# "A CASE CONTROL STUDY ON SIGNIFICANCE OF LOW- LYING PUBIC TUBERCLE IN THE DEVELOPMENT OF INGUINAL HERNIA"

**BY**

**REG NO: BH0121008**

# Dissertation

*Submitted to*
*KAHER, Belagavi, Karnataka,*
*In partial fulfilment of the requirements for the degree of*

## MASTER OF SURGERY (M.S.)

## in

## GENERAL SURGERY

**DEPARTMENT OF GENERAL SURGERY**
**JAWAHARLAL NEHRU MEDICAL COLLEGE,**
**KAHER, BELAGAVI – 590010**
**KARNATAKA.**

**DECEMBER-2024 / JANUARY -2025**

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**Dr. S.C. METGUD**$_{M.S}$
Professor and Head
Department of General Surgery,
KAHER's J.N.Medical College,
Nehru Nagar, Belagavi -590010

Date:
Place: Belagavi

**Dr. (Mrs)N. S. MAHANTASHETTI**$_{M.D(Peads)}$
Principal
KAHER's J.N.Medical College,
Nehru Nagar, Belagavi -590010

Date:
Place: Belagavi

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Nehru Nagar, Belagavi- 590 010, Karnataka, INDIA
0831 - 2471350 0831 - 2470759 www.jnmc.edu principal@jnmc.edu

Ref No: MDC/PG/ Date: 26-06-2024

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Chairperson-Antiplagiarism Committee &
Principal,
J. N. Medical College, Belagavi.

To,
**Reg. No. BH0121008**
Postgraduate Student,
2021-22 Batch,
Department of General Surgery
J. N. Medical College, Belagavi.

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**JAWAHARLAL NEHRU MEDICAL COLLEGE,**
**NEHRU NAGAR, BELAGAVI-590010 (KARNATAKA-INDIA)**

Website: http//www.jnmc.edu
E-Mail : dome@jnmc.edu

Phone: (+91-(0)831 Office : 2472550
Principal: 2471701
Fax No. +91 (0)831 – 2470759

**Ref No.MDC/JNMCIEC/** 07 **Date: 27/09/2022**

To

**REG NO: BH0121008**

PG Student in General Surgery,
J. N. Medical College,
BELAGAVI.

Sub: Institutional Ethical Clearance for the study.

With reference to the above, we wish to inform you that your proposed research project titled **"A CASE CONTROL STUDY ON SIGNIFICANCE OF LOW LYING PUBIC TUBERCLE IN DEVELOPMENT OF INGUINAL HERNIA FOR A PERIOD OF ONE YEAR AT A TERTIARY CARE CENTRE, BELAGAVI."**, is ethical and justifiable. The proposed research project has been cleared by the JNMC Institutional Ethics Committee.

**(Dr. Smita Sonoli)**
Member Secretary
JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi.

**(Dr. Harsha Hegde)**
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JNMC Institutional Ethics Committee
J.N.Medical College, Belagavi

# LIST OF ABBREVIATIONS.

| | |
|---|---|
| ASIS | Anterior Superior Iliac Spine. |
| COPD | Chronic Obstructive Pulmonary Disease. |
| CT | Computed Tomography. |
| MMP | Matrix Metalloproteinase. |
| MRI | Magnetic Resonance Imaging. |
| ppm | Polypropylene. |
| TB | Tuberculosis. |
| TEP | Total Extra-Peritoneal. |
| TAPP | Transabdominal Pre-Peritoneal. |

# ABSTRACT

**Background:** Inguinal herniae are characterized by the protrusion of abdominal contents through the inguinal canal or fascia transversalis. Although risk factors such as smoking, obesity and previous surgeries have been recognized in the development of inguinal hernia, the role of anatomical factors particularly the position of the pubic tubercle remains underexplored. This study investigates the association between a low-lying pubic tubercle and the development of inguinal herniae, aiming to enhance the understanding of the etiology of hernia.

**Material and Methods:** This case-control study involved 82 patients with inguinal herniae admitted to our tertiary hospital setup over one year. The controls included were matched with age, gender and BMI. The measurement of spino-spinous (SS) and spino-tubercular (ST) lines were taken as tools to assess the anatomical configuration of the pubic tubercle. Statistical analysis was determined with Student's t-test and logistic regression to evaluate the significance of anatomical position of pubic tubercle in development of hernia.

**Results:** The mean SS line was significantly lower in hernia patients compared to controls (26.3±0.4 vs. 23.22±0.61, $p<0.05$), indicating reduced obliquity of the inguinal canal. Conversely, the ST line was significantly higher in patients with inguinal hernia (9.51±0.62) as compared with controls (7.65±0.23, $p<0.05$), suggesting a much superiorly positioned pubic tubercle. These findings underscore the association between a low-lying pubic tubercle position and increased risk of development of inguinal hernia.

**Conclusion:** A low-lying pubic tubercle emerges as a significant anatomical risk factor for development of inguinal herniae. The altered SS and ST line measurements

reflect changes in inguinal canal obliquity and structural integrity, predisposing individuals to herniation. Further research is warranted to elucidate the mechanistic pathways underlying this association and explore preventive strategies for mitigating the risk of development of hernia in vulnerable populations.

**Keywords:** Inguinal hernia, Pubic tubercle, SS line, ST line, Anatomical risk factors, Preventive strategies.

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# INTRODUCTION

Inguinal hernia is the protrusion of contents of abdominal cavity through the inguinal canal or fascia transversalis. Inguinal hernia always contains a portion of peritoneal sac which may contain abdominal viscera- usually small bowel or omentum. Risk factors for the development of hernia include: smoking, tobacco chewing, chronic obstructive pulmonary diseases, obesity, collagen vascular diseases, bladder outlet obstruction and previous open appendectomy.[1]

Inguinal herniae can be classified as direct or indirect inguinal hernia based on its relation with the inferior epigastric vessels.[1,2] One common feature in all types of herniae is a zone of weakness through which herniation occurs. All the inguinal herniae occur within a single weak area in the lower part of abdomen called the myopectineal orifice.[3–5] The evolution of posture of homo sapiens/homo erectus from the Neanderthal era has been thought to cause a lack of development of a strong posterior rectus sheath and transversalis fascia which might direct to an evolutionary anatomical defect in the anterior abdominal wall.[6]

The distance of the pubic tubercle from the centre of the line connecting the 2 anterior superior iliac spines is directly proportional to the obliquity of the inguinal canal. Hence, a low-lying pubic tubercle results in a less oblique inguinal canal with narrow arching of conjoint tendon and a wider origin of both internal oblique and transverses abdominis muscles. This, thus leads to ineffective shutter mechanism of inguinal canal maintained by the above mentioned muscles[7], increasing the risk of development of inguinal hernia.

The limited origin of the internal oblique muscle from the lateral inguinal ligament is thought to be connected to the low-lying pubic tubercle. This muscle fails

to protect the deep inguinal ring, which can lead to inguinal herniation. Patients with low lying pubic tubercle experience decreased inguinal canal obliquity, constricted conjoint tendon arching, and impaired internal oblique muscle shutter mechanism. These changes ultimately result in an inefficient defence mechanism that causes an inguinal hernia.[8]

Indirect inguinal hernia is the herniation of abdominal contents through the deep ring, into the inguinal canal. The assessment of the obliquity of inguinal canal and the presence of a low-lying pubic tubercle plays a greater role in determining the development of indirect inguinal hernia than in direct inguinal hernia which is usually due to the weakness of the transversalis fascia. The assessment of this correlation necessitates additional research to explore the relationship between a low-lying pubic tubercle and the occurrence of indirect inguinal hernia. There are various risk factors for the inguinal hernia development but the exact anatomical cause is still not known. Based on the study results, low lying pubic tubercle is a major anatomical risk factor for the development of indirect inguinal hernia.[2]

The available literature regarding the anatomical risk factors responsible in the etiology of indirect inguinal hernia is limited among the Indian population. Hence, this study aimed to assess the significance of the presence of a low-lying pubic tubercle in patients with inguinal hernia at our tertiary hospital setup.

# AIMS & OBJECTIVES

To find out the incidence of inguinal hernia in low lying pubic tubercle at our tertiary hospital setup.

# REVIEW OF LITERATURE

## History

"Hernia is one of the oldest condition known to mankind. Surgical repair of hernia dates back to ancient Egyptian and Greek civilisations.[9] Galeno (129-199) in 'de semine' gave the correct description of the inguinal canal.[10] The earliest description of surgical approach to hernia repair was described by Celso in De Re Medica (1st century) which read "For a medium sized swelling, a single incision is enough, for a bigger sized swelling, two linear incisions are necessary and the cord is removed. The vessels are identified, tied and cut". This showed a lack of anatomical knowledge in that era.

"Five centuries later, Paolo D'Egina recommended cauterization and advocated for the tying and dissection of the entire sac, implying ligation of the cord. In 1559, Caspar Stromayr described the etiology, morphology, and treatment of hernia. August Gottlieb Richter emphasized the importance of not only closing the sac but also repairing the defect in the wall of the inguinal canal.[10,11] Bassini is credited for developing the precursor to modern inguinal hernia operation at end of 19th century. Bassini discovered that the transversalis fascia plays a key role in pathophysiology of inguinal hernia. Bassini created a physiologic reconstruction of the inguinal canal, suturing conjoint tendon and transversalis fascia with inguinal ligament. Bassini's operation was considered the gold standard for nearly a century.[12] Shouldice was the first to introduce local anaesthesia for inguinal hernia repair. Shouldice technique involves repair of 3 sheets which reduced the tension and post-operative pain.[13] For the first time, Witzel attempted inguinal hernia repair by using a silver mesh and experienced lot of complications and was abandoned."[14]

Polypropylene was introduced by Nobel Prize winner Giulio Natta with Karl Ziegler in 1954.[15] The first mesh hernia repair was performed by Usher in 1958. [10,11]

"Inguinal herniae account for 75 percent of all abdominal wall herniae worldwide. Inguinal hernia repair is one of the most common general surgical procedures in the world, accounting for approximately 10–15 percent of all surgical procedures, second only to appendectomy.[16] It is estimated that over 20 million inguinal hernia repairs are performed worldwide each year, with specific operation rates ranging from around 100 to 300/100,000 population/year[16]."

In India, the annual incidence of inguinal hernia is estimated to be 1,957,850.[16,17] Every year, approximately 100,000 inguinal herniae are repaired in the United Kingdom, and approximately 750,000 inguinal herniae are repaired in the United States. In United States, prevalence of inguinal hernia is estimated 5-10 percent. Inguinal hernia is found to be more common than femoral hernia and other abdominal wall herniae.[18] It is not uncommon for Inguinal hernia to present with the clinical complications like incarceration and strangulation[18].

"Herniae are most commonly found among males compared to females.[19] Men are 8 times more likely to develop hernia and 20 times more likely to need surgical repair when compared to female counterpart.[20] In males, the lifetime risk of developing the inguinal hernia is approx 25% when compared among the females as 5%. The median age of presentation is found to be 60 to 79yrs of age for women compared to 50 to 69yrs of age among the men.[21] 96% of the herniae comprises of inguinal hernia and 4% with the femoral hernia. Among both the genders, indirect inguinal hernia is the most common Inguinal hernia. Whereas, the direct hernia accounts for about 30 to 40% of Inguinal herniae among the males."[21–23]

**Various articles discussing significance of low-lying pubic tubercle in development of inguinal hernia :-**

- In a case-control study by Agrawal M et al., (2014) to assess the role of low-lying pubic tubercle in development of inguinal hernia, it was found that right-sided inguinal hernia (IH) was more prevalent at 59.25%, with a majority (94.5%) being direct IH. There were notable differences in weight, the SS line, and the ST line between cases and controls. In conclusion, this study unequivocally establishes that the occurrence of muscle and connective tissue variations in the inguinal region is influenced by the positioning of the groin relative to the interspinal plane, thereby elevating the risk of inguinal hernia.[24]
- In a study conducted by Babu A et al., (2017) to assess the role of low lying pubic tubercle in patients developing inguinal hernia, it was resulted that individuals with low-lying pubic tubercles have a decrease in the inguinal canal shutter mechanism's efficacy, which can result in the formation of an inguinal hernia. A subset of individuals with low-lying pubic tubercle are more susceptible to inguinal herniae.[25]
- In a study by Thomas A et al., (2018) to assess the presence of low lying pubic tubercle in patients with inguinal hernia, it was determined that most individuals exhibiting a lower-positioned pubic tubercle were diagnosed with inguinal hernia. Furthermore, a positive correlation was observed between the ratios of weight and ST length, as well as height and ST length, in both cases and controls. These findings suggest that factors such as a low-lying pubic tubercle and other associated anthropometric variables contribute to an increased susceptibility for the development of indirect inguinal hernia.[26]

- In a study by Farook MU et al., (2020) to assess the association of low-lying pubic tubercle in patients with inguinal hernia, the average cutoff value for the ST segment, assessed both clinically and radiologically, was 8.10 cm and 8.15 cm, respectively. On investigation, it was found that the ST line (indicated the length of the pubic tubercle) exhibited a notably greater measurement in patients with indirect inguinal hernia, both clinically and radiologically. Additionally, the mean SS and MIP to PT were significantly longer ($p < 0.05$) in individuals with indirect inguinal hernia. Clinical measurements suffice for non-obese individuals, while radiological measurements are necessary for those classified as obese (BMI > 25). From the outcomes of this research, it can be concluded that a lower-positioned pubic tubercle is linked to the occurrence of indirect inguinal hernia.[27]
- In a case control study by Rao PT et al., (2020) to assess the aspect of low lying pubic tubercle in development of inguinal hernia, it was concluded that the development of an inguinal hernia directly correlated with the measurements of the SS, ST, and MP lines. According to research, inguinal herniae are widespread in people between the ages of 51 and 60. There were more individuals with indirect inguinal herniae. Measurements showed that the patients' SS and ST lines were higher than the controls'. [28]
- In a case control study conducted by Sundresh N et al., (2020) to assess the role of low lying pubic tubercle in development of inguinal hernia. The mean SS measurement for the case group was 23.12, notably exceeding the control group's average of 22.87. Similarly, the ST value had a mean of 7.34 in the study group, contrasting with the control group's mean of 6.93. The statistical significance was affirmed with a t value of 8.57. Moreover, the average MP distance in the control group was 5.63, significantly higher than the study

group's 5.327. These findings lead to the conclusion that the anatomical features of the pubic tubercle and an abnormal protective mechanism of the internal oblique contribute to the etiology of inguinal hernia.[29]

- In a study by Jakhar DS et al., (2020) to assess the role of low-lying pubic tubercle in development of inguinal hernia. The mean level of ST line was significantly greater (7.37±0.182cm) than compared to controls (7.01±0.262cms). study documented with 98% cases with more than 7.01cm ST line whereas 66% controls were under the 7.01cms. study concluded that the participants with low lying tubercle are at higher risk of developing inguinal hernia.[4]
- In another study by Verma M et al., (2021) to assess the role of low-lying pubic tubercle. Study found that the mean measurement of ST line was7.34±0.16cm which was significantly higher than the controls 6.92±0.12cms. Concluded that patients with low-lying pubic tubercle are at high risk of developing inguinal hernia.[30]
- In a case control study by Chirayath MJ et al., (2021) to assess the association of low lying pubic tubercle with inguinal hernia. In cases, the average spine-to-spine distance measured 26.32 cm, while it was 25.86 cm in controls. The mean distance from the pubic tubercle to this line was 7.82 cm for cases and 6.77 cm for controls. Through multivariate analysis, it was established that the vertical distance from the pubic tubercle to the inter-spinous line, along with its ratio to height and weight, demonstrated a significant association with inguinal hernia. Individuals with a lower-positioned pubic tubercle exhibit a less effective protective mechanism for the inguinal canal, thereby increasing their susceptibility to inguinal hernia. Pelvimetric assessments can be utilized

to identify adults at risk, facilitating early surgical planning and aiding in decisions regarding prophylactic repair of the uninvolved contra-lateral side. [31]

- In a study by Rajeev A et al., (2022) to assess the impact of pelvic bone anatomy on inguinal hernia. Significant statistical differences were observed between the case and control groups in terms of the mean Radoievitch angles and the mean length of the Ami line ($p<0.05$). Patients with bilateral hernia exhibited a statistically significant increase in the Radoievitch angle compared to those with unilateral hernia (p-value <0.01) and indirect hernia compared to other hernia types (p-value <0.05). The findings suggest that an enlarged Fruchaud region, characterized by a larger Radoievitch angle or a longer Ami line, increases the likelihood of having an inguinal hernia. Additionally, a low-lying pubic tubercle was associated with a higher probability of bilateral,direct and indirect inguinal hernia. Pelvimetry emerges as a straightforward and routine test that surgeons can employ to accurately identify patients who may benefit more from non-mesh repairs.[32]
- In a case control study by Bhandary D et al., (2024) to assess the height of individual and low lying pubic tubercle as risk factor for inguinal hernia. The average SS value in the case group exceeded that of the control group, and the ST value was higher in the case group compared to the control group, with a significant p-value of <0.0001. Additionally, the mean (SS/ST ratio)/height was greater in the case group than the control group. The findings indicate that a majority of subjects with a low-lying pubic tubercle were diagnosed with inguinal hernia. In conclusion, the interspinal distance (SS line) and pubo-spinal distance (ST line) are more pronounced in cases compared to controls. The configuration of the bony pelvis emerges as a significant contributing factor in determining the risk of inguinal hernia development, as evidenced by

variations in ST length. Recognizing a low-lying pubic tubercle is crucial before selecting patients for surgical correction. Therefore, a thorough understanding of the anatomy of the inguinal region is imperative in guiding the selection of the appropriate surgical technique.[33]

**Brief anatomy**

**Abdominal wall**

"Tissues in the abdominal wall have different consistency and function; this must be known to every surgeon as it must be taken into account in hernia repair. Layered condensation of connective tissue is called fascia. The fasciae related to the inguinal canal are the Camper's, Scarpa's, Innominate and Cribriform. Aponeurotic tissue is connective tissue that is organized and has measurable strength, like external oblique crurae.[34]

**Layers of anterior abdominal wall**

The Anatomy of the inguinal region is of particular interest due to its relevance to hernia pathology[34]. The layers of the anterior abdominal wall from superficial to deep are: -

- Skin
- Fatty layer of Camper's fascia
- Membranous layer of Scarpa's fascia
- Deep fascia
- External oblique muscle

- Internal oblique muscle
- Transversus abdominus muscle
- Transversalis fascia
- Extraperitoneal fat
- Parietal peritoneum

