PATTERN AND EARLY SURGICAL OUTCOMES OF INGUINAL HERNIA REPAIR IN ADULTS AT THE MOI TEACHING AND REFERRAL HOSPITAL, ELDORET, KENYA

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A RESEARCH THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF MEDICINE IN GENERAL SURGERY OF MOI UNIVERSITY

DECLARATION

Candidate's Declaration

This Research Thesis is my original work and has not been presented for a degree in any other University. No part of this work may be reproduced without prior written permission of the author and/or Moi University.

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DEDICATION

I dedicate this work to my dear parents, for the immense effort and dedication in educating me and to all my teachers who over the years have modelled me to become a better person and doctor.

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ABSTRACT

Background: Inguinal hernia is a bulge of the peritoneum through a congenital or acquired defect in the muscular and fascial structures of the anterior abdominal wall. It is at risk of incarceration, strangulation and obstruction. The current gold standard treatment is the open tension free mesh repair but in most resource limited African countries the popular treatment is Bassini's repair. There are limited statistics from Kenya and Africa as a whole for the number of annual hernial repairs, prevalence, demographic patterns, clinical presentation and surgical management outcomes.

Objective: To describe pattern and early surgical outcomes of inguinal hernia repairs among adult patients at the Moi Teaching and Referral Hospital (MTRH).

Methods: This was a descriptive prospective study employing consecutive sampling. Prior Ethical approval was obtained. Adult patients with inguinal hernia (IH) operated for the first time at MTRH were included. A total of 103 adult patients were studied. Patients were recruited from surgical clinics, wards and accident and emergency department. Their demographic characteristics, clinical presentation, hernia characteristics, repair techniques and short-term surgical outcomes were recorded and patients followed up for one month after discharge. Data was collected using an interviewer administered structured questionnaire. Data analysis was done using STATA version 15. Descriptive statistics such as frequencies and percentages were used for categorical variables while mean, median and interquartile range were used for continuous variables.

Results: The age range was 18 to 93 years, a mean of 49.6 years and standard deviation of ±19.6 years. The male to female ratio was 33:1 with majority of patients admitted as emergencies 58(56.3%). The leading signs found in IH complications included irreducibility 58(56.3%), tenderness 50(48.5%) and, abdominal pain 48(46.6%). Majority of the IH at MTRH were irreducible at 56.3%. Among the irreducible IH, 55.2% were strangulated IH surgical repair techniques included open mesh repair (90.3%), laparoscopic mesh repair (3.9%) and tissue repair (5.8%). The overall morbidity and mortality rates were 35.9% and 2.9% respectively. The top three complications were prolonged ileus 9(8.7%), urinary retention 8(7.8%) and seroma formation 6(5.8%). Emergency cases were associated with longer hospital stay (p= <0.0001) and more complications postoperatively (p= <0.001) than elective cases. At one month of follow up, pain was the key parameter assessed. Mild, moderate, and severe pain were reported in 36%, 45% and 19% of patients respectively.

Conclusion: Majority of IH cases seen at MTRH presented as incarcerated emergencies in males and were mainly done open mesh repair. The morbidity and mortality rates were 35.9% and 2.9% respectively **Recommendation**: Community health education on IH should be done to prevent late presentations, complications and poor outcomes.

LIST OF ABBREVIATIONS AND ACRONYMS

A&E	Accident and Emergency
ICU	Intensive Care Unit
IH	Inguinal Hernia
IQR	Inter Quartile Range
IREC	Institutional Research and Ethics Committee
MTRH	Moi Teaching and Referral Hospital
OPD	Outpatient Department
WHO	World Health Organization

DEFINITION OF TERMS

Adult- a person aged 18 years and above.

Duration of hospital stay: number of days spent in the surgical unit from admission to discharge

Early surgical outcomes- refers to intra-operative and post-operative findings following IH repair up to a month post-surgery and in this study such parameters were post-operative complications, mortality and duration of hospital stay.

Elective procedure- is surgical procedure that is scheduled in advance because it does not involve a medical emergency.

Emergency procedure- surgical procedure done to treat an urgent life threatening medical condition.

Inguinal hernia (Direct type)- it is when the hernial sac comes through the inguinal floor medial to the inferior epigastric artery and the deep inguinal ring.

Inguinal hernia (Indirect type)- it is when the hernial sac comes through the deep inguinal ring lateral to the inferior epigastric artery. An important sub-classification of indirect hernia is the sliding hernia, in which bowel fused to the peritoneum comes through the internal inguinal ring.

Inguinal hernia- defined as a bulge of the peritoneum through a congenital or acquired defect in the mascular and fascial structures of the abdominal wall.

- **Incarcerated hernia**- there is entrapment of hernial sac and its contents such that the hernia cannot be returned into the peritoneal cavity.
- **Reducible hernia-** the contents of the hernia can be returned into the peritoneal cavity completely.
- **Strangulated hernia**- the contents of the hernia cannot be returned into the peritoneal cavity, and blood supply of hernia contents is compromised.

Management- clinical evaluation, investigations and treatment given to patients.

Morbidity-The occurrence of complications following a surgical procedure or other treatment.

Mortality- death attributable to pathophysiological changes of the disease/condition.

Outcome- the eventual results of management of patients; in this thesis within a month post-surgery.

Pattern- recurring factors or parameters in the clinical presentation of a disease or condition.

