

ANNEXURE IV: KEY TO MASTER CHART

S NO	–	Serial Number
M	–	Male
DM	–	Diabetes Mellitus
HTN	–	Hypertension
Mm	–	millimeter
Hg	–	mercury
Hrs	–	hours
Min	–	Minute
LIH	–	Left Indirect Inguinal Hernia
RIH	–	Right Indirect Inguinal Hernia
LDH	–	Left Direct Inguinal Hernia
RDH	–	Right Direct Inguinal Hernia
LICH	–	Lichtenstein Hernia Repair

Group A - Electrosurgical group																	
S NO	**IP NO**	**AGE**	**SEX**	**PULSE**	**BP**	**DM**	**HTN**	**DIAGNOSIS**	**SURGERY**	**PAIN SCORE**			**RESCUE ANALGESIA**			**SCAR**	**INCISION**
				/min	**mm hg**					**24 HRS**	**48 HRS**	**72 HRS**	**24 HRS**	**48 HRS**	**72 HRS**	**SCORE**	**LENGTH**
1	719309	35	M	72	110/70	-	-	LIH	LICH	4	3	3	-	-	-	42	10.4
2	719733	48	M	80	110/70	+	-	RDH	LICH	4	2	2	-	-	-	35	9.8
3	716712	59	M	64	120/70	+	-	RIH	LICH	3	3	3	-	-	-	32	11.2
4	738445	72	M	74	130/90	-	+	RDH	LICH	4	4	3	-	-	-	43	8.4
5	738258	63	M	68	120/80	-	-	LIH	LICH	5	3	2	+	-	-	34	9.4
6	738157	54	M	74	130/80	+	+	RIH	LICH	4	2	3	-	-	-	32	10.2
7	732537	62	M	76	110/70	+	-	LIH	LICH	4	3	1	-	-	-	34	10.8
8	730092	52	M	68	110/80	+	-	LIH	LICH	5	4	3	+	-	-	41	8.7
9	732958	28	M	72	140/90	-	+	RIH	LICH	4	3	2	-	-	-	34	9.6
10	737681	64	M	70	120/80	-	-	RDH	LICH	4	2	1	-	-	-	36	9.5
11	746786	42	M	64	120/70	-	-	RIH	LICH	3	3	1	-	-	-	35	10.2
12	749525	58	M	78	130/80	+	+	RIH	LICH	4	4	3	-	-	-	46	9.7
13	750618	46	M	80	140/90	-	+	RIH	LICH	3	3	2	-	-	-	38	10.4
14	757891	64	M	72	110/70	+	-	LIH	LICH	4	3	2	-	-	-	39	10.6
15	759880	51	M	76	120/80	-	-	LDH	LICH	3	2	1	-	-	-	46	8.9
16	755483	38	M	68	120/70	+	-	RIH	LICH	4	3	2	-	-	-	29	9.2
17	753461	32	M	66	130/80	+	+	RIH	LICH	2	3	3	-	-	-	45	9.7
18	760769	54	M	74	130/70	-	+	RDH	LICH	3	2	3	-	-	-	32	10.7
19	762800	57	M	64	110/70	-	-	LDH	LICH	4	3	2	+	-	-	35	9.5
20	762065	40	M	74	120/80	+	-	LIH	LICH	3	3	2	-	-	-	40	9.4
AVERAGE		50.95								3.7	2.9	2.2				37.4	9.815
SD		#NAME?								0.732695097	0.640723276	#NAME?				#NAME?	#NAME?

Group B- Scalpel group																	
S NO	**IP NO**	**AGE**	**SEX**	**PULSE**	**BP**	**DM**	**HTN**	**DIAGNOSIS**	**SURGERY**	**PAIN SCORE**			**RESCUE ANALGESIA**			**SCAR**	**INCISION**
				/min	**mm hg**					**24 HRS**	**48 HRS**	**72 HRS**	**24 HRS**	**48 HRS**	**72 HRS**	**SCORE**	**LENGTH**
1	719556	45	M	70	110/70	-	-	LIH	LICH	6	5	3	+	+	-	32	10.2
2	716712	51	M	80	120/74	-	-	LIH	LICH	4	4	2	-	-	-	35	8.5
3	714592	70	M	74	130/90	-	+	LDH	LICH	4	4	2	-	-	-	42	9.2
4	714624	58	M	65	140/80	+	+	LIH	LICH	3	3	3	-	-	-	38	11
5	712042	27	M	72	110/70	-	-	RIH	LICH	4	4	4	-	-	-	37	10.7
6	728650	63	M	74	120/70	+	-	LDH	LICH	5	4	2	+	+	-	43	8.6
7	729355	42	M	65	120/70	-	-	LIH	LICH	6	3	3	+	-	-	32	8.9
8	722693	58	M	80	130/80	-	+	RIH	LICH	4	3	3	-	-	-	25	9.4
9	725877	48	M	76	110/80	-	-	RIH	LICH	5	4	2	+	-	-	28	10.2
10	735499	57	M	68	120/80	+	+	LIH	LICH	5	3	2	+	-	-	36	10.6
11	738238	36	M	70	110/70	-	-	LIH	LICH	4	3	3	-	-	-	38	8.9
12	738645	52	M	68	120/70	-	-	LDH	LICH	5	4	2	-	-	-	42	9.4
13	739375	68	M	74	140/90	+	-	LDH	LICH	5	3	2	+	-	-	37	10.7
14	733156	62	M	76	130/80	+	+	RIH	LICH	6	3	3	+	-	-	45	9.1
15	742608	63	M	74	120/70	-	-	RIH	LICH	4	3	1	-	-	-	33	8.5
16	748153	32	M	66	130/80	+	+	RIH	LICH	5	4	4	-	-	-	34	9.4
17	743694	60	M	68	110/70	-	-	LIH	LICH	6	4	3	+	-	-	42	10.5
18	745342	51	M	75	110/70	+	-	RDH	LICH	5	3	2	-	-	-	29	10.8
19	756478	57	M	80	110/80	+	-	RIH	LICH	6	4	3	+	-	-	36	9.5
20	762129	44	M	74	120/80	-	-	LIH	LICH	5	3	2	+	-	-	37	10.4
AVERAGE		52.2								4.85	3.55	2.55				36.05	9.725
SD		11.74106603								0.87509398	0.604805319	0.759154655				5.276312508	0.846587577