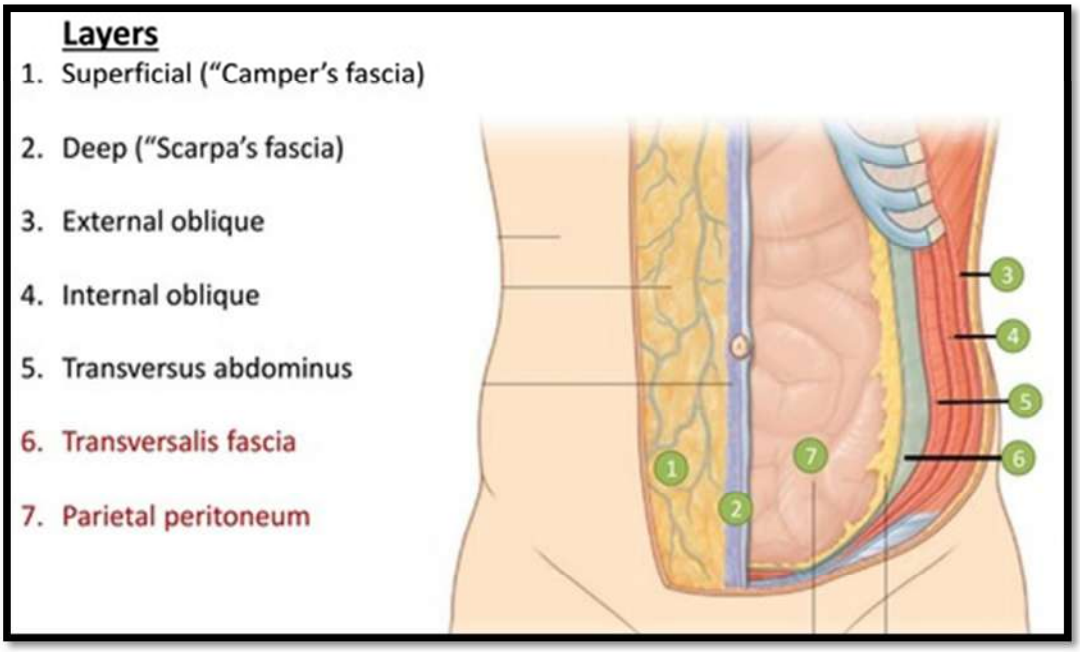


**Figure 1: Anterior abdominal wall[34]**

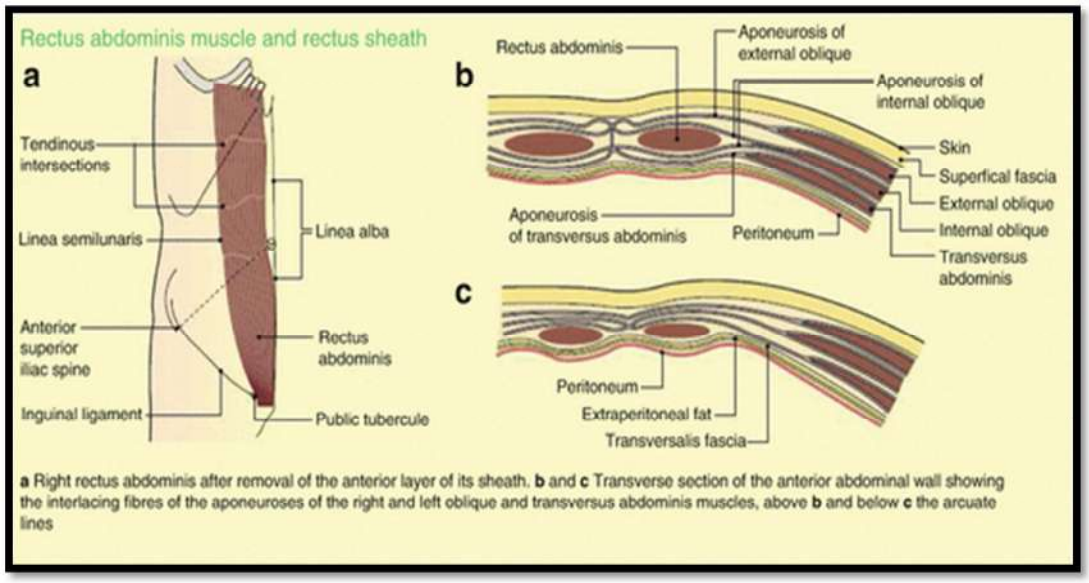


**Figure 2: Surgical anatomy of anterior abdominal wall**[34]

**Embryology**:

"The embryo transforms from a disc to a fetal shape between 3 and 4 weeks of gestation. The ectodermal disc layer folds to generate the neural tube, while the endodermal and mesodermal disc layers fold in the opposite way to create the ventral body wall and the gut tube. The mesoderm gives rise to the abdominal wall muscles and fascia.[35]

The testis migrates or descends into its corresponding scrotal chamber following the lead of the fibromuscular band called the gubernaculum testes which originates mostly within a peritoneal fold called the plica inguinalis, that extends to the bottom of the mesonephros from the inguinal area. Around the sixth month, the gubernaculum evolves into a powerful thick cord that is linked above to the lower end of the testis and penetrates the abdominal wall on its way to the bottom of the scrotal pouch, establishing the inguinal canal. [35]

The processus vaginalis descends into the scrotum with the gubernaculum, dragging thin fascial prolongations of the abdominal wall with it. Thus, the vaginal processes are covered by the aponeurosis of the external oblique, internal oblique, and fascia transversalis. When the testes and cord structures penetrate through the abdominal wall, they are surrounded by remnants of the external oblique (external spermatic) and fascia transversalis (internal spermatic fascia). [35]

During the first month of intrauterine life, the testicle appears as a swelling at the caudal end of the genital ridge which enlarges rapidly such that by the sixth week, it has a mesentery and remains behind the peritoneum.[36] The testis begins to descend in the second month and moves to the iliac fossa near the brim of the true pelvis in the third month. It reaches the deep ring by the beginning of the seventh month, moves through the inguinal canal, reaches the superficial inguinal ring in the eighth month and finally into the scrotum by the end of the eighth month. Typically, ovarian descent ends after the 12th week of pregnancy near the pelvic brim. [35]

When the testis migrates, the gubernaculum shortens and eventually atrophies, leaving behind a remnant at the bottom of the scrotum beneath the tunica vaginalis. The scrotal ligament is made up of truncated remains of the gubernaculum and links the testis to the bottom of the scrotal pouch. As the eighth month nears its end, the hollow formed by the upper section of the processus vaginalis and its peritoneal wall develops into a fibrous cord. The lower half of the process vaginalis is therefore entirely isolated from the general peritoneum and is made up of two layers, with the parietal component lining the scrotum and the visceral section adhering to the surface of the testis. [35]

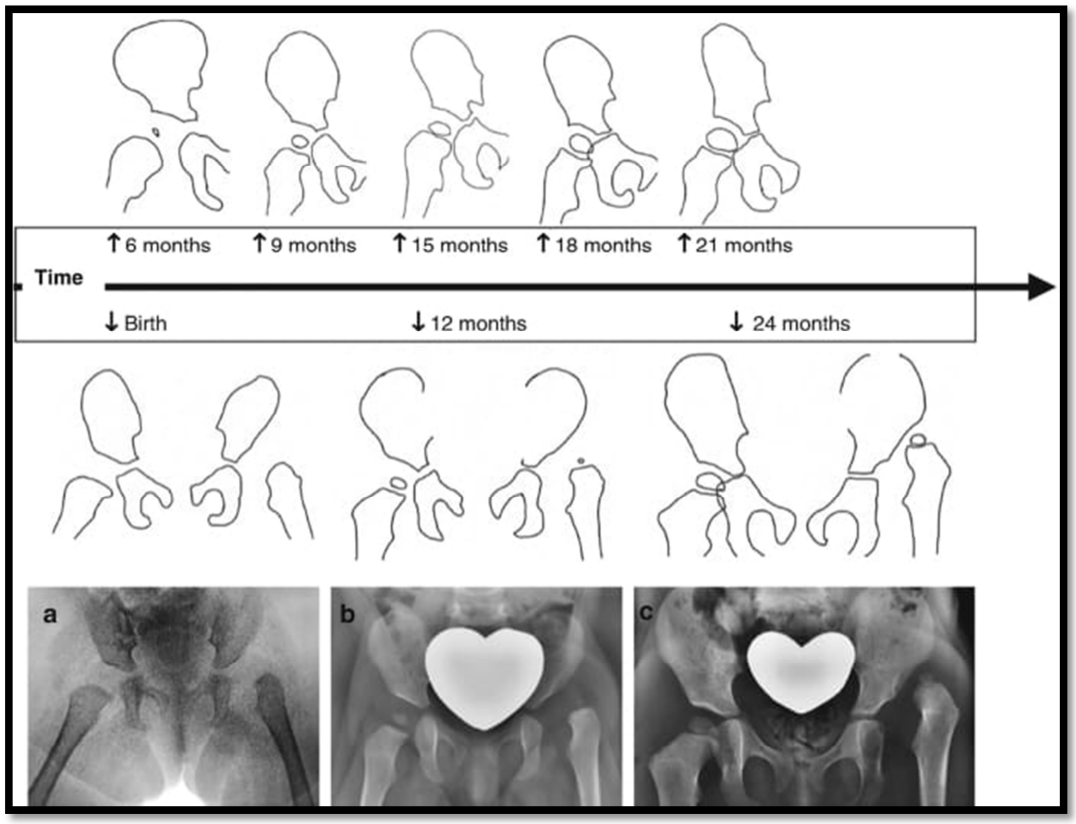


**Figure 3: Embryology**[35]

In females, similar to the process vaginalis in males, there is a canal of Nuck, which is a peritoneal pouch that travels down the inguinal canal into the labium majus. This is often eliminated long before delivery. The rare persistence of the vaginal process after delivery is the cause of inguinal hernia in females. [35]

**Inguinal region**

It is the part of the anterior abdominal wall below the anterior superior iliac spine. The medial border is formed by the pubis and the upper pubic ligament (Cooper's). Laterally, it is bounded by the epigastric vessels and the condensation of the transverse fascia at the inner ring. Inferiorly lie the anterior femoral sheath, the inguinal ligament, and the ilio-pubic tract, while superiorly lie the transverse abdominal aponeurosis and the arch. The inguinal canal is an oblique channel through

the lower portion of the anterior abdominal wall. In males, it facilitates the passage of structures to and from the testis to the abdomen. In females, the round ligament of the uterus travels from the uterus to the labium majus. As the canal passes through the flat muscles of the abdomen, its location weakens the lower medial part of the anterior abdominal wall, making it susceptible to herniae."[37]

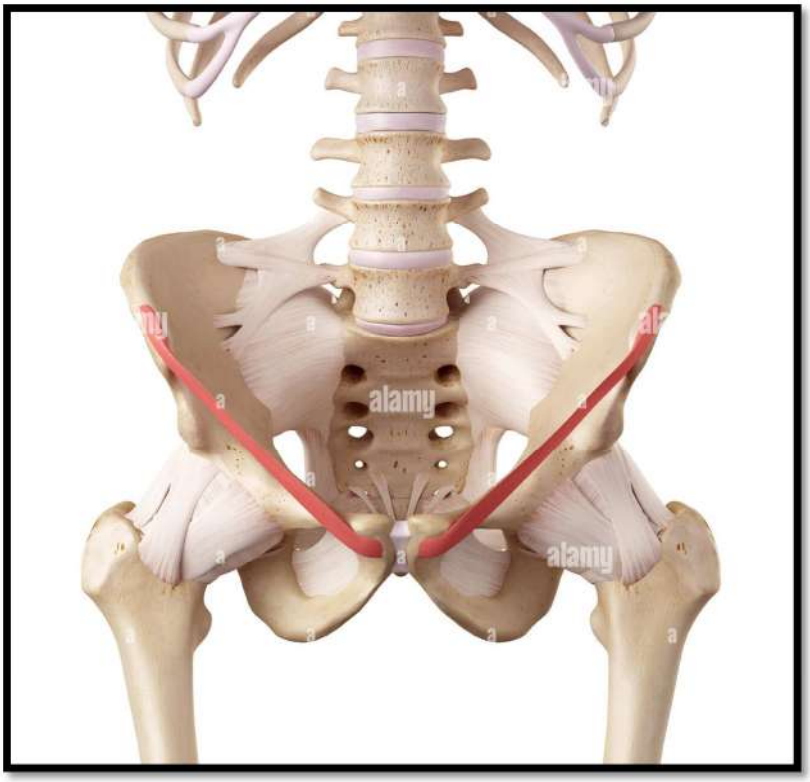

**Figure 4: Inguinal ligament**

The canal is about length of 4cms in adults which extends from the deep inguinal ring directed downward and medially to the superficial inguinal ring. The defect in the fascia transversalis constitutes the deep inguinal ring. The defect in aponeurosis of external oblique muscle constitutes the superficial inguinal ring. In the new-born child, the deep ring lies just posterior to the superficial ring, making the inguinal canal considerably short at this age. Later, as growth ensues, the deep ring moves laterally.[37]

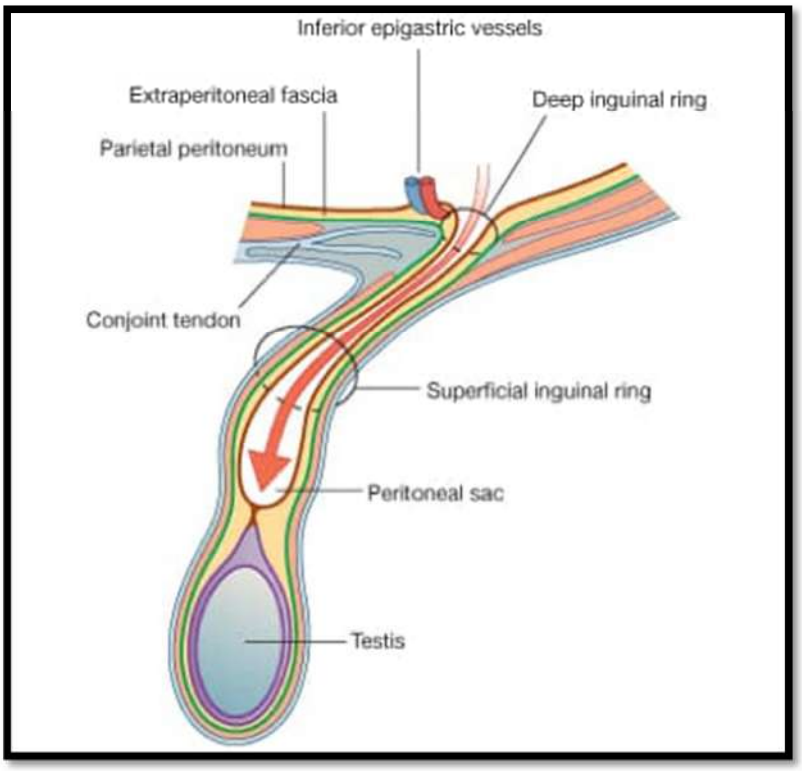


**Figure 5: Showing the inguinal canal in adult[38]**

**Myopectineal Orifice of Fruchaud:**

It is the site in the lower part of abdomen where most of the direct, indirect, femoral and some interstitial herniae occur in patients.[37]

The boundaries comprise of

- Inferior: Pectin Pubis
- Laterally: Iliopsoas
- Medially: Rectus muscle
- Superior: Conjoint tendon

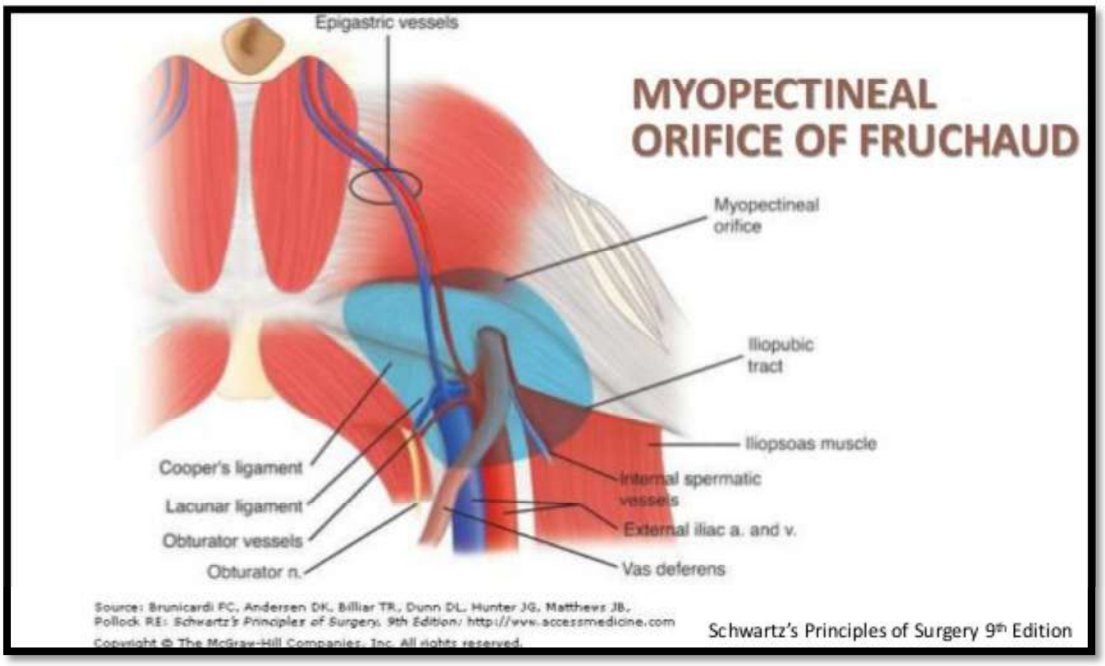


**Figure 6: Showing the Myopectineal orifice of Fruchaud**

**Theories of Hernia Formation[63]**

- Russel's theory: perforated sac
- Reid's metastatic emphysema theory: due to smoking
- Cloquet's lipoma theory: pile drives action of fat
- Fruchand's theory: big opening present in the lower abdomen between the pubic bone and the conjoint tendon is divided into two by the inguinal ligament. Through the upper part passes the inguinal hernia and through the lower passess the femoral hernia.
- Denervation theory: ilioinguinal nerve injury after appendectomy
- According to the oblique pelvis theory, individuals who have a high internal oblique arch are more likely to develop inguinal hernias. Because femoral

hernia in females are more prevalent than in males due to indirect hernias, which are less common in females.

- Wide female pelvis: low arch of the internal oblique provides the more efficient shutter mechanism. In direct inguinal hernias are uncommon in females, results in wider femoral ring so femoral hernia are more common among females.
- Uglavasky theory: due to chronic increased intra abdominal pressure
- Peacock's theory: defective collagen synthesis
- Walk's theory: weakness of the abdominal wall
- Kith's theory: stress related to degeneration of connective tissue of the fascia transversalis
- Dr Desarda's theory: loss of strength and physiologically dynamic nature of the posterior wall of the inguinal canal with absence of aponeurotic extension in the posterior wall and loss of the strength of Cremasteric fascia and musculo-apneurotic structures around the inguinal canal which cause the hernia formation.[64]

**Function of inguinal canal:**

It allows the cord structures (Spermatic cord) to pass both into and out of the testes to the abdominal cavity in males. In females, the smaller canal permits for the passage of the round ligament of uterus arising from the uterus to the labium majus.[37]

**DEFENCE MECHANISMS AGAINST HERNIA FORMATION-**

**SHUTTER MECHANISM-** This mechanism if formed by the arched fibres of internal oblique and transversus abdominus muscles. Contraction of these muscles while doing strenuous work, walking etc, causes the approximation of anterior and posterior walls of the inguinal canal, thus obliterating the lumen of the inguinal canal which prevents hernia formation.[39]

**SPHINCTER MECHANISM-** The fibres of the transversus abdominus encircle the deep inguinal ring. Contraction of this muscle obliterates the deep inguinal ring which prevents the occurence of hernia.[37]

**SLIT VALVE MECHANISM-** The two crura of the superficial inguinal ring approximate over another when external oblique fibers are in contraction, thus preventing the formation of hernia.[37]

**BALL VALVE MECHANISM-** The spermatic cord plugs the superficial inguinal ring and prevents the formation of hernia with the assistance of contraction of cremasteric muscle.