CHAPTER ONE: INTRODUCTION

1.1 Background of study

Inguinal hernia is a bulge of the peritoneum through a congenital or acquired defect in the muscular and fascial structures of the abdominal wall (Holzheimer., 2005). The exact cause of one to develop inguinal hernia is unknown. However, some factors have been implicated in the development of inguinal hernias. These include factors which are associated with repeated elevations of intra-abdominal pressure like chronic coughing due to obstructive pulmonary disease, doing a lot of weight lifting, straining during defecation due to constipation or colonic stenosis or hyperplasia of prostate and being overweight. They result in weakening of muscle fascia and connective tissue and hence the development of inguinal hernias (Friedman et al.,1993). Inguinal hernias present as a lump in the groin that goes away with minimal pressure or when the patient is lying down and are at risk of irreducibility or incarceration. It is usually diagnosed clinically with just history taking and confirmed by physical examination. However, in doubtful cases ultrasonography is indicated.

The inguinal hernias are one of the most common surgical conditions in the world. Studies have shown that about 75% of all abdominal wall hernias are inguinal hernias and are more common in men than women with life time risk of 27% for men and 3% for women (Jenkins J.T. & O'Dwyer P.J., 2008). The review of surgical literature shows that the most common type of hernia in Africa is the inguinal hernia (Ohene-Yeboah et al., 2009). The clinical presentation of the disease in Africa tends to run a more severe form with increased morbidity as a result of large and longstanding condition which is a consequence of neglecting this common surgical condition (Sanders et al., 2008).

Their repair is one of the most common surgical procedures done by surgeons worldwide. It is estimated that around 20 million hernial repairs are done annually in the world. In the USA alone about 800 000 cases of hernial repairs are done per year, while about 100 000 cases are done in France and 80 000 cases are carried out in the United Kingdom (Rutkow & Robbins., 1993).In Africa and Kenya there are hardly any statistics for annual hernia repairs, prevalence, demographic distribution, clinical presentations of inguinal hernias, hernial characteristics and their surgical management outcomes due to poor documentation but the burden of the disease is thought to be enormous with increased morbidity and mortality (Kushner et al., 2009).

Inguinal hernia carries a high mortality in Africa. One study reported up to 5% mortality in northwestern Nigeria. Mortality reported was higher with complicated cases of inguinal hernia (Mbah., 2007) even though the statistics of the disease are usually not adequate because only less than 1% of the population in sub-Saharan Africa is covered by accurate death registration systems and no country has sufficient quality data for the estimation of national mortality rate of inguinal hernias(Weiser et al., 2008).In most parts of Africa including Kenya, inguinal hernia is one such surgical condition that is mostly neglected or ignored resulting in a large number of deaths occurring almost on daily basis in remote areas across the continent due to lack of adequate surgical care for inguinal hernias(Nordberg et al., 2002).

The surgical treatment options of inguinal hernias include mess repair, tissue repair and laparoscopic repair. The current gold standard treatment of inguinal hernia is the open tension free mesh repair. The most popular technique in this type of procedure is the Lichtenstein procedure. This procedure involves the use of prosthetic mesh in the hernial site in order to strengthen the weak area (O'Dwyer et al., 2006). The mesh repair procedure has been proven to be associated with minimal recurrence rate and less

morbidity and mortality (Junge et al., 2001). Published data from Europe and USA show that the use of prosthetic materials gives best results in inguinal hernia repair (Lichtenstein et al., 1989). In Africa these prosthetic materials are not readily available for routine use and are considered to be expensive and therefore not cost effective (Adesunkanmi et al., 2004). Therefore, in Africa the standard surgical treatment of inguinal hernia is Bassini's repair (Archampong., 2006). Nowadays the most preferred method in inguinal hernia repair is laparoscopy because it is less invasive and gives good results (Pisanu et al., 2015). Inguinal hernia repair as published in previous studies does not come without complications. Like any other surgical procedure, most complications are seen in those patients with delayed presentation (Ohene-Yeboah., 2003).

1.2 Problem Statement

Inguinal hernia is among the most common surgical conditions worldwide and its repair is one of the most common surgical procedures done by general surgeons. In Africa and Kenya there are no statistics for annual hernia repairs, prevalence, demographic distribution, clinical presentations of inguinal hernias, hernial characteristics and their surgical management outcomes due to poor documentation. However, studies have demonstrated that the burden of IH in Africa is enormous due to large accumulated pools of untreated disease (Kushner et al., 2009). IH is also associated with high morbidity and mortality in Africa due to late presentation of patients leading to many deaths each year from complications like strangulation and intestinal obstruction as a result of lack of surgical interventions (Ohene-Yeboah et al., 2006). Although the diagnosis and management of IH can easily be achieved at MTRH, there are no statistics pertaining to the clinical presentation, surgical management and outcomes of this common condition hence the need for this study.

1.3 Justification of the Study

The results of this study will be instrumental in addressing the knowledge gap on the clinical patterns and surgical outcomes in MTRH while helping and guiding clinicians, patients and policy makers regarding treatment and outcomes of inguinal hernia.

1.4 Research Question

What is the pattern and early surgical outcome of inguinal hernia repair among adult patients at MTRH?

1.5 Study Objectives

1.5.1 Broad Objective

To describe the pattern and early surgical outcome of inguinal hernia repair among adult patients at MTRH.

1.5.2 Specific Objectives

1. To describe the demographic characteristics of adult patients with inguinal hernias at MTRH.
2. To describe the clinical presentation of inguinal hernias among adult patients at MTRH.
3. To describe the surgical management of inguinal hernias among adult patients at MTRH.
4. To determine the early surgical outcomes of inguinal hernias among adult patients at MTRH.

CHAPTER TWO:LITERATURE REVIEW

2.1 Introduction

The history of open surgery for groin hernias is itself the beginning or birth of surgery. Hernias have been known for many centuries as recorded in the surgical literature and their open repair surgery has evolved over many centuries to the current practice. Many stages of development of open groin hernia repair which occurred over centuries include the following:

a) The ancient era (Ancient Times to Fifteenth Century)

b) The era of the start of herniology (Fifteenth to Seventeenth Centuries)

c) The anatomic era (Seventeenth to Nineteenth Centuries)

d) The era of repair under tension (nineteenth to mid-twentieth century)

e) The era of tensionless repair (mid-twentieth century to the present) (Lau., 2002).

Five principles of modern hernia repair also developed through these periods of development and they are as follows:

a) Antiseptic or aseptic hernia operation

b) High ligation of the hernial sac.

c) Tightening of the internal ring.

d) Reconstruction of the posterior inguinal floor.

e) Tensionless repair.

The history of treating groin hernias has evolved from a simple life-saving procedures for strangulated hernia in the past to elective short stay surgery for uncomplicated hernias today. In this new era of evidence-based medicine, any hernia repair procedure must be carefully evaluated concerning its benefits and its costs. Benefits must be measured in clinical, social, and economic terms. Similarly, benefits are evaluated across the whole patient environment and across the whole health care system (Devlin et al., 1998).

2.2 Abdominal wall hernias

Abdominal wall hernias are one of the most common surgical conditions worldwide. Their repair is also one of the most common procedures done by surgeons in the world. Therefore, understanding these hernias is of paramount importance to both the general and pediatric surgeon. More than 1 million abdominal wall hernia repairs are performed each year in the United States, with inguinal hernia repairs constituting about 770,000 of these cases. Approximately 90% of all inguinal hernia repairs are performed on males (Condon., 1995). The various abdominal wall hernias include; epigastric, paraumbilical, umbilical, lumbar, Spigelian, inguinal and femoral.

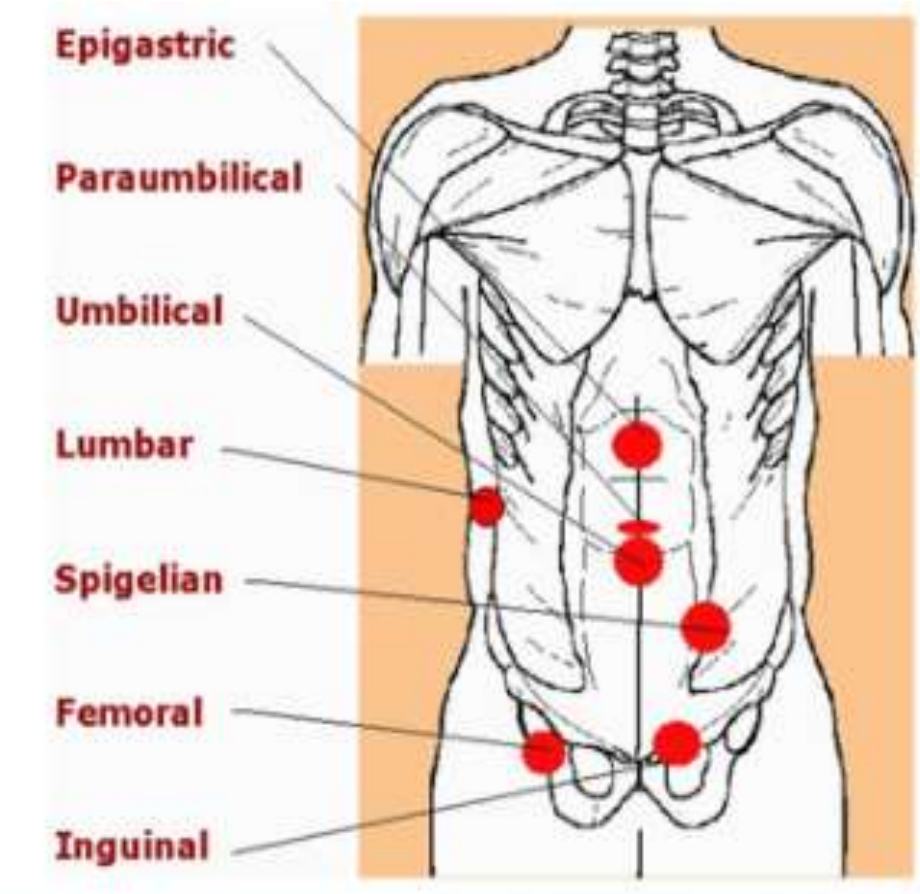


Figure 1: Anatomic locations for various abdominal wall hernias.

2.2.1 Presentation of abdominal wall hernias

Hernias are usually diagnosed clinically with history taking and confirmed by physical examination. However, in doubtful cases ultrasonography is indicated. The review of systems should be carried out when there are associated conditions, such as ascites, constipation, obstructive uropathy, chronic obstructive pulmonary disease, and cough. Hernias can be reducible, incarcerated or strangulated at the time of diagnosis.