Additionally, the obliquity of the inguinal canal itself acts as a defence mechanism against hernia formation[37]

**SHUTTER MECHANISM.**

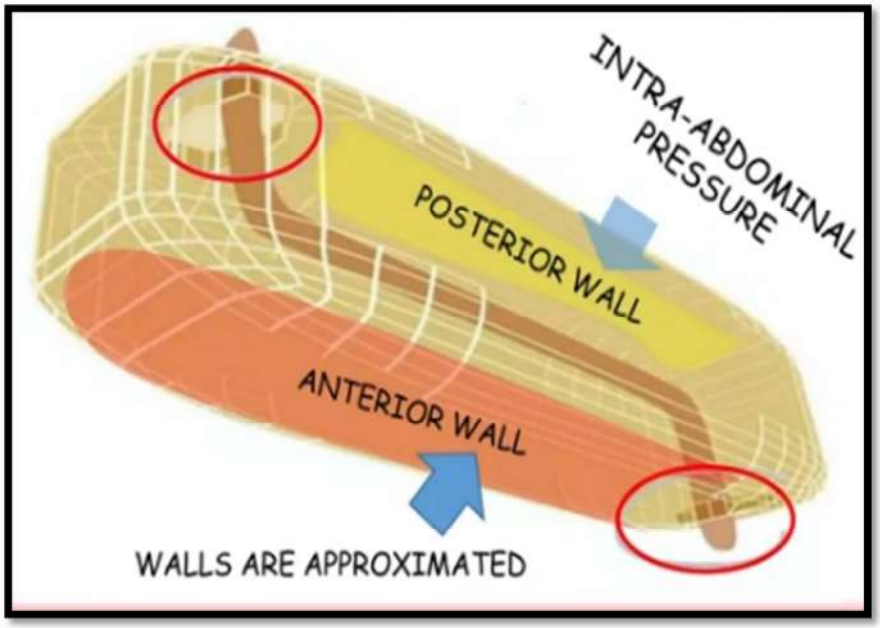


**Figure 7: Shutter mechanism**

**SLIT VALVE MECHANISM.**

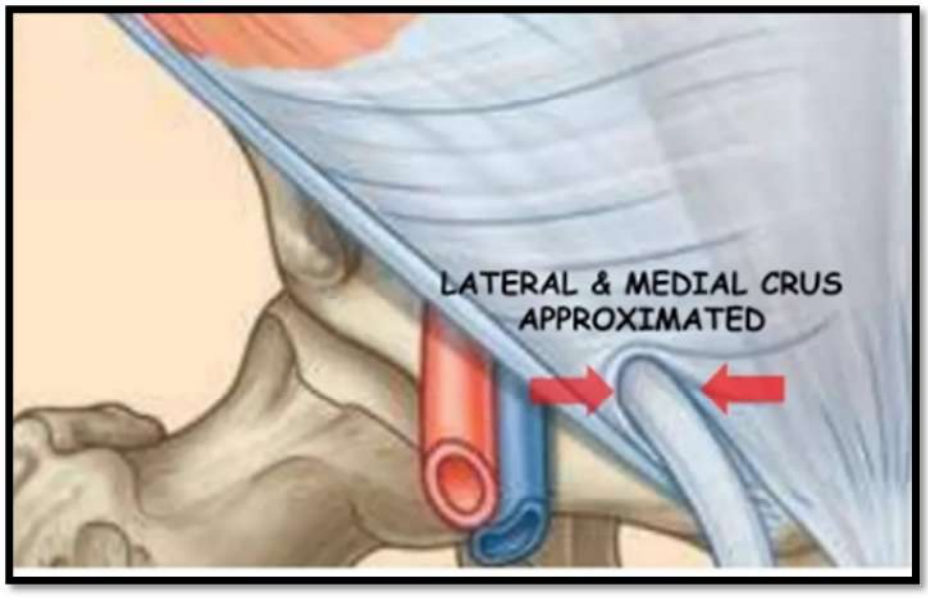


**Figure 8: Slit Valve mechanism**

**BALL VALVE MECHANISM.**

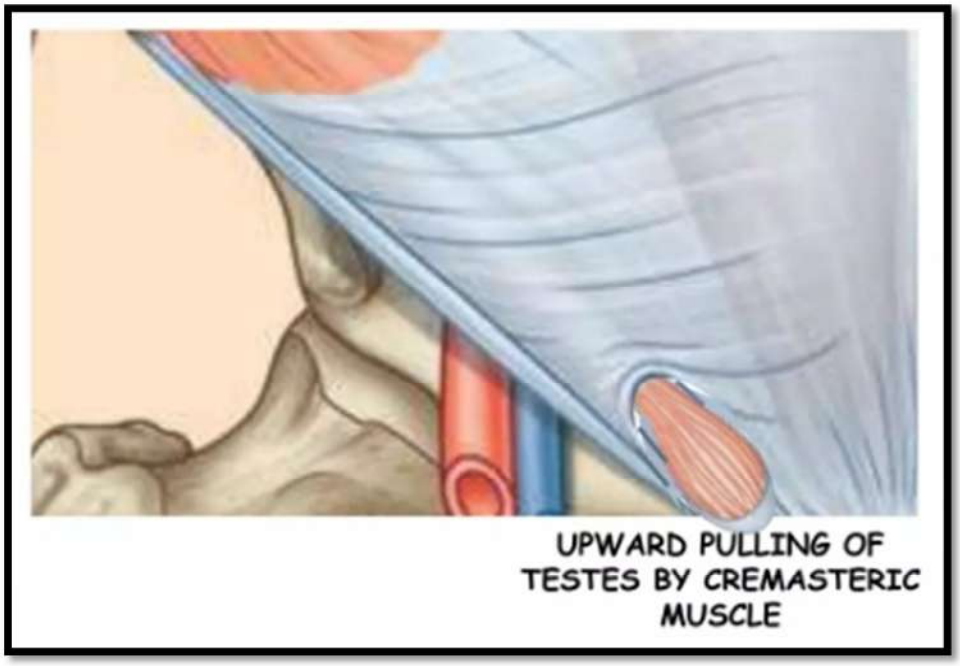


**Figure 9: Ball valve mechanism**

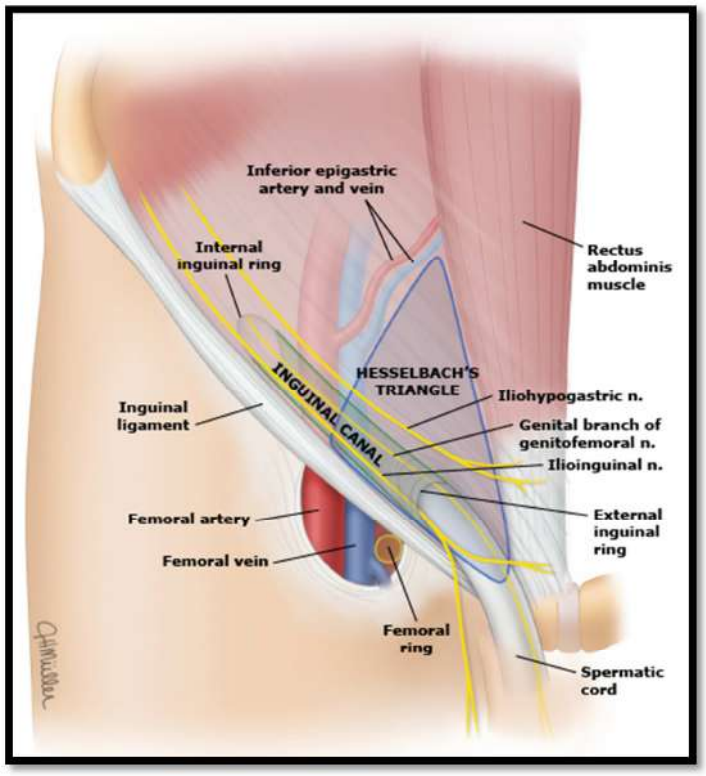


**Figure 10: Inguinal hernia anatomy[38]**

**Boundaries of inguinal canal;**

- Anterior wall is formed by aponeurosis of external oblique.
- Posterior wall by transversalis fascia and the conjoint tendon.
- Floor by superior surface of the inguinal ligament.
- Roof by internal oblique and transversus abdominus.[37]

**Components of an Inguinal hernia[37]**

- The sac: consists of a diverticulum of peritoneum which can be further divided into the body and fundus
- Mouth: between the sac interior and the abdominal cavity
- Neck : narrowest section between the mouth and the body of the hernial sac. It is a common site of obstruction
- Body: lie between the neck and the fundus
- Fundus: blind end

**Structure passing through the canal[37]**

| Male | Female |
|---|---|
| Spermatic cord | Obliterated processus vaginalis |
| Testicular artery | Lymphatics from uterus |
| Vas deference and its artery | Round ligament |
| Cremastric artery | |
| Autonomic nerves | |
| Obliterated remains of processus vaginalis | |
| Pampiniform plexus of veins | |
| Genital branch of genitofemoral nerve | |

Although the ilioinguinal nerve is a component of the inguinal ring, it enters the canal via piercing the internal oblique. muscle, i.e., it enters from the side rather than the rear. It is located in front of the cord and exits the canal via the superficial ring.[37]

**Contents of hernia**

- Enterocele
- Omentocele

**Coverings**

- Extraperitoneal tissue
- Internal spermatic fascia
- Cremastric fascia
- External spermatic fascia
- Skin

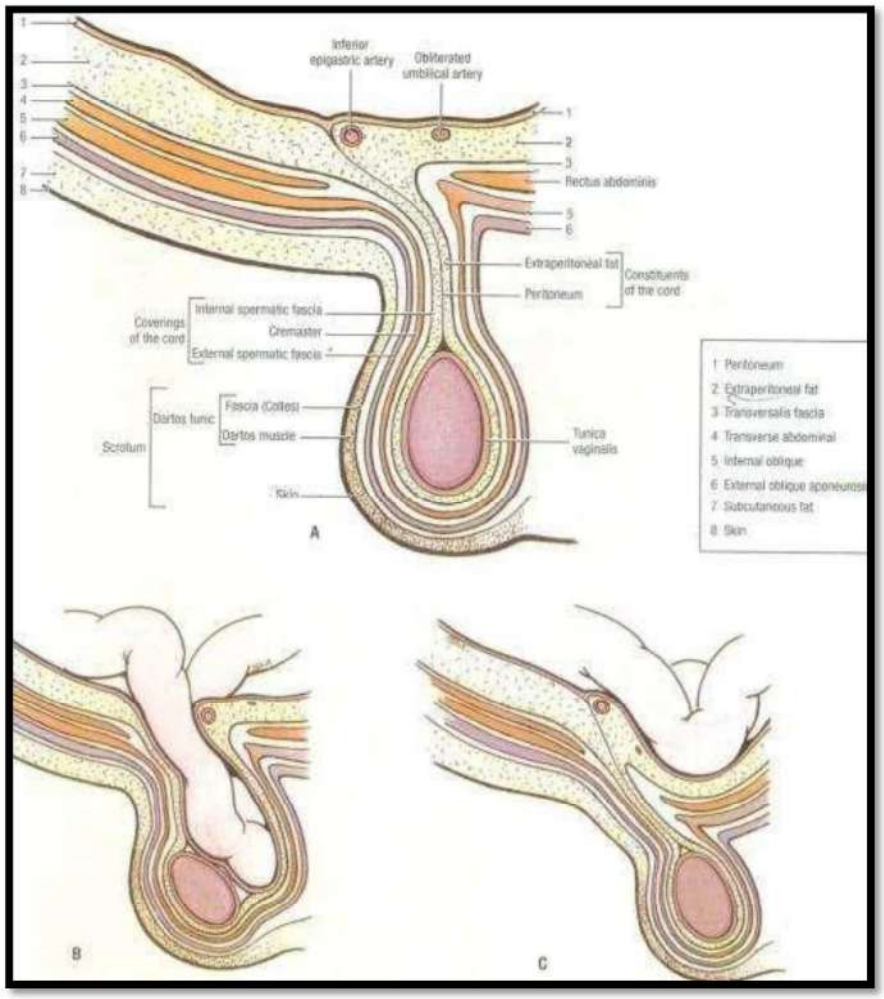


**Figure 11: Covering of inguinal hernia (A), Indirect (B) and Direct (C)[38]**

**Contents of the spermatic cord:** It contains[37]:

- Ductus deferens and its artery
- Testicular artery and veins
- Pampiniform plexus of veins
- Cremasteric artery and nerve
- Artery to vas deferens
- Genital branch of the genitofemoral nerve
- Sympathetic nerve fibres
- Lymphatic vessels

**Pubic Tubercle**

The pubic tubercle, a notable protuberance projecting forward on the upper edge of the superior ramus of the medial side of the pubic bone, serves as a key attachment site for the inguinal ligament. Additionally, a segment of the abdominal external oblique muscle inserts onto this anatomical feature. Adjacent to the pubic tubercle, the inferior epigastric artery traverses the space between it and the anterior superior iliac spine. Complementing the tubercle, the pubic spine extends as a rugged ridge from the pubic tubercle to the upper margin of the pubic symphysis.[40]

Adjacent to the pubic tubercle is the pubic spine, a rough ridge extending from pubic tubercle to the upper border of the pubic symphysis. This spine serves as another anatomical reference point in the pelvic region.

In clinical practice, two important measurements are often taken in relation to the pubic tubercle: the spino-spinous (SS) line and the spino-tubercular (ST) line. The SS line extends from the spinous process of the second lumbar vertebra to the highest point of the iliac crest. The ST line runs from the second lumbar vertebra spinous process to the pubic tubercle.[41]

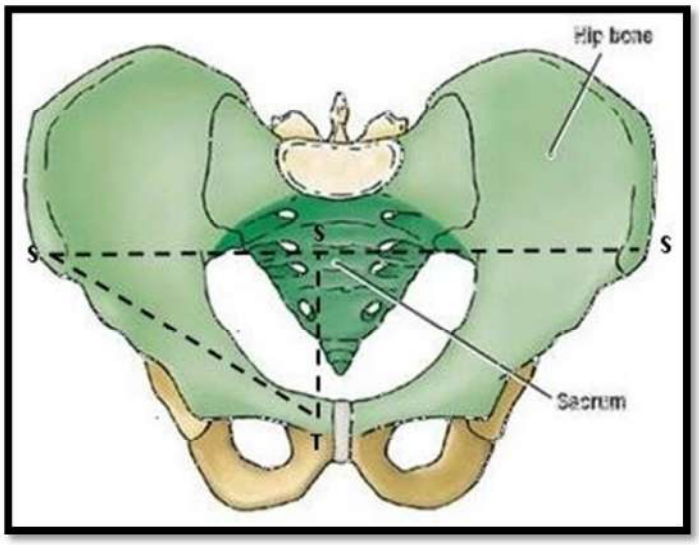


**Figure 12: Graphic illustration for the measurement, SS, interspinal distance. ST, the pubic tubercle height[41]**

These measurements are significant in assessing the relationship between the bony landmarks and the development of inguinal hernia.

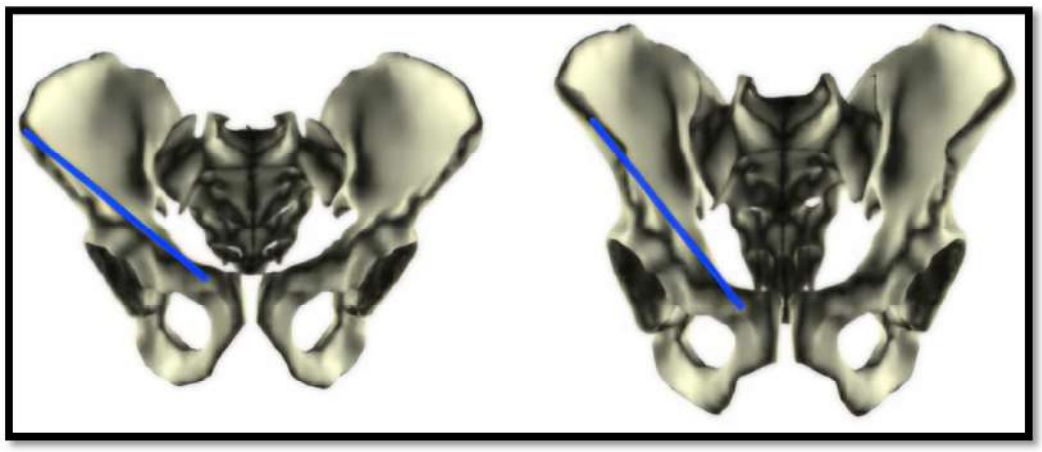

**Figure 13: Showing low lying tubercle**

Studies have shown that a low-lying pubic tubercle, as indicated by a lower/longer SS line measurement, may be associated with an increased risk of inguinal hernia development. Similarly, a higher ST line measurement, indicating a more superiorly positioned pubic tubercle which has also been linked to a higher incidence of inguinal herniae.[41]

The change in posture from prone to upright has caused decrease in the effectiveness of inguinal canal shutter mechanism leading to the development of inguinal hernia. The low pubic arch group shows a substantially longer inguinal ligament and a larger angle made by the superior boundary of the inguinal ligament and supra inguinal space at its medial insertion.[41]

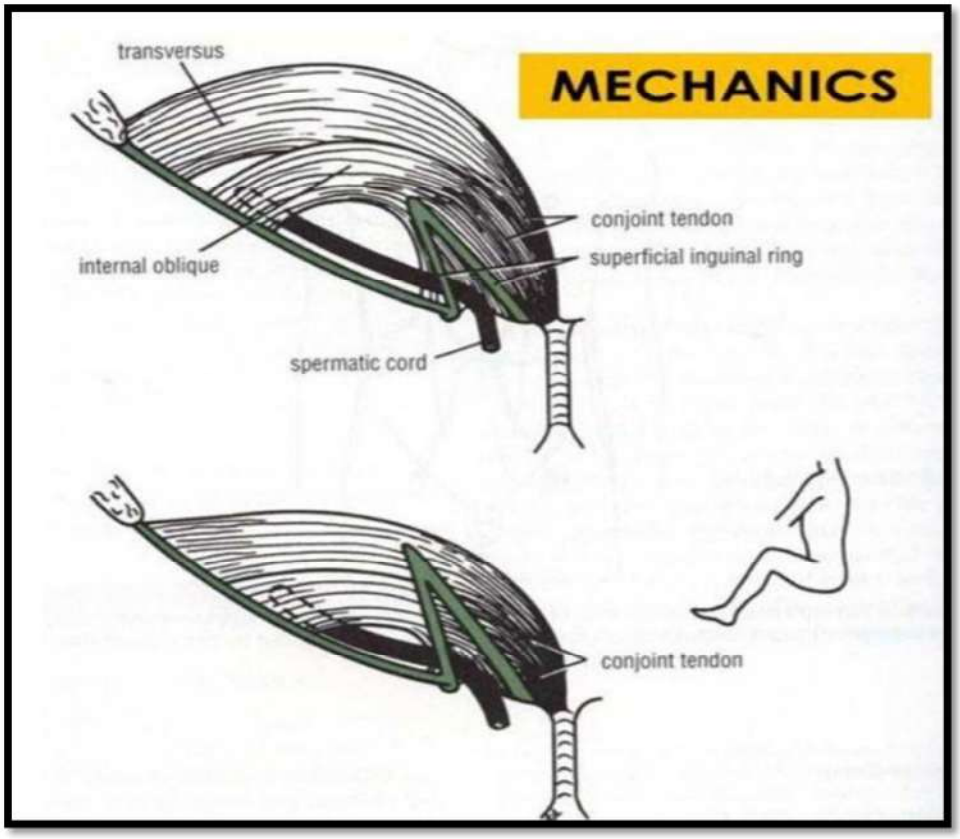


**Figure 14: Mechanics of inguinal canal**

**Low lying tubercle and Risk of Inguinal Hernia**

The downward positioning of the pubic tubercle correlates with a reduced coverage of the deep inguinal ring by the internal oblique muscle, stemming from its narrow origin at the lateral inguinal ligament. This compromised anatomical configuration diminishes the protective barrier around the deep inguinal ring, thereby increasing the susceptibility to inguinal herniation.[42]