Generally reducible or non-complicated hernias, present as a lump or swelling at the hernia site in the abdomen that goes away with minimal pressure or when the patient is lying down. Patient may complain of aching sensation that radiates into the area of the hernia. A dull pain or tenderness upon examination may be elicited. The lump or swelling enlarges with increasing intra-abdominal pressure and or standing.

In incarcerated hernias, the lump or swelling cannot be manipulated or is irreducible through the fascial defect. The individual may present with nausea, vomiting and symptoms of bowel obstruction like abdominal distension and tenderness. There could also be painful enlargement of a previously painless hernia lump or swelling.

In strangulated hernias, the swelling cannot be reduced through the fascial defect. Other associated symptoms like nausea, vomiting, and symptoms of bowel obstruction like abdominal distension and tenderness may be present. Signs and symptoms of systemic toxicity secondary to ischemic bowel may also be present. Strangulation should be suspected if pain and tenderness of a previously incarcerated hernia persist after reduction.

2.2.2 Physical examination of abdominal wall hernias

When attempting to identify a hernia, look for a swelling or mass in the area of the fascial defect, as follows:

For inguinal hernias, place a fingertip into the scrotal sac and advance up into the inguinal canal.

If the hernia is elsewhere on the abdomen, attempt to define the borders of the fascial defect.

If the hernia comes from superolateral to inferomedial and strikes the distal tip of the finger, it most likely is an indirect hernia.

If the hernia strikes the pad of the finger from deep to superficial, it is more consistent with a direct hernia.

A bulge felt below the inguinal ligament is consistent with a femoral hernia. Other abdominal wall hernias would normally be visible in their common anatomic locations in the abdomen and confirmed by presence of facial defect on examination.

2.2.3 Clinical descriptions of various abdominal wall hernias

a) Inguinal hernia: it normally presents as a bulge in the inguinal region or scrotum which is mostly intermittent. The bulge may be accompanied by a dull ache or burning pain, which usually worsens with exercise or straining e.g. coughing or micturition.
b) Spigelian hernia: occurs through slit like defect in the anterior abdominal wall adjacent to semilunar line. It mostly occurs in the lower abdomen where the posterior sheath is deficient. Local pain and signs of obstruction from

incarceration of spigelian hernia include pain that increases with contraction of the abdominal musculature.

c) Interparietal hernia: it is similar to Spigelian hernia and it occurs most frequently in previous incisions.

d) Lumbar hernia: characterized by vague flank discomfort combined with an enlarging mass in the flank and progressive protrusion through lumbar triangles, more commonly through the superior (Grynfeltt-Lesshaft) triangle than through the inferior (Petit). Lumbar hernias are not prone to incarceration.

e) Umbilical hernia: presents as bulge at the central or midabdominal area at the umbilicus.

f) Epigastric hernia: presents as small lumps along the linear alba reflecting openings through which preperitoneal fat can protrude. It may be adjacent to the umbilicus or umbilical hernia.

2.2.4 Pathophysiology of abdominal wall hernias

a) Inguinal hernia

The pinchcock action of the internal ring musculature during abdominal muscular straining prohibits protrusion of the intestine into a patent processus. Muscle paralysis or injury can disable the shutter effect. In addition, the transversus abdominis aponeurosis flattens during tensing, thus reinforcing the inguinal floor. A congenitally high position of the aponeurotic arch may preclude the buttressing effect. Neurapraxic or neurolytic sequelae of appendectomy or femoral vascular procedures may increase the incidence of hernia in these patients.

Clinical presentations suggest repetitive stress as a factor in hernia development. Increased intra-abdominal pressure is seen in a variety of disease states and seems to

contribute to hernia formation in these populations. Elevated intra-abdominal pressure is associated with chronic cough, ascites, increased peritoneal fluid from biliary atresia, peritoneal dialysis or ventriculoperitoneal shunts, intraperitoneal masses or organomegaly and obstipation.

b) Femoral hernia

A femoral hernia follows the tract below the inguinal ligament through the femoral canal. The canal lies medial to the femoral vein and lateral to the lacunar (Gimbernat) ligament. Because femoral hernias protrude through such a small defined space, they frequently become incarcerated or strangulated. Perihernial fasciae or muscles may be malformed (Chen et al., 2010).

c) Umbilical hernia

An umbilical hernia occurs through the umbilical fibromuscular ring, which is usually obliterated by age 2 years. They are congenital in origin and are repaired if they persist in children older than 2-4 years. Although umbilical hernias in children arise from failed closure of the umbilical ring, only one in 10 adults with umbilical hernias had this defect as a child. Adult umbilical hernias occur through a canal bordered anteriorly by the linea alba, posteriorly by the umbilical fascia, and laterally by the rectus sheath. Proof that umbilical hernias persist from childhood to present in adulthood is only hinted at by an increased incidence among black Americans. Multiparity, increased abdominal pressure, and a single midline decussation are associated with umbilical hernias (Katz., 2001).

d) Incisional hernia

An incisional hernia is an iatrogenic condition that occurs in 2-10% of all abdominal operations secondary to breakdown of the fascial closure of surgical procedure. Even after repair, recurrence rates approach 20-45% (Wantz., 1999).

e) Spigelian hernia

A spigelian hernia occurs through a defect in the spigelian fascia, defined by the lateral edge of the rectus abdominis at the semilunar line (from costal arch to pubic tubercle). Abnormal orientation of the semilunar and semicircular lines, along with obesity, increased intra-abdominal pressure, aging, and rapid weight loss, leads to the production of spigelian hernias.

There are two subtypes of spigelian hernia, interstitial and subcutaneous. Distinguishing between these subtypes helps optimize the surgical approach and is best done by means of computed tomography (CT) (Martin et al., 2013

f) Other abdominal hernias

An aberrant formation of the decussations of the linea alba, leading to a midline pattern of single anterior and posterior lines, predisposes to the formation of epigastric hernias (epiploceles). Internal supravesical hernias probably arise from a congenital fascial deficiency. Perihernial fasciae or muscles may be malformed in lumbar hernias. Interparietal hernias are often a product of ectopic testicular descent. Multiparity and age produce laxity of the pelvic floor to cause perineal hernias.

2.2.5 Laboratory diagnostic studies

Laboratory studies that may be helpful in investigating hernia cases include the following:

a) Stain or culture of nodal tissue - This can help diagnose atypical tuberculous adenitis.

b) Complete blood count (CBC) - Results are nonspecific, however, leukocytosis with left shift may occur with strangulation.

c) Electrolyte, blood urea nitrogen (BUN), and creatinine levels - It is advisable to assess the hydration status of the patient with nausea and vomiting; these tests are rarely needed for patients with hernia except as part of a preoperative workup.

d) Urinalysis - This can help narrow the differential diagnosis of genitourinary causes of groin pain in the setting of associated hernias.

e) Lactate levels – Elevated levels may reflect hypoperfusion.

2.2.6 Imaging studies in hernia diagnosis

Generally, imaging studies are not required in the normal workup of a hernia case as history alone and physical examination are sufficient to achieve the diagnosis. However, imaging studies may be useful in certain scenarios, as follows:

Ultrasonography can be used in differentiating masses in the groin or abdominal wall or in differentiating testicular sources of swelling.

If an incarcerated or strangulated hernia is suspected, upright chest films or flat and upright abdominal films may be obtained.

Computed tomography (CT) or ultrasonography may be necessary if a good examination cannot be obtained, because of the patient's body habitus, or in order to diagnose a spigelian or obturator hernia.

2.2.7 Management of abdominal wall hernias

Abdominal hernias can be managed non-operatively or operatively.

a) Non-operative therapeutic measures include the following:
   i. Trusses
   ii. Binders or corsets
   iii. Hernia reduction
   iv. Topical therapy
   v. Compression dressings
b) Operative measures

Surgical options depend on type and location of hernia and varies. Basic types of inguinal hernia repair include the following:

i. Bassini's repair
ii. Cooper repair
iii. Darn repair
iv. Acellular dermal implants
v. McVay repair
vi. Shouldice repair
vii. Lichtenstein repair
viii. Herniotomy repair in children
ix. Laparoscopic methods of transabdominal preperitoneal repair (TAPP) and the totally extraperitoneal repair (TEP).

2.2.8 Indications for abdominal wall hernia repairs

Inability to reduce the hernia is itself a concern for a strangulated bowel especially in a patient with a toxic appearance. All incarcerated or strangulated hernias demand admission and immediate thorough surgical evaluation. Patients with comorbid risk factors for sedation should have a surgeon present for the initial reduction attempt. Surgical options will depend on the type and location of the hernia.

a) Inguinal hernia

In general, the presence of an inguinal hernia, in the absence of mitigating factors, constitutes an indication for repair to prevent the complications of prolonged exposure such as incarceration, obstruction and strangulation. Although pressure reduction of an incarcerated hernia is generally safe, failure to reduce is not infrequent and mandates prompt exploration.

Signs of inflammation or obstruction should rule out attempts at reduction. Difficult reduction should promptly be followed by repair. Unintentional reduction of the intestine with vascular compromise leads to perforation and peritonitis with high morbidity and mortality. En masse reduction after vigorous attempts at reducing a hernia with a small fibrous neck results in ongoing compromise of the entrapped bowel (London et al., 2009)

b) Umbilical hernia

In adults, umbilical hernia repair is indicated for incarceration, a small neck in relation to the size of the hernia, ascites, chromatic skin change, or rupture. In children, the approach to managing an umbilical hernia is related to the natural history of umbilical hernias and their importance in adulthood.

Most umbilical hernias close spontaneously in children during the preschool-age period. Therefore, repair of an umbilical hernia is not indicated in children younger than 5 years unless the child has a large proboscoid hernia with thin, hyperpigmented skin or is undergoing an operation for other reasons or if the hernia causes familial or social problems.

It is the size of the fascial defect, rather than the size of the external protrusion, that predicts the potential for spontaneous closure. Usually fascial rings measuring less than 1 cm in diameter usually close spontaneously, whereas rings larger than 2 cm seldom do. Accordingly, many pediatric surgeons will repair umbilical hernias with large (>2.5 cm) fascial defects earlier than hernias with smaller fascial defects (London et al., 2009)

c) Other hernia types

Painful preperitoneal fat in an epiplocele or paraumbilical hernia may be incarcerated. This is because these defects will not close spontaneously and potential danger exists strangulation and therefore elective outpatient repair is recommended.