"The lower the pubic tubercle, there are more morphological alterations found in the external oblique, internal oblique, transversus, cremasteric muscles and the fascia transversalis. When the internal oblique arching fibres are shortened, they approximate to the inguinal ligament and compress the spermatic cord, creating a shutter like mechanism at the internal inguinal ring. The unusual origin and insertion of internal oblique and transverses abdominus muscle results in an ineffective shutter mechanism of the inguinal canal. The origin of the internal oblique from the inguinal ligament far away from the pubic tubercle and its lower fibers not covering the deep ring has been postulated in the development of indirect inguinal hernia. The various degrees of incompleteness of the defense mechanisms mediated by the internal oblique in the inguinal region leads to an anatomical predisposition to the formation of a direct inguinal hernia.[42]

"Fundamentally, all sites of herniation possess one common feature i.e. a zone of weakness where structures pass from or to the abdominal cavity. In case of inguinal hernia, as the testis descends from the abdominal cavity to the scrotum in male it first passes through a defect called the deep inguinal ring in the transversalis fascia, just deep to abdominal muscles. The transversus abdominus and internal oblique muscles, which make up the innermost two layers of the lateral abdominal wall, arch over the deep inguinal ring from lateral to medial before descending and attaching to the pubic tubercle. The arch is known as the conjoint tendon because these two muscles combine and become tendinous. Below this arch there is no muscle but only transversalis fascia and external oblique aponeurosis resulting in weakness, and the lowness of the pubic tubercle is linked to thin origin of internal oblique muscle from lateral inguinal ligament. This thin and slender origin of internal oblique fails to protect the deep ring and consequently inguinal herniation occurs.[42]

The lower the pubic tubercles are located, the more often morphological alterations are found in the external oblique, internal oblique, transversus, cremastric muscles and fascia transversalis.[42]

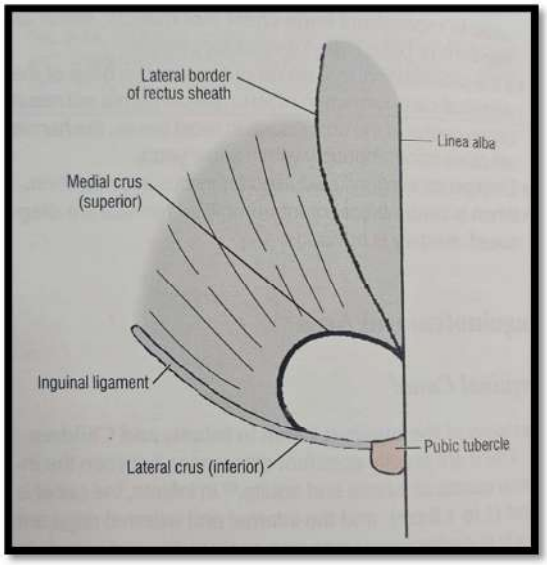


**Figure 15: Showing pubic tubercle and insertions**

"The external ring is a triangular opening of the aponeurosis of external oblique, the base being the pubic crest, margins formed by the crura superior (medial) and inferior (lateral) the superior crura formed by the external oblique aponeurosis itself and the inferior by the inguinal ligament. more specifically the medial crus is attached to the lateral border of the rectus sheath and to the tendon of rectus abdominus muscle in a very peculiar way and the lateral crus is attached to the **pubic tubercle.**[42]""

"So, in the presence of a low lying pubic tubercle the attachment, of the lateral crus of external inguinal ring is lowered and the diameter of the ring increases, increasing the risk for the occurrence of inguinal hernia.[42]""

"The **shutter like mechanism** at the internal inguinal ring is provided by contraction of the arching fibres of the internal oblique muscle, which, when

shortened, approximate themselves to the inguinal ligament and compress the spermatic cord. The unusual origin and insertion of internal oblique and transverses abdominus muscle, results in an **ineffective shutter mechanism** of the inguinal canal.[42]"

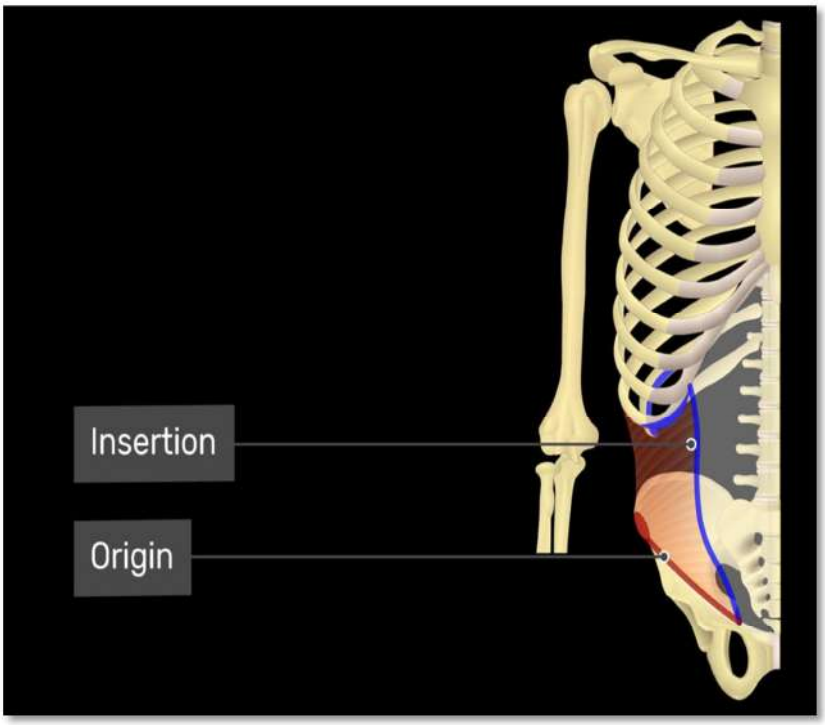


**Figure 16: Showing insertion and origin of internal oblique muscle.**

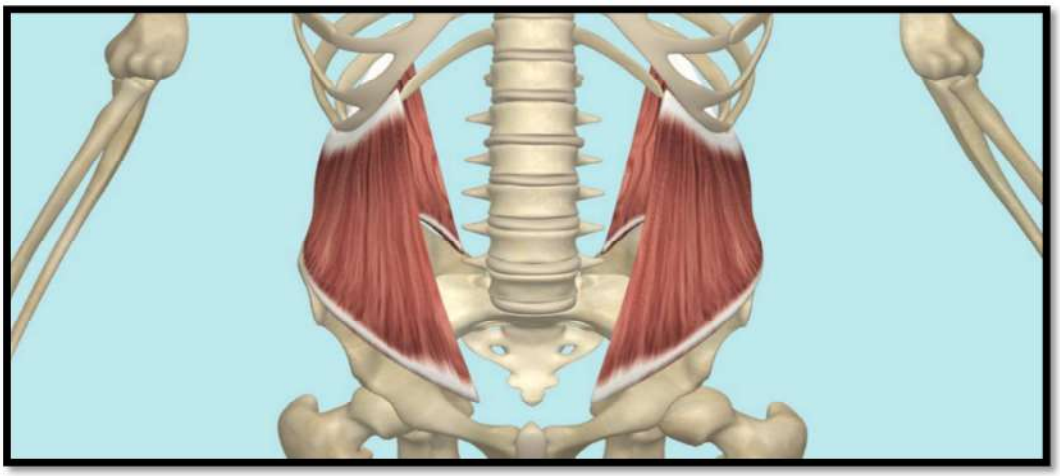

**Figure 17: Showing transversus abdominus muscle**

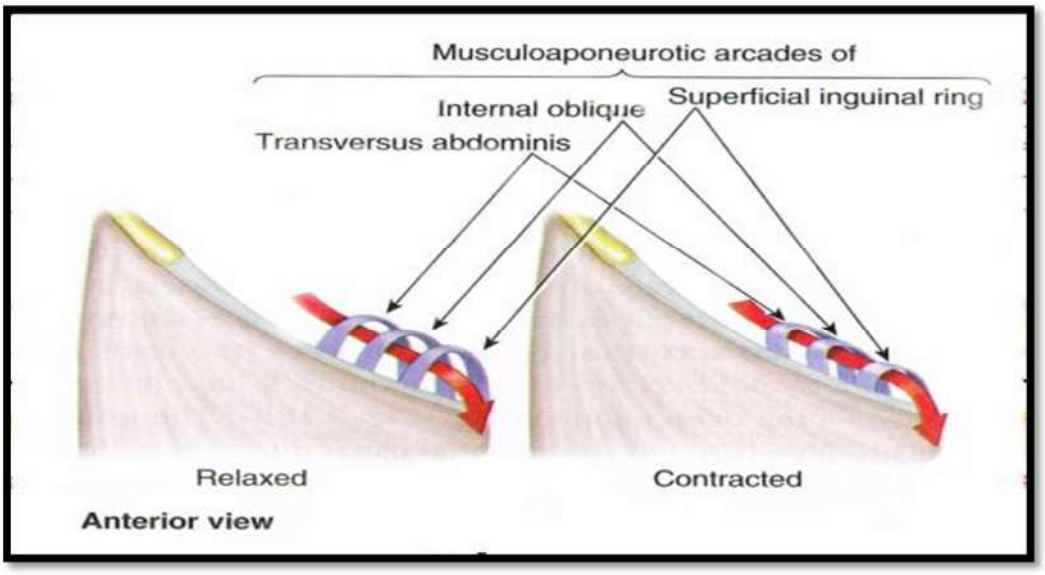


**Figure 18: Showing relaxed and contracted state of transversus abdominus**[42]

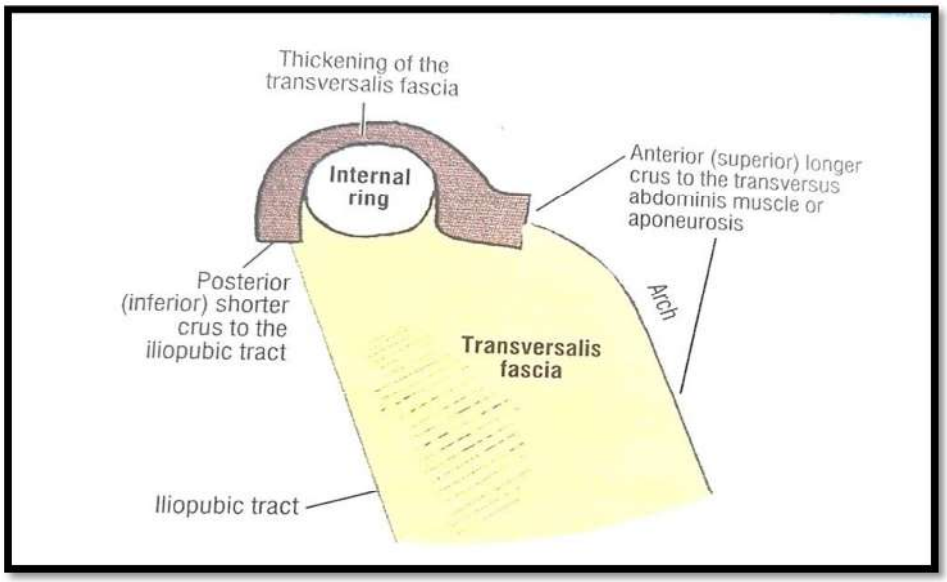


**Figure 19: Showing the internal ring position**[42]

The thickening of the transversalis fascia around the deep ring is normally not seen in patients with a low lying pubic tubercle because of the narrow origin of transversus abdominus muscle and can cause **defective sphincteric mechanism** of inguinal canal which then predisposes to the development of inguinal hernia[42]

**Key mechanism**

Increased length of inguinal canal due to lower pubic tubercle creates a potentially larger space, weakening the natural barrier to prevent herniation and allows the abdominal content to protrude more easily through the canal.[42]

Alteration in inguinal ligament tension, as the ligament may become taut or elongated when the tubercle is lowered causes a change in ligament tension which compromises on the supportive function of the inguinal ligament to the inguinal canal which increases the risk of abdominal content pushing through the weakened areas. [42]

Displacement of the canal structures, as there can be shift in position of the deep and superficial rings due to relative altered anatomy. This can disrupt the alignment and overlapping of fascial layers and muscles which may weaken the natural support of the canal increasing the susceptibility of hernia. [42]

A low lying pubic tubercle also can alter the attachment point and functional dynamics of the conjoint tendon. This alteration can weaken the inguinal canal's posterior wall, at the level of deep inguinal ring which makes easier for the abdominal content to herniate.[42]

The cumulative impact of increased canal length altered ligament tension and displaced anatomical structures directly can contribute for higher propensity of hernia formation. The resultant weakness and mechanical changes facilitate the formation of both direct and indirect inguinal hernia by providing a path of reduced resistance.[42]

**Risk factors for Hernia:**

The various factors contributing to development of inguinal hernia are

- Prior hernia
- Old age
- Male gender
- Race – Caucasian
- Chronic cough
- Abdominal wall injury
- Smoking of cigarette
- Patients with family history

Among the women, it was found that residents of rural areas and those with greater height were independently associated with a higher incidence of acquired inguinal hernia. In patients with lower BMI and height had relative dominance of women with femoral hernia and emergency presentations.[43]

**Role of biochemical mediators, collagen and extra cellular matrix in hernia formation[44]**

Despite multiple risk factors, including architectural traits and those related with other disorders (vomiting, obesity, coughing, COPD, and constipation), the fundamental cause of the various forms of herniae is biological in origin. As a result of its fundamental role in the connection of abdominal organs, recent study has focused on connective tissue abnormalities in the process of hernia formation.[45]

Collagen, the primary biomechanical strength component of connective tissue, is known to give strength and operate as a scaffold in the forms of type I, II, and III. Kind I collagen is a mature type that develops thick collagen fibrils and has more mechanical strength than thinner type III collagen fibrils. The existence of intermolecular and intramolecular covalent connections formed by the hydroxylation and glycosylation of lysine and hydroxylysine, respectively, accounts for the bulk strength of type I collagen.[46]

"As a result, the quantity and ratio of Type I/III collagen production and deposition have a considerable impact on connective tissue quality. Collagen fibres expand in diameter during remodeling and maturation when the ratio of Types I and III collagen changes. A change in the Type I/III collagen ratio reduces tensile strength and mechanical stability. Since collagen subtype changes play a vital role in the pathogenesis of herniae, they have become a significant component for inquiry in the hunt for hernia origin.[47-49]

MMPs are proteins that belong to a family of at least 15 zinc (Zn)-dependent endopeptidases that have extracellular activities. MMP-1 and MMP-13 are the primary matrix enzymes in charge of fibrillar type I, II, and III collagen turnover. As a result, variations in MMP-1 and MMP-13 protein expression might have caused changes in the protein-level ratio of type I to type III collagen. Overexpression of MMP and immature collagen isoforms have been found in hernia patients,[50] as well as in individuals with inguinal and incisional herniae.[51,52]

**Anatomical location:** Inguinal herniae are classified according to the anatomic location of the abdominal wall defect. There are several classification schemes for Inguinal hernia, but for convenience and simplified as the direct and indirect inguinal hernia.[53]

- Indirect hernia
- Direct hernia

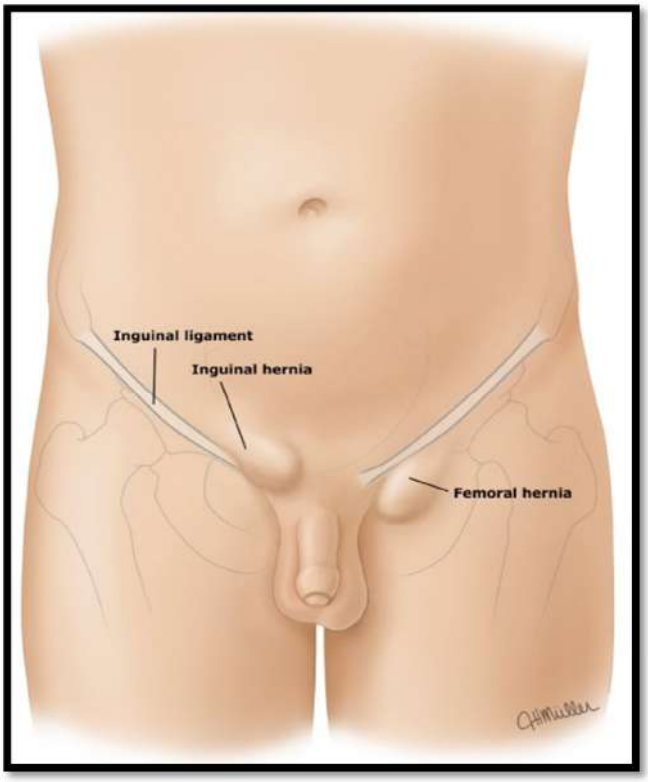


**Figure 20: Inguinal Hernia[38]**

**Indirect inguinal hernia:**

"Indirect inguinal hernia is seen as protrude at the internal inguinal ring which is the site where the spermatic cord in males and the round ligament in females exits the abdomen. The sac originate just lateral to the inferior epigastric artery. This can develop more frequently on the right side in both the gender due to the later descent of the right testicle in males during the infant period.[53]

Most of the indirect inguinal hernia is found to be congenital type, even though they may not be seen clinically in neonatal period or the during the childhood. The shutter mechanism is postulated to close the internal ring to a slit, which may be dysfunction in patients with patent processus vaginalis. Elevated pressure intra-

abdominal cavity with reduction in the muscle tone or the connective tissue disorder can lead to the abdominal content to push and through the widened internal ring into the inguinal can resulting in the detectable inguinal hernia in patients." [54-56]

**Direct Inguinal Hernia: [53]**

This type of hernia protrude medial to inferior epigastric vessels within the Hesselbach's triangle, which is formed by inguinal ligament which is also known as Poupart's ligament, which lies inferiorly and inferior epigastric vessels laterally and rectus sheath medially.

Direct inguinal hernia occur as result of weakness in the floor of the inguinal canal. This weakness appears to be due to connective tissue abnormalities. This can be due to chronic overstretching or the injury to the abdominal musculature.

**Clinical features:**

Inguinal hernia can occur at any age. Peak presentation times is during initial few months of life, late teens, early twenties, and between the ages of 40 and 60. In young people, indirect herniae are more common than direct herniae.

Occupation: Heavy employment, particularly lifting, places a significant load on the abdominal muscles. The emergence of a hernia may correlate with strong physical exertion or patent processus vaginalis if there is underlying weakness.[58]

A common symptom associated with hernia is a heaviness or dull discomfort in the Inguinal, which may or may not be associated with a visible bulge. Inguinal hernia in women can also result in vague pelvic discomfort. Moderate-to-severe pain in hernia is unusual and, when present, should raise the possibility of incarceration or strangulation.

When intra-abdominal pressure is raised- as it is during heavy weight lifting, straining or extended standing- inguinal discomfort is at its worst. The discomfort is caused by very little pressure and goes away when the patient stops straining or lies down. Constriction of the hernia content (such as fat or bowel) at the neck of the hernia sac is the cause of this pain. Typically, discomfort is more prominent at the end of the day or after prolonged standing. Therefore, patients is manual or physically demanding professions will experience discomfort more often than those in sedentary occupations. Stretching of the ilioinguinal nerve can also cause discomfort while standing or straining, this pain is usually characterised as a radiating "twinge" that quickly goes away when the stretch is released .[57-59]

**Physical examination & Diagnosis:**

The symptoms of patients varies with the type, size, duration and presence or absence of complications.[60]

**Symptoms:[60]**

- Swelling in inguino-scrotal region
- Pain

**Sign:**

- A globular or pyriform swelling with an expansile cough impulse, which generally reducible almost diagnostic of hernia.
- Direct hernia arises from posterior wall of inguinal canal while indirect hernia arise from the deep ring.[60]

| | **Indirect hernia** | **Direct hernia** |
|---|---|---|
| Age | Occurs earlier in life | Older age group |
| Gender | Not uncommon in female | Rare in female |
| Occupation | No relation | Common with strenuous work |
| Bilateral | Rare | Common |
| Shape | Usually pyriform | Globular usually |
| Extent | Complete or incomplete | Incomplete usually |
| Occurance | Deep ring | Through Hesselbach's triangle |
| Reducibility | More difficult to reduce | Reduce spontaneously |
| Direction of reduction | Upwards, laterally and backwards | Upwards and backwards |
| Finger invagination | Cough impulse at tip of finger | Cough impulse on pulp |
| Deep ring occlusion | No bulge | Bulge present |
| Irreducibility | Common | Less common |

**Differentiating from the femoral hernia:**

Distinguishing inguinal from femoral hernia can be complicated, especially in obese people, which has therapeutic consequences because the site of the hernia impacts the path to treatment. For an inguinal hernia that shows no symptoms or very little symptoms, watchful waiting may be an option; however, because of the significant risk of complications, it is not advised for femoral hernia.