Because of the potential for incarceration, spigelian hernias should be repaired, as should interparietal, supravesical, lumbar, obturator, sciatic, and perineal hernias. Notably, strangulation can occur in a Richter hernia without evidence of incarceration or obstruction.

2.2.9 Surgical approaches to abdominal wall hernias

Surgical approaches vary for various hernias as described below:

a) Femoral hernia

A standard Cooper ligament repair, a preperitoneal approach, or a laparoscopic approach may be used; the procedure includes dissection and reduction of the hernia sac and obliteration of the defect in the femoral canal by approximating the iliopubic tract to the pectineal (Cooper) ligament or by using a mesh.

b) Umbilical hernia

In children, umbilical hernia repair is best performed with general anesthesia, whereas in adults, regional or local anesthesia can be used. A semicircular incision in the infraumbilical skin crease exposes the umbilical sac. A plane that is created to encircle the sac at the level of the fascial ring expedites repair. The defect is closed primarily in a transverse direction with a single layer of interrupted sutures. If the defect is very large, mesh is occasionally required.

Although excessively wrinkled skin can appear cosmetically troublesome, elasticity and growth usually corrects the problem because the skin incision lies within the umbilical fold. In cases with severe redundant skin, removal of a circle of skin and peritoneum to access the hernia, followed by a purse-string closure, provides an excellent cosmetic result. A pressure dressing is applied for several days after repair.

c) Epigastric hernia

The defect should be marked with the patient standing before the operation. After anesthetic induction, a small vertical incision directly overlying the defect is carried to the linea alba. Incarcerated preperitoneal fat may be either excised or returned to the preperitoneum. The edges of the fascial defect are approximated transversely with

interrupted sutures. Recurrence is rare, though a second epigastric hernia may develop elsewhere as a separate defect.

d) Spigelian hernia

Despite being rare and difficult to diagnose, spigelian hernias are easily approached. A transverse incision over the hernia to the sac allows dissection to the neck, and clean approximation of the internal oblique muscle and transversus abdominis completes the repair. Laparoscopic repair allows accurate delineation of the anatomy and helps establish the diagnosis in suspect instances.

e) Interparietal hernia

Because most interparietal hernias are associated with an undescended testis, the spermatic cord should be identified. In a young child, an orchiopexy is performed if the testis is not gangrenous; in an older child or adult, the testicle should be removed.

f) Supravesical hernia

Supravesical hernias are repaired with the standard techniques used for inguinal and femoral hernias, usually via a paramedian or midline incision. The internal supravesical hernia repair should include division and closure of the neck of the sac.

g) Lumbar hernia

A lumbar hernia is best approached with the patient in the lateral decubitus position and with the use of a lumbar roll or kidney rest. A skin-line oblique incision extends from the 12th rib to the iliac crest. A layered closure or mesh onlay for large defects is successful.

2.3 Inguinal hernia in adults

Inguinal hernia is a bulge of the peritoneum through a congenital or acquired defect in the muscular and fascial structures of the abdominal wall (Holzheimer., 2005).

They are most commonly seen in the groin. Inguinal hernias are more common than femoral hernias.

2.3.1 Classification of Inguinal Hernias

Inguinal hernias are classified as follow:

1. Congenital: it is present since birth
    a) Complete congenital hernia: occupying the whole length of the processus vaginalis.
    b) Incomplete congenital hernia: occupying the upper part of the processus vaginalis and not the tunica vaginalis.
2. Acquired: hernia in adults:
    1) Oblique or indirect: hernia passing through the deep inguinal ring (most of these hernias are due to the presence of variable length of patent processus vaginalis) and usually passes through the superficial ring to the scrotum. It is more common in males than females.
    2) Direct: hernia which does not pass through the deep inguinal ring and rarely reaches scrotum. It is usually divided into two types:
        a) Lateral: lateral to the medial umbilical ligament (the obliterated umbilical artery) through the so called inguinal fossa.
        b) Medial: medial to the medial umbilical ligament, through the supravesical fossa.

2.3.2 Causes of Inguinal Hernias

The exact cause of one to develop inguinal hernia is unknown. However, some factors have been implicated in the development of inguinal hernias. These include factors associated with repeated elevations of intra-abdominal pressure like chronic obstructive pulmonary disease (COPD), doing a lot of weight lifting, straining with defecation or urination, being overweight, ascites, peritoneal dialysis, ventriculoperitoneal shunt, family history of hernias and a weakening of muscle fascia and connective tissue [18] (Friedman et al.,1993). A significant increase in the frequency of hernia defects have been found to be associated with connective tissue disorders like Marfans and Elhers-Danlos syndromes, cutis laxa and osteogenesis imperfacta (Uitto J., 1986). Several authors have shown thinner, lighter anterior rectus sheaths, conjoined tendons, and transverse abdominis aponeuroses in patients with inguinal hernias (Wagh et al., 1974). Moreover, several other studies also found out in bilateral inguinal hernias to be associated with severe atrophy of anterior rectus sheath than were in unilateral hernias. Further studies also revealed diminished amount of insoluble collagen and hydroxyproline in the anterior rectus sheath of patients with inguinal hernias than compared with that in the controls (Wagh et al., 1974). Patients with inguinal hernias have been found to have a decrease in the Type Ⅰ/Type Ⅲ collagen ratio. This alteration in the ratio was found in studies to be due to an increase in the Type Ⅲ procollagen Messenger RNA (*m*RNA*)* and a concomitant increase in the synthesis of Type Ⅲ collagen. Therefore, this increase in type Ⅲ collagen synthesis may alter the physical properties of collagen matrix in the anterior abdominal wall and predispose individuals to the development of inguinal hernia (Wagh et al., 1974).