CT of the Inguinal region can help differentiate femoral from inguinal hernia. Sufficiently thin slices using multi-detector CT may allow localization of the hernia sac.

**Figure 21: Bilateral Inguinal Herniae on CT scan**

The CT scan of the pelvis through the femoral heads show bilateral fat containing inguinal herniae (arrows) extending medial to the pubic tubercle (arrowheads) and associated with non-compressed femoral veins (dashed arrows).

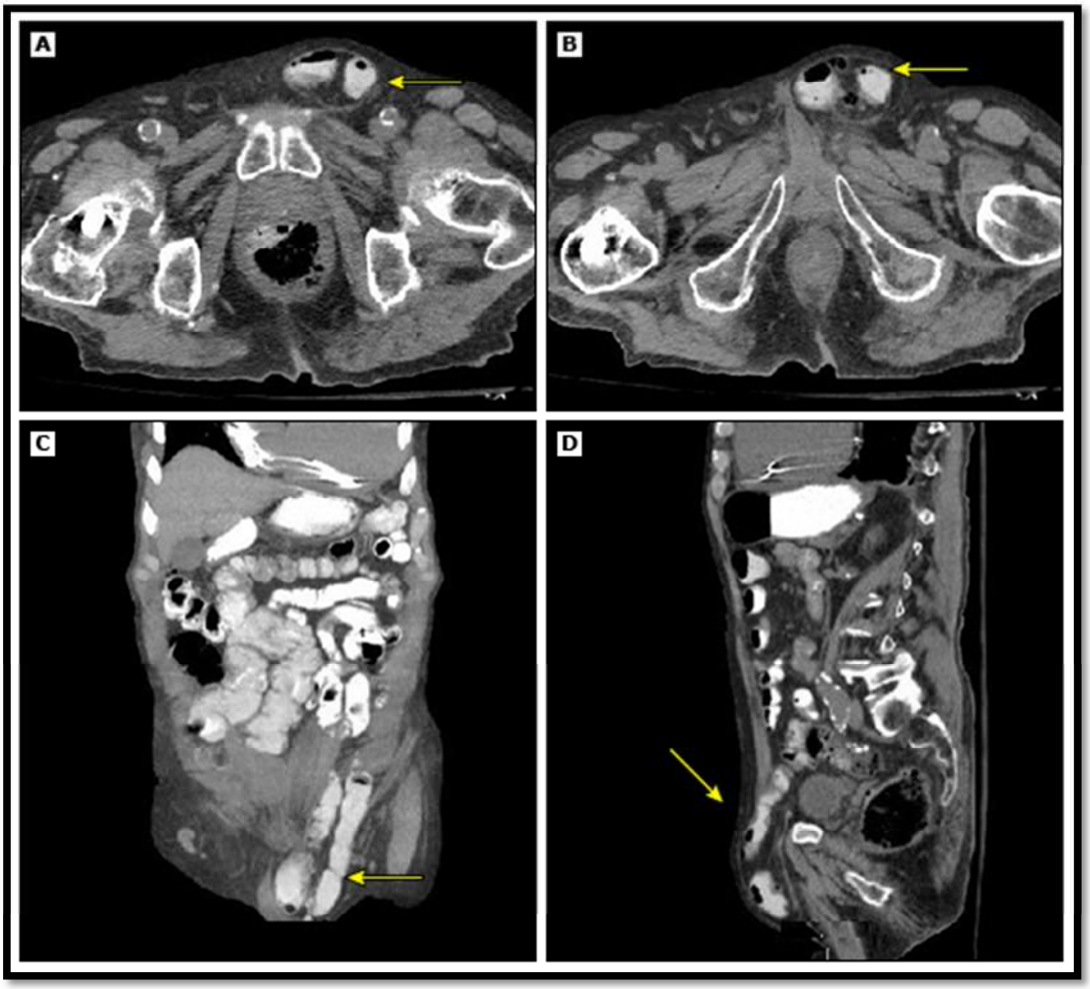


**Figure 22: Left inguinal hernia-non-obstructing on CT and position of pubic tubercle**

"The axial CT images of the lower pelvis (A, B) reveal a left-sided inguinal mass containing contrast-filled small bowel (arrow), which is consistent with an inguinal hernia. A coronal reconstruction (C) and sagittal reconstruction (C) demonstrate non dilated small bowel within the hernia sac (arrows).

MRI tends to distinguish inguinal from femoral hernia with a sensitivity and accuracy of more than 95%, which is better than CT.[64] However, costs and lack of uniform availability hinder the practicality of the MRI."

# MATERIALS & METHODS

**Source of Data:** patients with inguinal hernia admitted in general surgery wards at KAHER'S Dr. Prabhakar Kore Charitable Hospital and Medical Research Centre, Nehru Nagar, Belagavi and KLES Dr. Prabhakar Kore Hospital and Medical Research Centre.

**Study Design:** Case control study between cases (who get admitted with inguinal hernia) and controls (the people who are matched and have inguinal hernia)

**Study Period:** 1 year -September 2022 to August 2023.

**Sample Size: 82**

**Sample size formula:**

The formula used for sample size calculation is $n = \frac{2\left(Z_{\alpha/2}+Z_{\beta}\right)^2}{d^2}$

$$where, d = \left(\frac{|\mu_1 - \mu_2|}{\sigma}\right)$$

where, $\mu_1$ is mean of the first group, $\mu_2$ is mean of the second group, $\sigma^2$ is the common error variance, $Z_{\alpha/2}$ value is 1.96 for 95% confidence level and $Z_{\beta}$ value is 1.0364 for 85% power.

The mean value of ST line was 8.2 ± 1.22 and 7.6 ± 0.33 in cases and controls respectively. Considering similar result in our study, at 5% level of significance and 85% power, the minimum sample size is obtained to be 41 subjects for each group. Total sample size required is 41 x 2 = 82 subjects.

As sample size increases, the accuracy increases.

**Reference:** Farook, S. M. U., Pai, R. D., Kumar, T. L., & Prabhu. (2020). Association of Low-lying Pubic Tubercle in Patients with Inguinal Hernia. Indian Journal of Surgery, 83(5), 1198–1202. [66]

**Sampling design:** case control study

**Sampling technique:** consecutive sampling

**Inclusion Criteria:**

- Any case of uncomplicated inguinal hernia above 18 years.
- All the normal individuals without any hernia as controls

**Exclusion Criteria:**

- Hernia due to BPH/Abdominal Mass/ Post traumatic.
- Hernia associated with Hydrocele/ Undescended testes/ Irreducible/ Strangulated/ Obstruction
- Patients less than 18 years of age.
- History of Pelvic fracture/ Anomaly/ Hip Surgery

**Study protocol:**

**Data collection procedure:** Patients with inguinal hernia after taking written and informed consent, with same number of age, gender and BMI matched individuals taken as controls were studied. The anthropometric measurements of pelvis like SS (spino spinous line) line, ST (spino tubercular) line were measured, The various parameters will be measured such as SS line (distance between each anterior superior iliac spine), ST line (vertical distance between the pubic tubercle of affected side) and the SS line (SS/ST, height, weight, BMI, height/ST, weight/ST).The data collected were entered into Microsoft office excel. An attempt was made to find any relationship between ST Line and SS Line measurement and height, weight, BMI, age and side of hernia of the patient.

**STATISTICAL ANALYSIS**

The data collected was entered into Microsoft Excel operating on windows 10.0. The quantitative variables were summarized as mean and standard deviation while qualitative variables as percentage and proportion. To the statistical significance between the two independent groups, Student's test while in more than two groups, and correlation between continuous data was analysed using Pearson's correlation. Applicability of spino tubercular line in predicting Inguinal hernia is checked by Logistic regression and Receiver Operating Characteristic (ROC) curves. Cut off values are obtained by simultaneously maximizing sensitivity and specificity. The difference was considered significant when p value was less than 0.05. The statistical package used was SPSS v23.0.

Data will be analyzed using statistical software R version 4.2.0 and Microsoft Excel. Frequency tables will used to represent categorical variables. Continuous variables will be represented by Mean ± SD / Median (Min, Max) form. Chi-Square test will used to check the association between categorical v ariables. Normality of variable is checked by Shapiro Wilk test and QQ plot. Two sample t test/Mann Whitney U test can be used to compare means/distributions of variables between the groups. P-value less than or equal to 0.05 indicates statistical significance.

# RESULTS

In present study total of 82 patients included, with mean age of 49.87±16.5yrs.

**Table 1: Showing mean age of patients**

| | N | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|---|
| Age | 82 | 21.0 | 79.0 | 49.878 | 16.5592 |

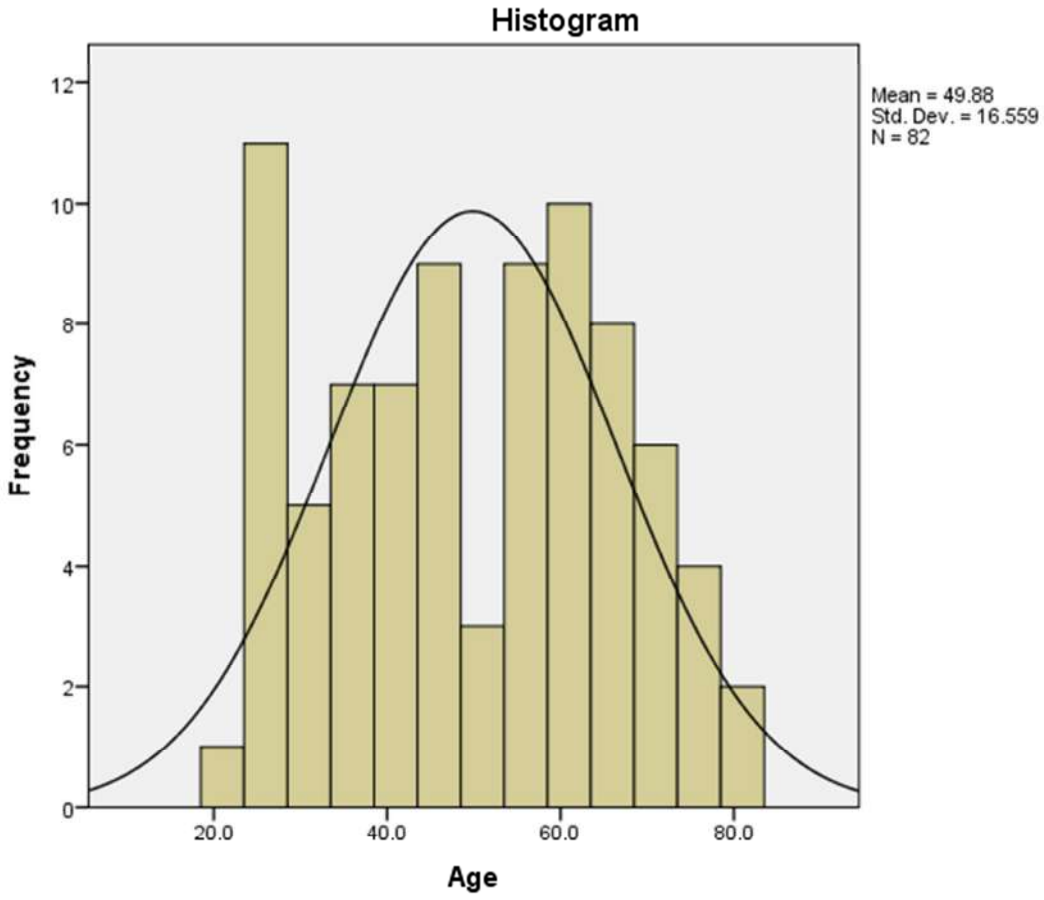


**Figure 23: Showing mean age of patients**

**Table 2: Mean age comparison between the groups**

| | Case | | Control | | P-value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Age | 48.7 | 15.9 | 51.1 | 17.3 | 0.66 |

On comparison of the mean age between the groups, there is comparable mean with no significant difference noted.

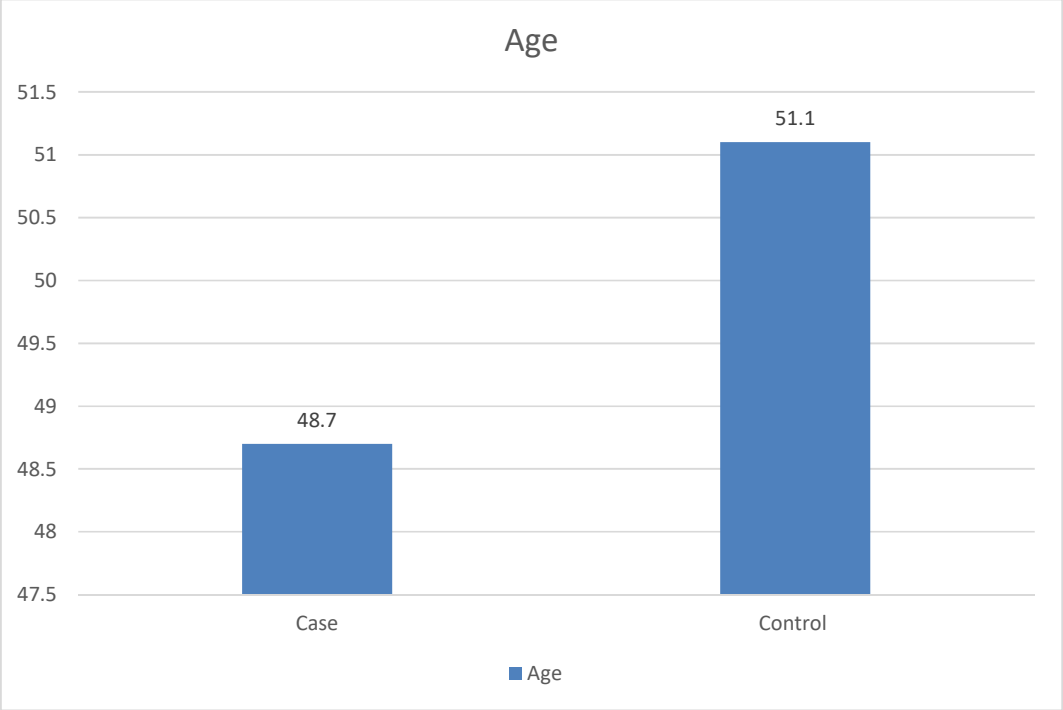


**Figure 24: Mean age comparison between the groups**

**Table 3: Comparison of occupation between the groups**

| | | Case | | Control | | p-value |
|---|---|---|---|---|---|---|
| | | Count | Column N % | Count | Column N % | |
| Occupation | Auto Driver | 1 | 2.4% | 1 | 2.4% | 0.695 |
| | Business | 9 | 22.0% | 6 | 14.6% | |
| | Carpenter | 0 | 0.0% | 2 | 4.9% | |
| | Cloth Vender | 1 | 2.4% | 0 | 0.0% | |
| | Daily Labour | 1 | 2.4% | 2 | 4.9% | |
| | Electrician | 1 | 2.4% | 1 | 2.4% | |
| | Ex Military | 0 | 0.0% | 4 | 9.8% | |
| | Factory Worker | 3 | 7.3% | 1 | 2.4% | |
| | Farmer | 11 | 26.8% | 14 | 34.1% | |
| | Fruit Vendor | 0 | 0.0% | 1 | 2.4% | |
| | House Keeper | 1 | 2.4% | 1 | 2.4% | |
| | Manual Labor | 1 | 2.4% | 0 | 0.0% | |
| | Mechanic | 1 | 2.4% | 2 | 4.9% | |
| | Plumber | 0 | 0.0% | 2 | 4.9% | |
| | Private Employee | 1 | 2.4% | 0 | 0.0% | |
| | Security | 1 | 2.4% | 0 | 0.0% | |
| | Student | 3 | 7.3% | 4 | 9.8% | |
| | Teacher | 1 | 2.4% | 0 | 0.0% | |
| | Unemployed | 3 | 7.3% | 0 | 0.0% | |
| | Watchman | 2 | 4.9% | 0 | 0.0% | |

On comparison of occupation, there is no significant difference in the type of occupation between the groups.

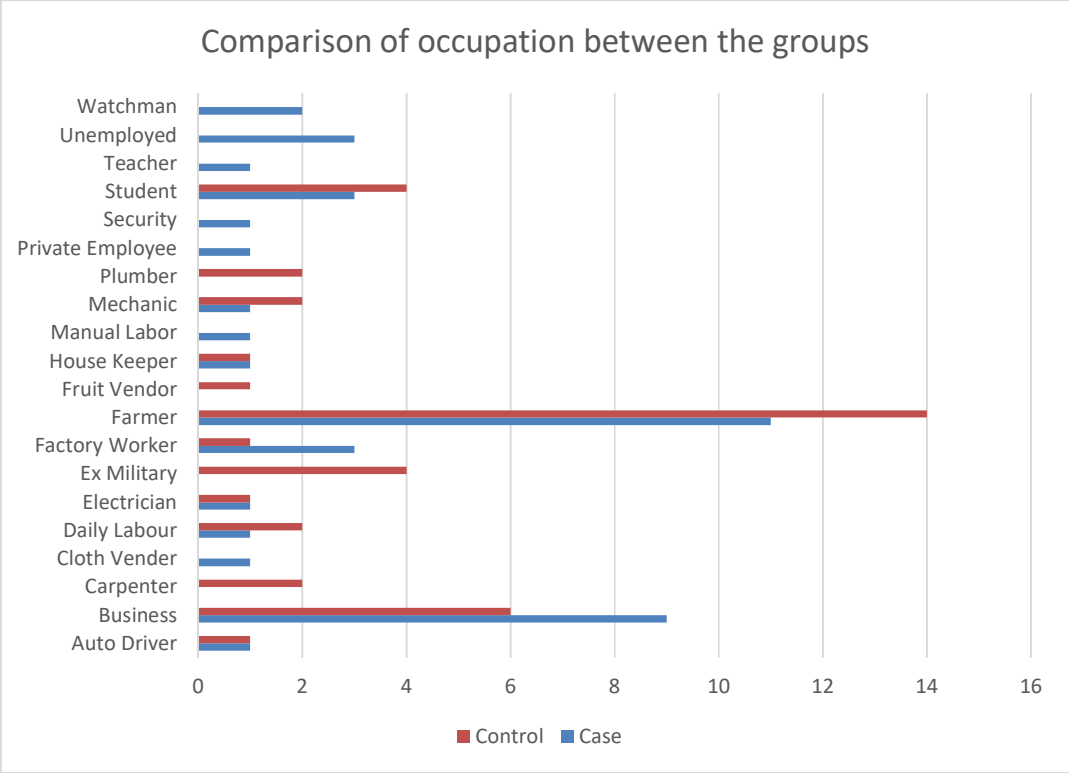


**Figure 25: Comparison of occupation between the groups**

**Table 4: Comparison of comorbidities and habits between the groups**

| | | Case | | Control | | p-value |
|---|---|---|---|---|---|---|
| | | Count | Column N % | Count | Column N % | |
| H/O DM | Absent | 21 | 51.2% | 21 | 51.2% | 1.00 |
| | Present | 20 | 48.8% | 20 | 48.8% | |
| H/O HTN | Absent | 25 | 61.0% | 19 | 46.3% | 0.184 |
| | Present | 16 | 39.0% | 22 | 53.7% | |
| Alcoholic | Absent | 21 | 51.2% | 18 | 43.9% | 0.507 |
| | Present | 20 | 48.8% | 23 | 56.1% | |
| Smoker | Absent | 24 | 58.5% | 22 | 53.7% | 0.656 |
| | Present | 17 | 41.5% | 19 | 46.3% | |

On assessment of comorbid conditions, there is comparable distribution of patients with diabetes mellitus, hypertension, habits such as smoking and alcohol consumption between the groups.