2.3.3 Pathophysiology of Groin Hernias

All groin hernias present a defect in the transversalis fascia. Myopectineal orifice is the weak area bounded by internal oblique muscle, the transverse abdominis muscle, iliopsoas muscle, rectus abdominis muscle and sheath, and the pectin of the pubis. The integrity of the abdominal wall is dependent on the oblique orientation of the inguinal canal, a sphincter like structure of the internal ring and transversalis fascia. Development of groin hernia depends on numerous factors; obesity, obstructive pulmonary disease, hyperplasia of prostate, ascites, pregnancy, constipation and colonic stenosis and which are regarded as predisposing factors because of chronically raising intra-abdominal pressure (Schumpelick et al.,1994).

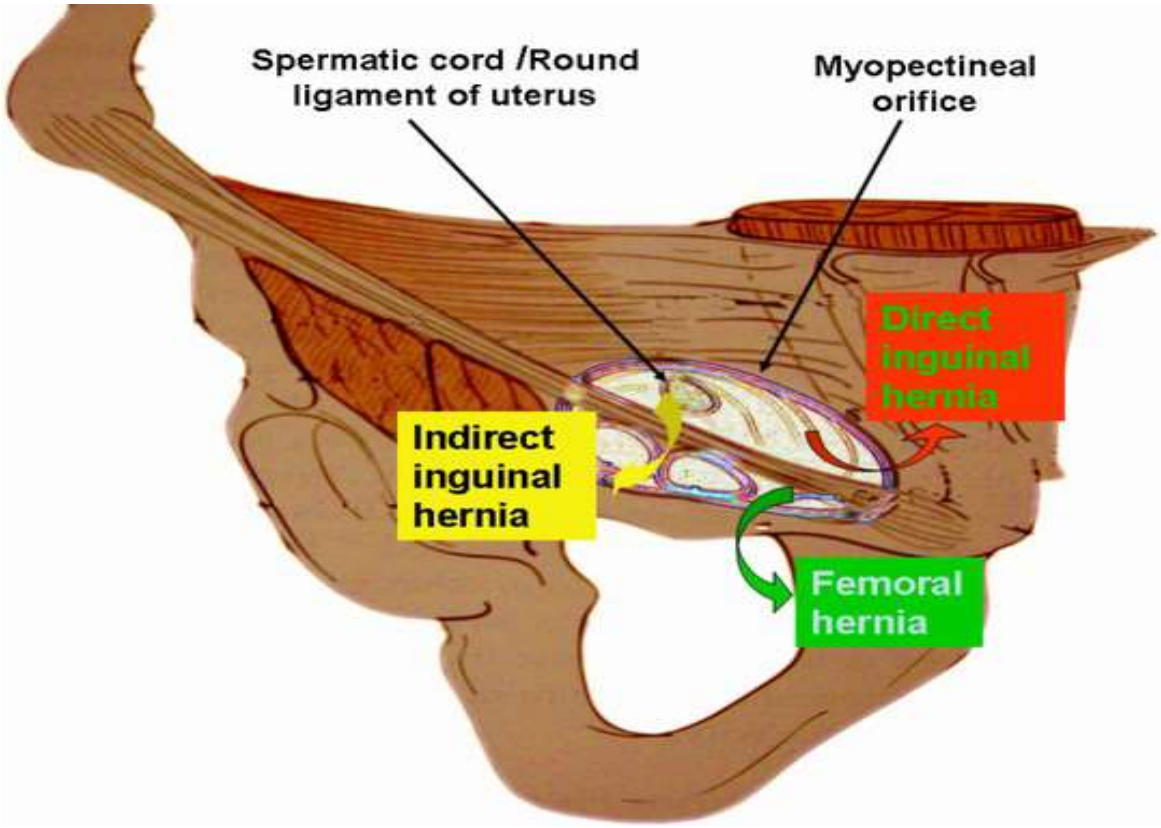


Figure 2: Diagram showing myopectineal orifice and groin hernias. Source (Yang & Liu., 2016)

2.3.4 Inguinal canal anatomy

It is a passage for the spermatic cord in male or the round ligament of uterus in female. It is a four sided canal which runs obliquely downwards and medially from the deep inguinal ring above the mid-point of inguinal ligament to the superficial inguinal ring just above and lateral to the pubic tubercle. Its length is about one and half inches. The inguinal canal has four walls: anterior, posterior, roof and floor.

a) Anterior wall: it is formed by the external oblique aponeurosis in its whole length and the fleshy fibers of internal oblique in the lateral half.
b) Posterior wall: is formed by fascia transversalis along its whole length, conjoint tendon covering medial half, reflected ligament along its medial quarter.
c) Roof: is formed by the arching fibers of internal oblique assisted by those of the transversus abdominis.
d) Floor: formed by the inguinal ligament along its whole length and on its medial end is formed by the lacunar ligaments.