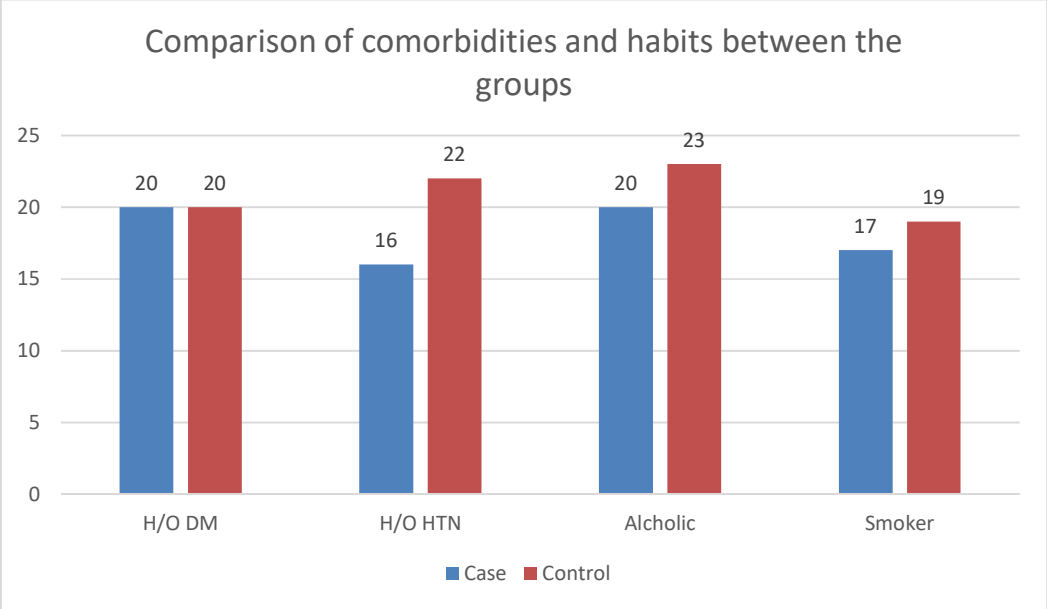


**Figure 26: Comparison of comorbidities and habits between the groups**

**Table 5: Comparison of height and weight between the groups**

| | Case | | Control | | p-value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Height in cms | 180.8 | 2.2 | 178.8 | 2.2 | 0.96 |
| Weight in kg | 80.4 | 8.2 | 80.2 | 8.5 | 0.97 |

By physical characters, patients in both the group were comparable with mean height and weight.

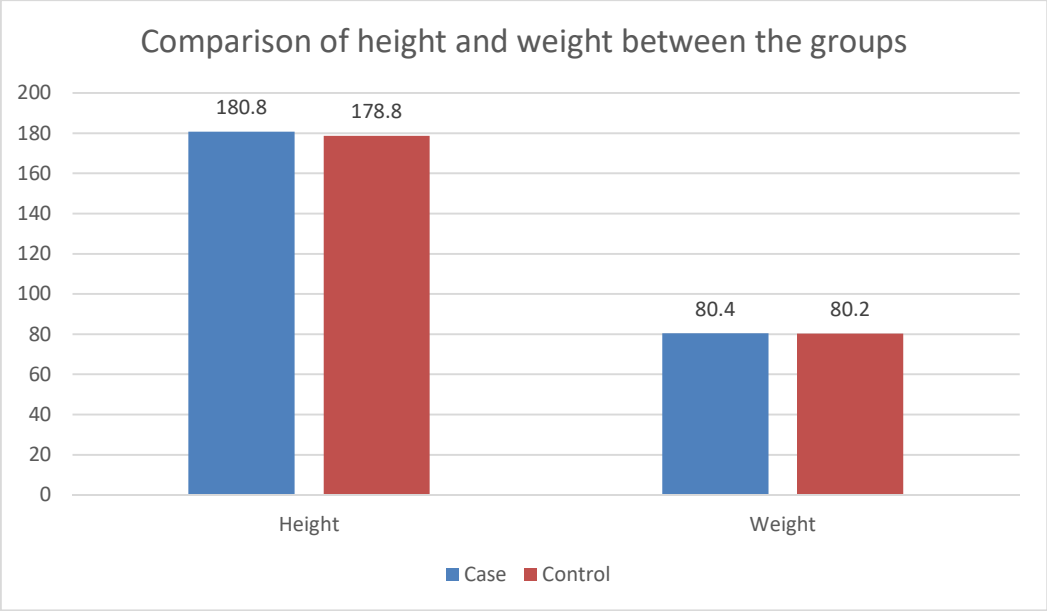


**Figure 27: Comparison of height and weight between the groups**

**Table 6: Comparison of the presenting complaints between the groups**

| | | Case | | Control | | p-value |
|---|---|---|---|---|---|---|
| | | Count | N % | Count | N % | |
| Complain of swelling | Present | 41 | 100.0% | 41 | 100.0% | - |
| Complain of pain | Absent | 24 | 58.5% | 30 | 73.2% | 0.162 |
| | Present | 17 | 41.5% | 11 | 26.8% | |
| Impulse of coughing | Present | 41 | 100.0% | 41 | 100.0% | - |
| Hernia Type | Direct | 12 | 29.3% | 18 | 43.9% | 0.169 |
| | Indirect | 29 | 70.7% | 23 | 56.1% | |
| Vomiting Nausea | Absent | 33 | 80.5% | 34 | 82.9% | 0.775 |
| | Present | 8 | 19.5% | 7 | 17.1% | |
| Constipation | Absent | 11 | 26.8% | 16 | 39.0% | 0.240 |
| | Present | 30 | 73.2% | 25 | 61.0% | |
| Complicated Inguinal hernia | No | 41 | 100.0% | 41 | 100.0% | - |

On assessment of the complaints there was no significant difference with respect to complaints of presence of swelling, pain, type of hernia, impulse on coughing, vomiting and nausea and constipation, between the groups.

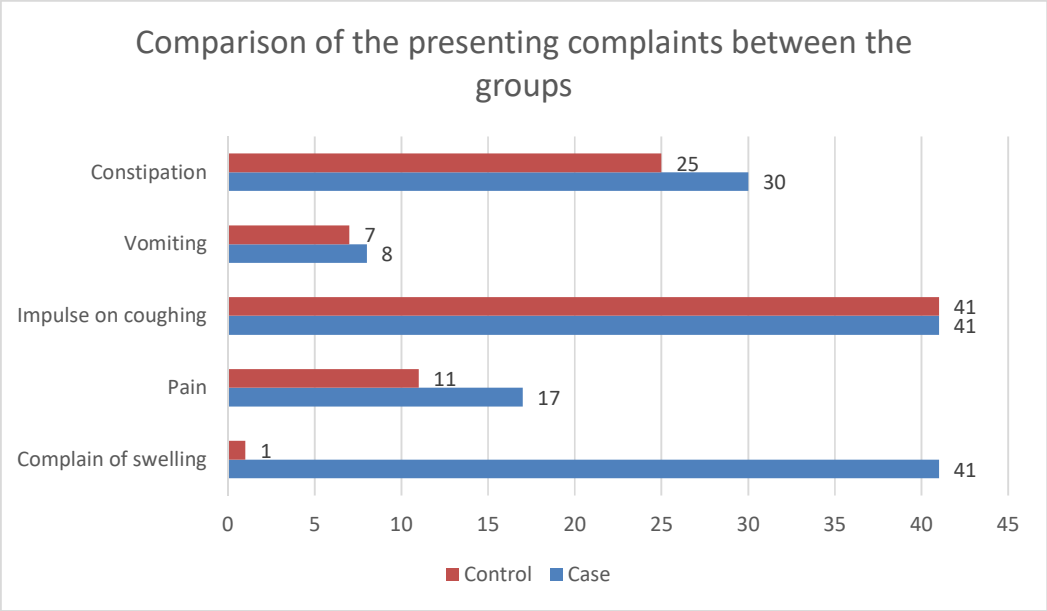


**Figure 28: Comparison of the presenting complaints between the groups**

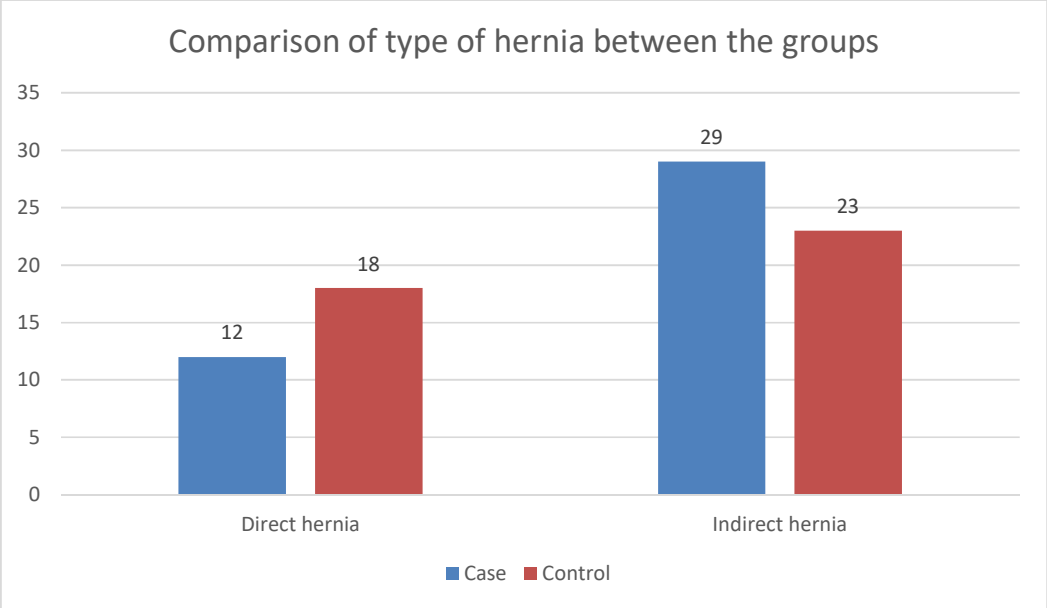


**Figure 29: Comparison of type of hernia between the groups**

**Table 7: Comparison of examination findings between the groups**

| | | Case | | Control | | p-value |
|---|---|---|---|---|---|---|
| | | Count | N % | Count | N % | |
| Ring finger | Absent | 41 | 100.0% | 41 | 100.0% | - |
| Middle finger | Absent | 29 | 70.7% | 23 | 56.1% | 0.169 |
| | Present | 12 | 29.3% | 18 | 43.9% | |
| Index finger | Absent | 12 | 29.3% | 14 | 34.1% | 0.635 |
| | Present | 29 | 70.7% | 27 | 65.9% | |
| Reducibility | Present | 41 | 100.0% | 41 | 100.0% | - |
| Ring occlusion test | No | 29 | 70.7% | 23 | 56.1% | 0.169 |
| | Yes | 12 | 29.3% | 18 | 43.9% | |
| Content | Bowel | 7 | 17.1% | 6 | 14.6% | 0.762 |
| | Omentum | 34 | 82.9% | 35 | 85.4% | |
| Type of procedure | Lap | 1 | 2.4% | 1 | 2.4% | - |
| | Open | 40 | 97.6% | 40 | 97.6% | |

On assessment of the ring finger test, middle finger test, index finger test, reducibility of the hernia, ring occlusion test and content of hernia, all these were comparable between the selected groups.

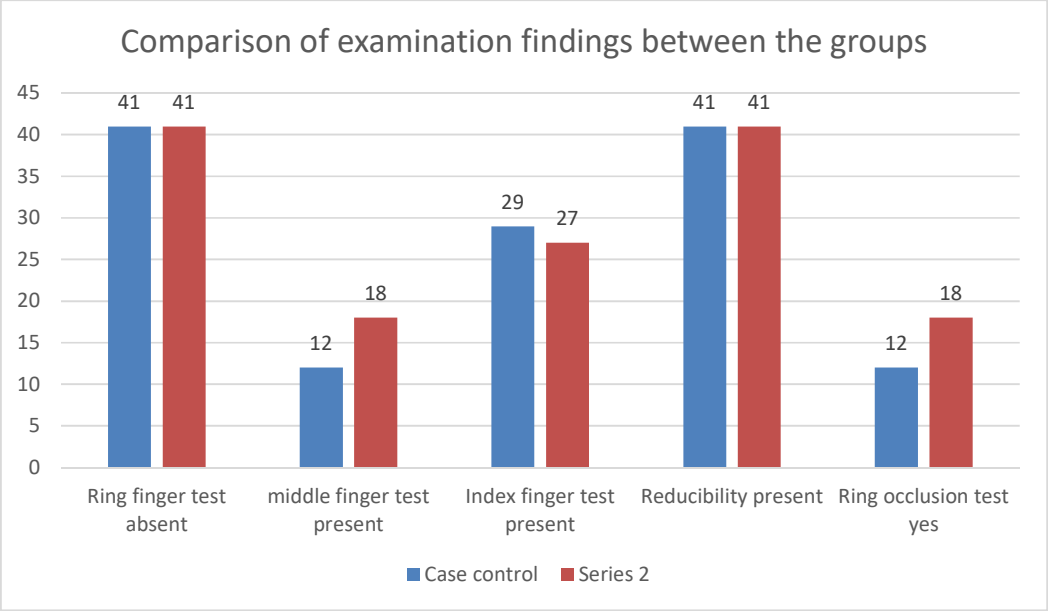


**Figure 30: Comparison of examination findings between the groups**

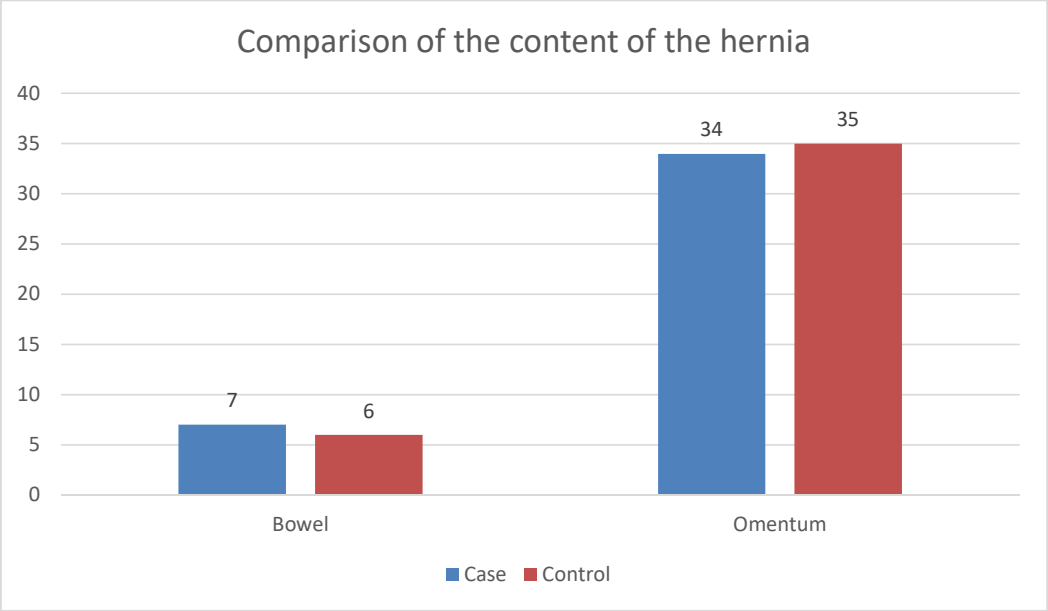


**Figure 31:- Comparison of the content of the hernia**

**Table 8: Comparison of mean SS and ST line between the groups**

| | Case | | Control | | p-value |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Measurements Spino-spinous line | 26.3 | .4 | 23.22 | 0.61 | 0.01* |
| Spino Tubercular line | 9.51 | 0.62 | 7.65 | 0.23 | 0.01* |

On comparison of the measurements, there is significant lower mean level of spino-spinous line (SS line) in cases (26.3±0.4) as compared to controls (23.22±0.61). ($p<0.05$) Similarly, the mean level of spino-tubercular line (ST line) was significantly higher in cases (9.51±0.62) as compared to controls (7.65±0.23).($p<0.05$)

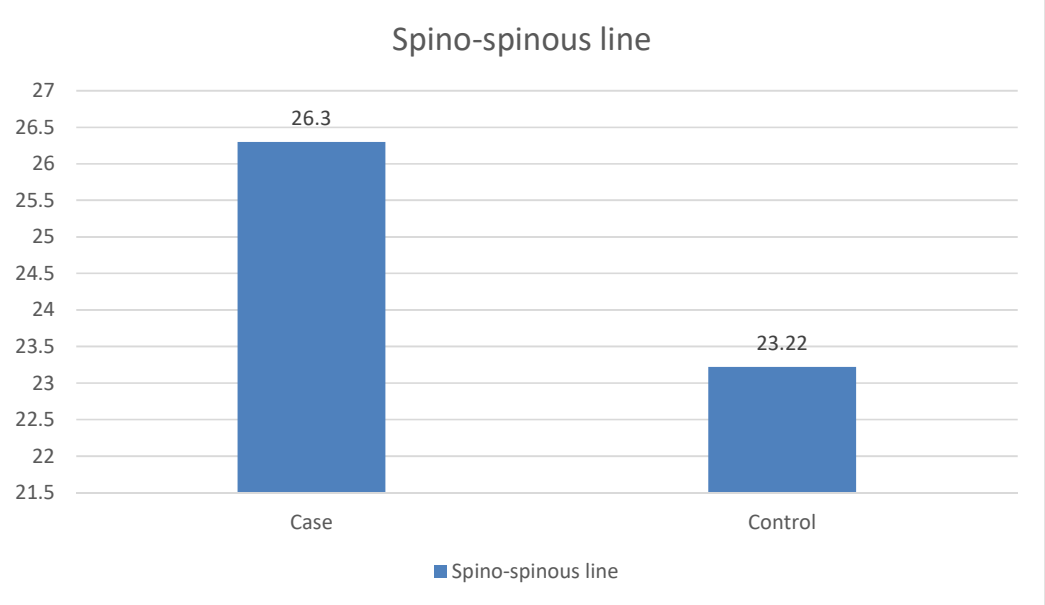


**Figure 32 :-Comparison of mean SS line between the groups**

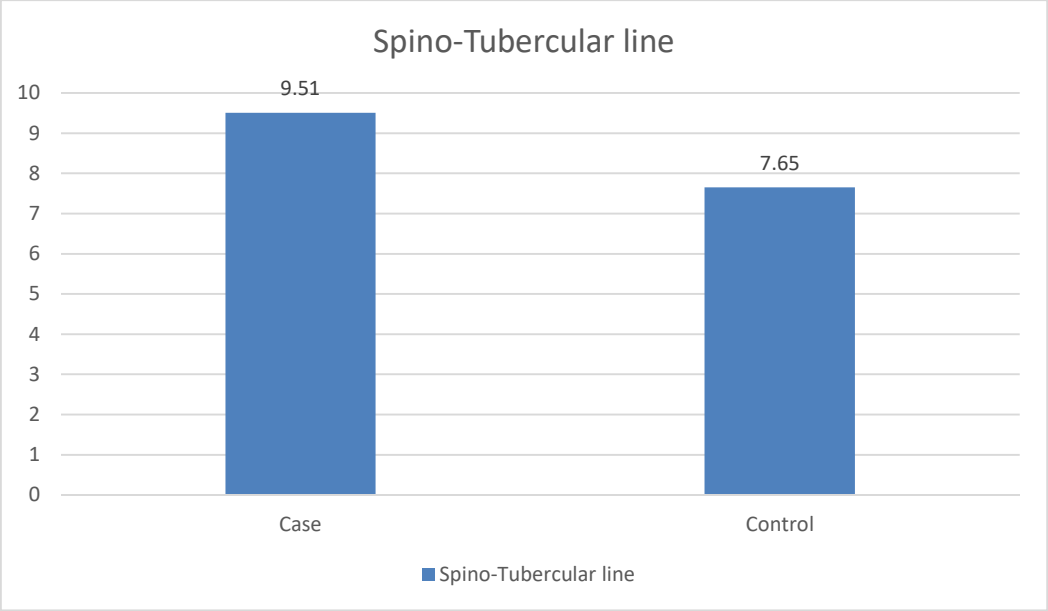


**Figure 33: Comparison of mean ST line between the groups**

# DISCUSSION

Inguinal hernia, characterized by the protrusion of abdominal contents through the inguinal canal or fascia, remains a prevalent condition worldwide, necessitating surgical intervention in a significant portion of affected individuals. While various risk factors contribute to the development of inguinal hernia, recent attention has turned to the anatomical configuration of the inguinal region, particularly focusing on the position of the pubic tubercle. The pubic tubercle, a prominent landmark in the lower abdomen, plays a crucial role in the integrity of the inguinal canal. Recent investigations have suggested a correlation between the positioning of the pubic tubercle and the predisposition to inguinal herniation. Specifically, a lower position of the pubic tubercle has been postulated to weaken the protective mechanisms of the inguinal canal, thereby increasing the risk of herniation.

Understanding the significance of the low-lying pubic tubercle in the pathogenesis of inguinal hernia holds implications for patient selection and surgical management. By elucidating the anatomical factors predisposing individuals to inguinal herniation, clinicians can refine their approach to hernia repair and optimize patient outcomes.

In present study total of 82 patients included, with mean age of 49.87±16.5yrs. On comparison of the mean age between the groups, there is comparable mean with no significant difference noted. Patients were comparable in both the group with respect to physical characters, occupation, comorbidities, hernia type, and physical examination findings between the groups.

In study by Agarwal M et al., Right-sided inguinal hernia (IH) was more prevalent at 59.25%, with a majority (94.5%) being direct IH. [69]In similar study by

Jakhar SJ et a., documented in age group of 60-70yrs.[4] In study by Thomas the mean age was found to be 47.41yrs with comparable between the groups. Also the physical character such as height and weight were comparable between the groups. [26]

On comparison of the measurements, there is significant lower mean level of spinospinous line (SS line) in cases (26.3±0.4) compared to controls (23.22±0.61). ($p<0.05$) Similarly, the mean level of spino-tubercular line (ST line) was significantly higher in cases (9.51±0.62) compared to controls (7.65±0.23).($p<0.05$)

In line study by Sundresh N et al., mean SS measurement for the case group was 23.12, notably exceeding the control group's average of 22.87. Similarly, the ST value had a mean of 7.34 in the study group, contrasting with the control group's mean of 6.93. These findings lead to the conclusion that the anatomical features of the pubic tubercle and an abnormal protective mechanism of the internal oblique contribute to the etiology of inguinal hernia.[29]

In concordance by Jakhar et al., documented the mean value of the ST line in study group is 7.37±0.182, which is significantly greater ($p=0.0001$) than the controls, where the mean value is 7.01±0.262.[4] Another study by Farhan M et al., documented with mean value of the ST line in their study group is 7.81±0.82, which is significantly greater ($p=0.001$) than the controls, where the mean value is 6.54±0.80.[31] Another study by Verma M et al., mean measurement of ST line was7.34±0.16cm which was significantly higher than the controls 6.92±0.12cms. Concluded that patients with low-lying pubic tubercle are at high risk of developing inguinal hernia.[30]

Chirayath MJ et al., the average spine-to-spine distance measured 26.32 cm, while it was 25.86 cm in controls. The mean distance from the pubic tubercle to this line was 7.82 cm for cases and 6.77 cm for controls.[31]

Agrawal M et al., documented notable differences in weight, the SS line, and the ST line between cases and controls.[69]Individuals with low-lying pubic tubercles have a decrease in the inguinal canal shutter mechanism's efficacy, which can result in the formation of an inguinal hernia in study by Babu A et al. A subset of individuals with low-lying pubic tubercle are more susceptible to inguinal herniae.[70] Furthermore, a positive correlation was observed between the ratios of weight and ST length, as well as height and ST length, in both cases and controls. These findings suggest that factors such as a low-lying pubic tubercle and other associated anthropometric variables contribute to an increased susceptibility for the development of indirect inguinal hernia.[26]

In concordance another study by Bhandary D et al., average SS value in the case group exceeded that of the control group, and the ST value was higher in the case group compared to the control group, with a significant p-value of <0.0001. Recognizing a low-lying pubic tubercle is crucial before selecting patients for surgical correction. Therefore, a thorough understanding of the anatomy of the inguinal region is imperative in guiding the selection of the appropriate surgical technique.[33]

Another study by Farook MU et al., documented that the ST line, indicating the length of the pubic tubercle, exhibited a notably greater measurement in patients with indirect inguinal hernia, both clinically and radiologically. Additionally, the mean SS and MIP to PT were significantly longer ($p < 0.05$) in individuals with indirect inguinal hernia. Clinical measurements suffice for non-obese individuals, while radiological measurements are necessary for those classified as obese (BMI > 25). From the outcomes of this research, it can be concluded that a lower-positioned pubic tubercle is linked to the occurrence of indirect inguinal hernia.[27] Rao PT et al., development of an inguinal hernia was directly correlated with the importance of the

SS, ST, and MP lines. According to a research, inguinal herniae are widespread in people between the ages of 51 and 60. There were more individuals with indirect inguinal herniae. Measurements showed that the patients' SS and ST lines were higher than the controls'. [28]

The shutter-like mechanism at the internal inguinal ring is facilitated by the contraction of the arching fibers of the internal oblique muscle. When these fibers contract, they move closer to the inguinal ligament, compressing the spermatic cord. However, an unusual origin and insertion of the internal oblique and transversus abdominus muscles can result in an ineffective shutter mechanism of the inguinal canal.

The position of the low-lying pubic tubercle is crucial when selecting patients for surgical correction. It is believed that if the distance between the inguinal ligament and the musculoaponeurotic arch is greater, the classical inguinal hernia repair may not be suitable, and such patients should be considered for hernioplasty instead. Therefore, a thorough understanding and demonstration of the inguinal region's anatomy are essential before choosing the appropriate surgical technique.

# SUMMARY

- In present study total of 82 patients included, with mean age of 49.87±16.5yrs.
- On comparison of the mean age between the groups, there is comparable mean with no significant difference noted.
- On comparison of occupation, there is no significant difference in the type of occupation between the groups.
- On assessment of comorbid conditions, there is comparable distribution of patients with diabetes mellitus, hypertension, habits such as smoking and alcohol consumption between the groups.
- By physical characters, patients in both the group were comparable with mean height and weight.
- On assessment of the complains there was no significant difference in presence of swelling complain, pain, type of hernia, impulse on coughing, vomiting and nausea, constipation between the groups.
- On assessment of the ring finger test, middle finger, index finger, reducibility, ring occlusion test and content of hernia were comparable between the groups.
- On comparison of the measurements, there is significant lower mean level of spinospinous line (SS line) in cases (26.3±0.4) compared to controls (23.22±0.61). ($p<0.05$)
- Similarly, the mean level of spino-tubercular line (ST line) was significantly higher in cases (9.51±0.62) compared to controls (7.65±0.23).($p<0.05$)

# CONCLUSION

The present study investigates the significance of a low-lying pubic tubercle in the development of inguinal hernia by examining 82 patients with a mean age of 49.87±16.5 years. The findings reveal a significant correlation between the anatomical positioning of the pubic tubercle and the occurrence of inguinal hernia. Specifically, the mean level of the spinospinous line (SS line) is significantly lower in patients with inguinal hernia (26.3±0.4) compared to the control group (23.22±0.61), with a p-value of less than 0.05, indicating strong statistical significance. Similarly, the spino-tubercular line (ST line) is significantly higher in patients with hernia (9.51±0.62) compared to controls (7.65±0.23), also with a p-value of less than 0.05.

These results suggest that the anatomical configuration characterized by a lower SS line and a higher ST line may contribute to the development of inguinal hernia. This anatomical predisposition likely affects the obliquity and structural integrity of the inguinal canal, thereby increasing the risk of herniation. Consequently, the low-lying pubic tubercle emerges as a significant anatomical risk factor for inguinal hernia. Future research should focus on further elucidating the mechanisms by which this anatomical feature influences hernia formation and exploring potential preventive strategies in at-risk populations.

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# ANNEXURE - I - INFORMED CONSENT FORM

## "A CASE CONTROL STUDY ON SIGNIFICANCE OF LOW LYING PUBIC TUBERCLE IN THE DEVELOPMENT OF INGUINAL HERNIA"

**Name of Student/Principal Investigator:**

**Name of Guide:**

**NAME OF CO GUIDE:**

**Objective: To find out the prevalence of inguinal hernia in low lying pubic tubercle at our tertiary hospital setup.**

**Introduction:** An inguinal hernia is a protrusion of abdominal-cavity contents through the inguinal canal or fascia transversalis. There are two types of inguinal hernia; direct and indirect, which are defined by their relationship to the inferior epigastric vessels. As the distance from pubic tubercle to the horizontal line (The line joining two anterior-superior iliac spine) increases, the inguinal canal becomes less oblique. A low lying pubic tubercle results in less obliquity of inguinal canal and narrow arching of conjoint tendon with wide origin of internal oblique muscle and transverses abdominis muscle. It leads to ineffective shutter mechanism of inguinal canal. Thus increasing the risk of future development of inguinal hernia.

**Explanation of procedure**: Patients with inguinal hernia after taking written and informed consent, with same number of age, gender and BMI matched normal individuals taken as controls were studied. The anthropometric measurements of pelvis like SS line, ST line will be measured, The various parameters will be measured such as SS line (distance between each anterior superior iliac spine), ST line (vertical distance between the pubic tubercle of affected side) and the SS line (SS/ST,

height, weight, BMI, height/ST, weight/ST).The data collected will be entered into Microsoft office excel. An attempt will be made to find any relationship between ST Line and SS Line measurement and height, weight, BMI, age and side of hernia of the patient.

**Withdrawal from participation in the study:** Participation in this study is voluntary. You will be free to decide whether to participate in this study or continue participation once enrolled. In case you decide to withdraw your participation, you are free to do so. However, please convey the decision to the principal investigator.

**Possible benefits from participating in the study:** You will/will not have nor get any benefits by participating in this study. The data gathered will help the population at large.

**Possible risks from participating in the study:** There are no risks involved in participating in this study.

**Privacy and confidentiality:** The information collected from you will be coded, to prevent any person from identifying you. Your identity will never be revealed. The data collected from you will be kept confidential and only processed or aggregated data will be used for publication.

**Financial incentives:** You will not receive any payment for participating in this study.

**Authorization for publication of aggregated data:** Results obtained after processing of the aggregated data will be published for scientific purposes and or presented to scientific groups.However, your identity will never be revealed.

**Questions:** In case of any questions with regard to this study, you are free to contact: Dr Harsha Hegde, Chairperson, Ethical committee of JNMC, 0831-2473777 Extension 4052.

**Legal rights:** By signing this consent form, we are not waving any of your legal rights.

## CONSENT STATEMENT

I am making a voluntary decision to participate in the study **"**A CASE CONTROL STUDY ON SIGNIFICANCE OF LOW LYING PUBIC TUBERCLE IN DEVELOPMENT OF INGUINAL HERNIA". My signature below indicates that I have decided to participate and I have read the information provided above or the information provided above has been read to me in the language that I understand best. I was given the opportunity to ask questions and that they have been answered to my satisfaction.

Name of the of the participant-

Signature /left thumb impression of the participant-

Name of the witness-

Signature/ left thumb impression of the participant-

Name of the investigator-

Signature of investigator

# ANNEXURE - II - PROFORMA

**SCREENING:**

I.P.No

1.Name of The Patient:

2.Age:

3.Gender: Male/ Female

4. DOA:

5.DOD:

6.Date of Interview:

7:Address:

Patient with uncomplicated inguinal hernia:

- Yes
- No

Patient age above 18:

- Yes
- No

Applicant is willing to give consent

- Yes
- No

Patient has no associated illness or complications:

- Yes
- No

**FINAL RESULT**

- Ineligible
- Eligible but refused
- Eligible and participating

# PROFORMA

Name:

DOA:__/__/_____

Age: __ __ YEARS

Sex:M/F

Occupation:

DOD:__/__/_____

Address:

**CHIEF COMPLAINTS:**

Swelling – YES / NO

Pain – YES /NO

**H/O PRESENT ILLNESS:**

Swelling- YES/NO

does it disappear spontaneously on lying down- YES/NO

Pain - dragging and aching type of pain

Systemic symptoms - colicky abdominal pain

Vomiting/nausea -YES/NO

abdominal distension-YES/NO

absolute constipation-YES/NO

chronic cough-YES/NO

frequency/difficulty in micturition-YES/NO

h/o heavy weight lifting- YES/NO

**PAST HISTORY:**

H/O Similar episodes before-YES/NO

H/O any Chronic drug use-YES/NO

H/O DM / SHT / BA / TB /Seizure disorder-YES /NO

H/O previous surgery - -YES/NO

h/o inguinal hernia repair done on same/opposite side-YES/NO

**PERSONAL HISTORY:**

Smoker-YES/NO

Alcoholic-YES/NO

Diet-MIXED / VEGITARIAN

Bowel – NORMAL/CONSTIPATED/LOOSE STOOLS

Bladder-NORMAL/INCREASED FREQUENCY/DECREASED FREQUENCY

**GENERAL PHYSICAL EXAMINATION:**

**HEAD TO TOE EXAMINATION**

Head-

Eyes-

Ears-

Neck-

Spine-

Nose-

Sinuses-

Lips-

Buccal mucosa and teeth-

Pharynx –

Chest-

Abdomen-

Genitilia-

Upper limb-

Lower limb-

**SYSTEMIC EXAMINATION**

PER ABDOMEN

**Inspection** -

o Swelling – YES/NO

o Impulse on coughing YES/NO

· **Palpation** - Position and extent

o Impulse on coughing –

zieman's technique- ring finger +,-

middle finer+,-

index finger +,-

o Reducibility +/-

o Ring occlusion test YES/NO

Percussion - dull / resonant

Auscultation – for bowel sounds - +/-

o P/R – Prostatomegaly- YES/NO

**CARDIO VASCULAR SYSTEM – S1,S2+ - yes/no**

**RESPIRATORY SYSTEM – BAE+ - yes/no**

**CENTRAL NERVOUS SYSTEM –NO NEUROLOGICAL DEFICIT - yes/no**

**DIAGNOSIS:**

**INVESTIGATIONS: routine- yes/no**

**MANAGEMENT:**

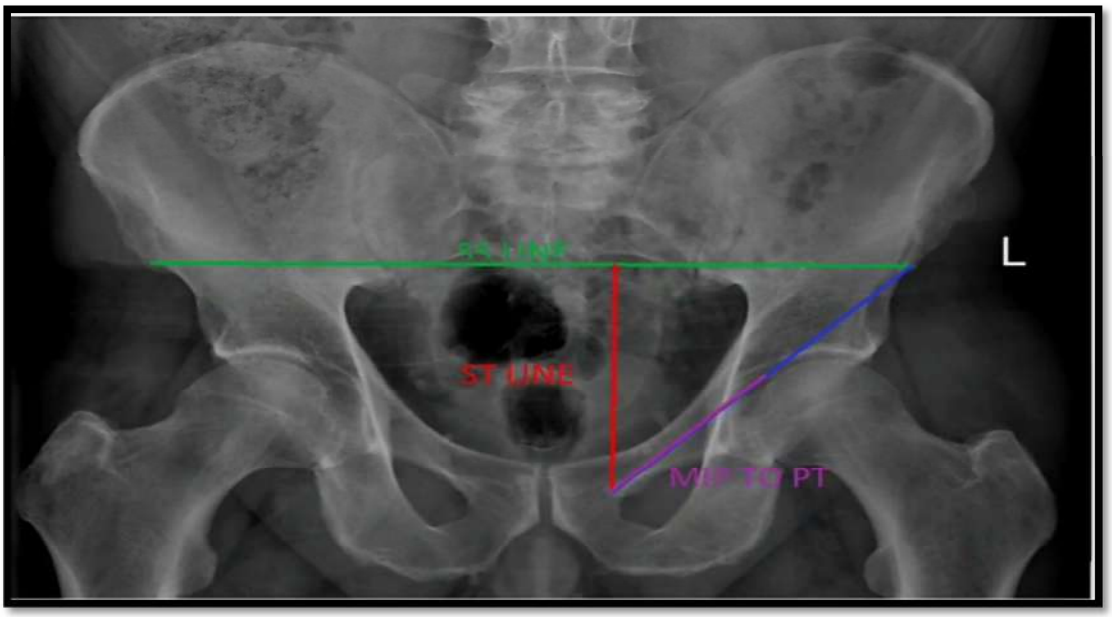
THERAPEUTIC PROCEDURE: LAPAROSCOPIC HERNIA REPAIR/OPEN INGUINAL HERNIA REPAIR.

**MEASUREMENTS:**

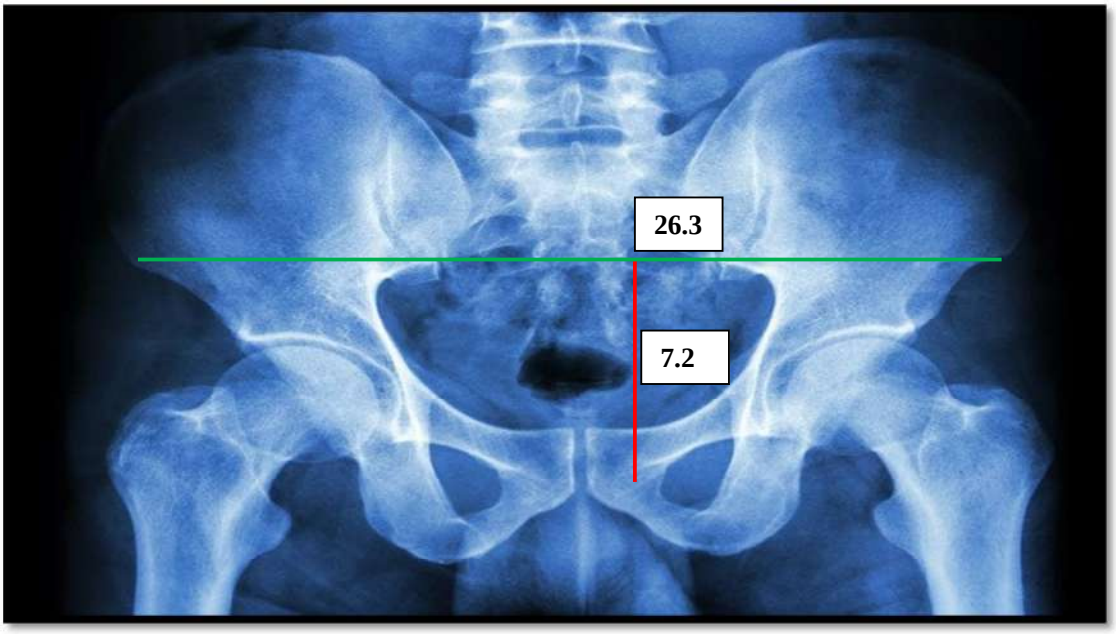
SPINO-SPINOUS LINE-

SPINO-TUBERCULAR LINE-

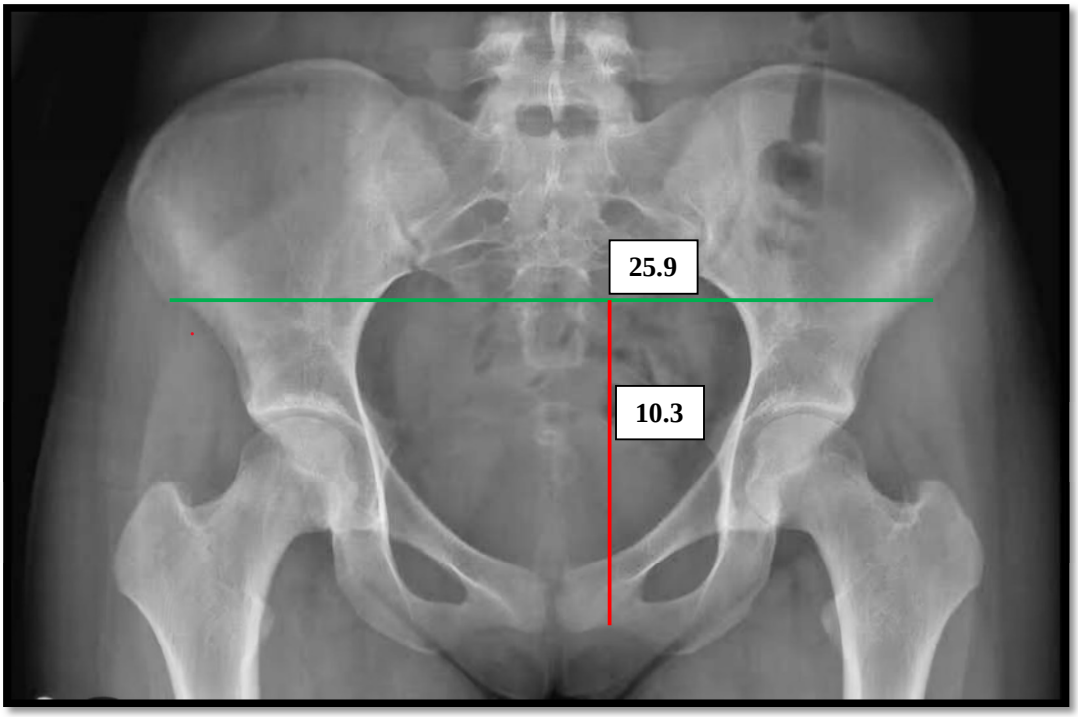
## ANNEXURE - III - PHOTOGRAPHS




**Photographs 1: X-RAY HIP (NORMAL)**




**Photographs 2: X-RAY HIP (CONTROL)**




**Photographs 3: X-RAY HIP (CASE)**

# ANNEXURE - IV - KEY TO MASTER CHART

- Sl. No. –Serial number
- IP.NO – In patient number
- Age: in years
- M- Male
- F- Female
- P– Present
- A – Absent
- H/O – History of
- T2DM – Type 2 Diabetes mellitus.
- HTN – Hypertension
- R- Right sided
- L- Left sided
- I – Indirect inguinal hernia
- D – Direct inguinal hernia
- Y- Yes
- N – No

# ANNEXURE - V - MASTER CHART

## ANNEXURE - V - MASTER CHART

| Sl NO | IP No | GROUP | Age | Gender | Occupation | H/O DM | H/O HTN | Alcholic | Smoker | Height in cms | Weight in kg | Complain of swelling | Complain of pain | Impulse of coughing | Hernia Type | Vomiting/Nausea | Constipation | Complicated Inguinal hernia | Ring finger | middle finger | index finger | reducibility | Ring occlusion test | Content | Type of procedure | Measurements Spino spinous line | Spino-Tubercular line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10050979 | CASE | 55 | MALE | FARMER | P | P | P | P | 178 | 72 | P | P | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 26.1 | 9.8 |
| 2 | 10050468 | CASE | 67 | MALE | MANUAL LABOR | A | A | P | A | 176 | 78 | P | A | P | IN | A | P | N | A | A | P | P | N | BOWEL | OPEN | 25.9 | 9.7 |
| 3 | 10049836 | CASE | 34 | MALE | BUSINESS | A | A | P | P | 179.5 | 91 | P | A | P | IN | A | P | N | A | A | P | P | N | BOWEL | OPEN | 26.5 | 10.3 |
| 4 | 10048507 | CASE | 67 | MALE | FARMER | A | P | P | P | 180.3 | 77 | P | A | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 26.1 | 9.9 |
| 5 | 10046846 | CASE | 70 | MALE | HOUSE KEEPER | P | A | P | P | 177.4 | 59 | P | A | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 9.8 |
| 6 | 10046838 | CASE | 48 | MALE | WATCHMAN | A | P | P | P | 175 | 72 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26 | 9.6 |
| 7 | 10046728 | CASE | 45 | MALE | CLOTH VENDER | A | P | P | A | 181.2 | 64 | P | A | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 26.3 | 10.4 |
| 8 | 10046797 | CASE | 28 | MALE | STUDENT | A | A | A | A | 176.3 | 85 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 26.7 | 9.9 |
| 9 | 10043763 | CASE | 34 | MALE | BUSINESS | A | A | A | A | 177 | 79 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 27 | 10.3 |
| 10 | 10043813 | CASE | 52 | MALE | MECHANIC | P | A | A | P | 178.6 | 88 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.7 | 10.1 |
| 11 | 10038905 | CASE | 45 | MALE | FARMER | P | A | P | A | 179 | 87 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.8 | 9.8 |
| 12 | 10031247 | CASE | 67 | MALE | FARMER | P | P | A | P | 176 | 76 | P | P | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 9.7 |
| 13 | 10020584 | CASE | 63 | MALE | FARMER | P | P | P | P | 177.4 | 89 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.5 | 10.3 |
| 14 | 10013890 | CASE | 58 | MALE | DAILY LABOUR | P | A | P | A | 179.4 | 76 | P | P | P | IN | P | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.1 | 9.9 |
| 15 | 1163742 | CASE | 27 | MALE | FACTORY WORKER | A | A | A | P | 181 | 70 | P | P | P | IN | P | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 9.8 |
| 16 | 10007443 | CASE | 36 | MALE | ELECTRICIAN | A | A | P | A | 182.3 | 78 | P | P | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 26 | 9.6 |
| 17 | 10009225 | CASE | 55 | MALE | FARMER | P | P | A | A | 178 | 76 | P | P | P | IN | P | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.3 | 10.4 |
| 18 | 1209331 | CASE | 34 | MALE | FARMER | A | P | A | P | 175 | 88 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 26.7 | 9.9 |
| 19 | 1175288 | CASE | 67 | MALE | BUSINESS | P | A | P | A | 180 | 87 | P | P | P | D | A | P | N | A | P | A | P | Y | BOWEL | OPEN | 27 | 10.3 |
| 20 | 1172525 | CASE | 46 | MALE | TEACHER | A | P | A | A | 175.4 | 85 | P | A | P | IN | P | A | N | A | A | P | P | N | BOWEL | LAP | 26.7 | 10.1 |
| 21 | 1171128 | CASE | 40 | MALE | FARMER | A | P | A | A | 182.3 | 78 | P | P | P | IN | P | P | N | A | A | P | P | N | OMENTUM | OPEN | 27.2 | 10.3 |
| 22 | 10055371 | CASE | 26 | MALE | FACTORY WORKER | A | A | A | P | 181.4 | 77 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.3 | 10.2 |
| 23 | 10003498 | CASE | 67 | MALE | UNEMPLOYED | P | P | P | A | 179.5 | 90 | P | P | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 9.9 |
| 24 | 10003862 | CASE | 29 | MALE | AUTO DRIVER | A | A | A | A | 178.3 | 88 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.7 | 9.9 |
| 25 | 10003954 | CASE | 36 | MALE | FACTORY WORKER | A | A | A | A | 176 | 76 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.8 | 10.3 |
| 26 | 10004234 | CASE | 40 | MALE | PRIVATE EMPLOYEE | A | P | P | P | 178 | 78 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 10.1 |
| 27 | 1004893 | CASE | 58 | MALE | FARMER | P | A | A | A | 181 | 89 | P | P | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.5 | 9.8 |
| 28 | 1006131 | CASE | 31 | MALE | BUSINESS | A | A | P | A | 182 | 69 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 26.1 | 9.7 |
| 29 | 1007082 | CASE | 25 | MALE | STUDENT | A | A | A | A | 179 | 70 | P | P | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 10.3 |
| 30 | 1009547 | CASE | 29 | MALE | BUSINESS | A | A | P | P | 179.5 | 76 | P | P | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26 | 9.9 |
| 31 | 10009771 | CASE | 46 | MALE | BUSINESS | P | P | A | A | 181.4 | 78 | P | P | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.3 | 9.8 |
| 32 | 10010937 | CASE | 76 | MALE | UNEMPLOYED | P | P | A | A | 176.3 | 87 | P | P | P | D | A | A | N | A | P | A | P | Y | BOWEL | OPEN | 26.7 | 9.6 |
| 33 | 10011169 | CASE | 26 | MALE | STUDENT | A | A | P | P | 177 | 69 | P | A | P | IN | A | P | N | A | A | P | P | N | BOWEL | OPEN | 27 | 10.4 |
| 34 | 10014259 | CASE | 39 | MALE | BUSINESS | P | P | A | A | 181 | 92 | P | P | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.7 | 9.9 |
| 35 | 10014252 | CASE | 70 | MALE | FARMER | P | A | P | P | 179.3 | 89 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 27.2 | 10.3 |
| 36 | 10014184 | CASE | 77 | MALE | UNEMPLOYED | P | A | P | A | 178.4 | 88 | P | P | P | D | P | A | N | A | P | A | P | Y | OMENTUM | OPEN | 26.3 | 10.1 |
| 37 | 10015143 | CASE | 51 | MALE | BUSINESS | P | A | A | P | 179.2 | 93 | P | A | P | D | P | A | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 10.3 |
| 38 | 10017682 | CASE | 71 | MALE | FARMER | P | A | A | A | 178.2 | 87 | P | P | P | D | A | P | N | A | P | A | P | Y | BOWEL | OPEN | 26.5 | 10.1 |
| 39 | 10021534 | CASE | 60 | MALE | WATCHMAN | P | P | A | A | 176 | 79 | P | A | P | D | P | A | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 10.2 |

| Sl NO | IP No | GROUP | Age | Gender | Occupation | H/O DM | H/O HTN | Alcholic | Smoker | Height in cms | Weight in kg | Complain of swelling | Complain of pain | Impulse of coughing | Hernia Type | Vomiting/Nausea | Constipation | Complicated Inguinal hernia | Ring finger | middle finger | index finger | reducibility | Ring occlusion test | Content | Type of procedure | Measurements Spino spinous line | Spino-Tubercular line |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 10021638 | CASE | 44 | MALE | SECURITY | A | A | P | P | 181 | 78 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 26.3 | 9.9 |
| 41 | 10029976 | CASE | 56 | MALE | BUSINESS | P | A | A | A | 183 | 87 | P | A | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.7 | 9.7 |
| 42 | 1161918 | CONTROL | 60 | MALE | FARMER | A | P | P | P | 183.4 | 65 | P | A | P | D | P | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25 | 8.5 |
| 43 | 1162024 | CONTROL | 25 | MALE | STUDENT | A | A | A | P | 178 | 78 | P | P | P | IN | P | A | N | A | A | P | P | N | OMENTUM | OPEN | 25.7 | 9 |
| 44 | 1162426 | CONTROL | 69 | MALE | BUSINESS | P | P | P | A | 176 | 91 | P | P | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 9.2 |
| 45 | 1163970 | CONTROL | 47 | MALE | MECHANIC | A | A | A | A | 179.5 | 77 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 25.3 | 9.4 |
| 46 | 1163535 | CONTROL | 42 | MALE | PLUMBER | A | A | P | A | 180.3 | 59 | P | A | P | IN | A | P | N | A | A | P | P | N | BOWEL | OPEN | 23.2 | 8.1 |
| 47 | 1165227 | CONTROL | 49 | MALE | CARPENTER | P | P | A | P | 177.4 | 72 | P | A | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 9.5 |
| 48 | 1165549 | CONTROL | 58 | MALE | EX MILITARY | P | P | P | A | 175 | 64 | P | A | P | IN | A | P | N | A | A | P | P | N | BOWEL | OPEN | 26.4 | 8.2 |
| 49 | 1169036 | CONTROL | 21 | MALE | STUDENT | A | A | A | P | 181.2 | 85 | P | A | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 26.3 | 8.8 |
| 50 | 1169039 | CONTROL | 65 | MALE | FARMER | P | A | A | A | 176.3 | 79 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.7 | 7.9 |
| 51 | 1169584 | CONTROL | 64 | MALE | FARMER | P | A | P | P | 177 | 88 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 27.2 | 8 |
| 52 | 1174515 | CONTROL | 27 | MALE | AUTO DRIVER | A | A | P | P | 178.6 | 87 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 24.2 | 8.9 |
| 53 | 1176119 | CONTROL | 27 | MALE | STUDENT | A | A | P | A | 179 | 76 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 9.8 |
| 54 | 1178213 | CONTROL | 24 | MALE | STUDENT | A | A | A | A | 176 | 89 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.7 | 8.6 |
| 55 | 1178283 | CONTROL | 28 | MALE | FARMER | P | A | P | A | 177.4 | 76 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 25.8 | 8.8 |
| 56 | 1180427 | CONTROL | 63 | MALE | FARMER | P | P | A | P | 179.4 | 70 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 20.3 | 8.9 |
| 57 | 1180438 | CONTROL | 45 | MALE | PLUMBER | A | P | P | A | 181 | 78 | P | A | P | D | A | A | N | A | P | A | P | Y | OMENTUM | OPEN | 26.5 | 9 |
| 58 | 1170740 | CONTROL | 65 | MALE | EX MILITARY | P | P | P | P | 182.3 | 76 | P | A | P | D | P | A | N | A | P | A | P | Y | OMENTUM | OPEN | 26.1 | 9.2 |
| 59 | 1181973 | CONTROL | 39 | MALE | DAILY LABOUR | A | P | P | A | 178 | 88 | P | A | P | IN | P | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 8.6 |
| 60 | 1184919 | CONTROL | 38 | MALE | BUSINESS | P | P | A | P | 175 | 87 | P | A | P | IN | A | A | N | A | A | P | P | N | BOWEL | OPEN | 26 | 8.9 |
| 61 | 1191070 | CONTROL | 29 | MALE | BUSINESS | A | P | A | P | 180 | 85 | P | A | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 24.3 | 9.5 |
| 62 | 1191537 | CONTROL | 76 | MALE | FARMER | A | P | A | A | 175.4 | 78 | P | A | P | D | A | P | N | A | P | P | P | Y | OMENTUM | OPEN | 26.7 | 8.9 |
| 63 | 1192009 | CONTROL | 29 | MALE | DAILY LABOUR | P | A | A | A | 182.3 | 77 | P | A | P | IN | A | P | N | A | A | P | P | N | BOWEL | OPEN | 27 | 8.8 |
| 64 | 1193323 | CONTROL | 60 | MALE | EX MILITARY | P | A | A | A | 181.4 | 90 | P | A | P | D | A | A | N | A | P | P | P | Y | OMENTUM | OPEN | 26.7 | 7.9 |
| 65 | 1199954 | CONTROL | 61 | MALE | EX MILITARY | P | P | P | P | 179.5 | 88 | P | A | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 27.2 | 8 |
| 66 | 1203385 | CONTROL | 55 | MALE | MECHANIC | P | A | P | A | 178.3 | 76 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.3 | 8.2 |
| 67 | 1206967 | CONTROL | 78 | MALE | FARMER | P | A | A | P | 176 | 78 | P | P | P | D | A | A | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 9.8 |
| 68 | 1207716 | CONTROL | 61 | MALE | FARMER | P | A | P | A | 178 | 89 | P | P | P | D | A | A | N | A | P | P | P | Y | OMENTUM | OPEN | 26.5 | 9.6 |
| 69 | 1208603 | CONTROL | 27 | MALE | ELECTRICIAN | A | A | P | P | 181 | 69 | P | P | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 8.8 |
| 70 | 1003412 | CONTROL | 79 | MALE | FARMER | A | P | A | P | 182 | 70 | P | P | P | D | A | A | N | A | P | P | P | Y | BOWEL | LAP | 26.3 | 8.9 |
| 71 | 10052699 | CONTROL | 46 | MALE | BUSINESS | A | P | P | A | 179 | 76 | P | P | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.7 | 8.9 |
| 72 | 10049836 | CONTROL | 37 | MALE | BUSINESS | P | P | A | A | 179.5 | 78 | P | A | P | IN | A | P | N | A | A | P | P | N | BOWEL | OPEN | 26.7 | 8.9 |
| 73 | 10048269 | CONTROL | 54 | MALE | FARMER | A | A | P | A | 181.4 | 87 | P | A | P | D | A | A | N | A | P | A | P | Y | OMENTUM | OPEN | 25.7 | 9.8 |
| 74 | 10046534 | CONTROL | 62 | MALE | HOUSE KEEPER | P | P | P | P | 176.3 | 69 | P | A | P | IN | A | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 9.6 |
| 75 | 10044237 | CONTROL | 79 | MALE | FARMER | P | A | P | A | 177 | 92 | P | P | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.3 | 8.8 |
| 76 | 10044243 | CONTROL | 71 | MALE | FARMER | P | P | A | P | 181 | 89 | P | A | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 26 | 8.9 |
| 77 | 10041918 | CONTROL | 63 | MALE | FACTORY WORKER | A | A | P | A | 179.3 | 88 | P | P | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 9 |
| 78 | 10006593 | CONTROL | 43 | MALE | BUSINESS | P | P | P | P | 178.4 | 93 | P | A | P | IN | P | A | N | A | A | P | P | N | OMENTUM | OPEN | 26.4 | 9.2 |
| 79 | 10038830 | CONTROL | 58 | MALE | CARPENTER | A | P | A | A | 179.2 | 87 | P | P | P | IN | A | A | N | A | A | P | P | N | OMENTUM | OPEN | 26.3 | 9.4 |
| 80 | 10032280 | CONTROL | 40 | MALE | FRUIT VENDOR | A | P | P | P | 178.2 | 79 | P | A | P | IN | P | P | N | A | A | P | P | N | OMENTUM | OPEN | 26.5 | 8.9 |
| 81 | 10028182 | CONTROL | 61 | MALE | FARMER | A | P | P | A | 176 | 78 | P | A | P | IN | P | P | N | A | A | P | P | N | OMENTUM | OPEN | 25.9 | 9.5 |
| 82 | 10026420 | CONTROL | 70 | MALE | FARMER | A | P | A | P | 181 | 87 | P | P | P | D | A | P | N | A | P | A | P | Y | OMENTUM | OPEN | 25.9 | 9.7 |