2.3.5 Contents of the inguinal canal

The contents of the inguinal canal include spermatic cord in male and round ligament in females, ilioinguinal nerve, cremasteric artery and genital branch of genitofemoral nerve.

2.3.6 Compensatory factors that strengthen the inguinal canal

The canal could appear as a weak lower part of the anterior abdominal wall which permits the passage of some of the contents of the abdominal cavity down through which may reach the scrotum, a condition called inguinal hernia, however, certain compensating factors help in strengthening the inguinal canal.

1. The obliquity of the canal brings the two rings away from each other which resist the increased intra-abdominal pressure.
2. The posterior wall is strengthened by the conjoint tendon and the reflected ligament.
3. The internal oblique supports the deep ring anteriorly while the reflected ligament supports the superficial ring posteriorly.
4. The arching fibers of internal oblique around the canal perform what is called the shutter mechanism as it closes the canal as it contracts.

2.3.7 Structures in the inguinal region

a) Blood vessels

Vessels regularly found during inguinal hernia repairs are the superficial circumflex iliac, superficial epigastric, and external pudendal arteries, which arise from the proximal femoral artery and course superiorly. The inferior epigastric artery and vein run medially and cephalad in the preperitoneal fat near the caudad margin of the internal inguinal ring.

The external iliac vessels pass posterior to the inguinal ligament and iliopubic tract and anterior to the pectineal ligament to enter the femoral sheath. The external spermatic artery arises from the inferior epigastric artery just caudad to the internal inguinal ring to supply the cremaster muscle.

b) Other structures

The inguinal ligament bridges the space between the pubic tubercle and the anterior superior iliac spine and rotates posteriorly and then superiorly to form a shelving edge. It is the caudad edge of the external oblique aponeurosis. This ligament revolves medially to create the lacunar ligament, which inserts on the pubis and courses medially

and superiorly toward the midline. The external oblique aponeurosis has a triangular opening with a superior apex, through which the cord enters the inguinal canal.

The transversus abdominis is the predominant abdominal wall layer for the prevention of inguinal hernias. The transversus abdominis aponeurotic arch inserts inferiorly on the Cooper ligament and contributes to the anterior rectus sheath medially.

The pectineal ligament courses from the superior part of the superior pubic ramus periosteum. The components incorporate fibers from the lacunar ligament, the transversus abdominis aponeurosis, and the pectineus.

An aponeurotic band from the caudad portion of the transversus abdominis creates the iliopubic tract. It is the anterior margin of the femoral sheath and the caudad border of the internal ring. The course is from the superior pubic ramus medially to the iliopectineal arch and iliopsoas fascia, anterior to the femoral vessels, and then laterally to the anterior superior iliac spine.

The iliacus fascia thickens as it exits the pelvis to form the iliopectineal arch. The fascia curves forward, lateral to the external iliac vessels, and combines with fibers from the inguinal ligament, from the internal oblique muscle and the transversus abdominis, and from part of the ligament lateral attachment of the iliopubic tract. The external iliac vessels pass beneath the inguinal ligament and iliopubic tract but anterior to the pectineal ligament to enter the femoral sheath.

The femoral sheath, with contributions from the transversalis, pectineus, psoas, and iliacus fasciae, has three compartments. A femoral hernia most often occurs in the most medial compartment. The femoral canal is bounded laterally by the femoral vein. The

medial margin is the transversus abdominis aponeurosis insertion and transversalis fascia. The femoral canal holds lymphatic channels and lymph nodes.

The superolateral border of the Hesselbach triangle is the inferior epigastric vessels. The inguinal ligament constitutes the inferolateral side. The lateral edge of the rectus sheath is the medial side.

The internal ring is bordered by the transversalis fascia circumferentially and deep, the arch of the internal oblique and transversus abdominis muscles superomedially, and the iliopubic tract inferolaterally. The course of the spermatic cord or round ligament through the abdominal wall defines the inguinal canal. Transversus abdominis aponeurosis and transversalis fascia combine to make the floor of the inguinal canal in 75% of persons (a minority have only transversalis fascia). The external oblique aponeurosis is anterior, and the inguinal ligament is inferior.

The vas deferens and the testicular artery and vein constitute the spermatic cord. The innominate fascia extends onto the cord as the external spermatic fascia. The cremasteric fascia and the cremaster muscle extend from internal oblique muscle and its aponeurosis to provide the most external investment of the cord. The next layer, the internal spermatic fascia, is an extension of the transversalis fascia and contains the cord structures and tunica vaginalis (or an indirect hernial sac, when present).

The inferior epigastric artery, which arises from the external iliac artery and courses with its companion vein vertically in the preperitoneal fat, is the anatomic point differentiating indirect inguinal hernias from direct inguinal hernias. Hernias presenting superolateral to the inferior epigastric vessels are indirect inguinal hernias, whereas those arising inferomedial to these vessels are direct inguinal hernias.

The iliohypogastric and ilioinguinal nerves originate principally from the first lumbar nerve root and have contributions from the 12th thoracic root. The nerves traverse the transversus abdominis in the middle of the iliac crest, are deep to the internal oblique muscle until the anterior superior iliac spine, and then become superficial just beneath the external oblique aponeurosis.

The ilioinguinal nerve then runs anterior to the spermatic cord in the canal to receive sensation from the pubis and the upper scrotum (labium majus). The genital branch of the genitofemoral nerve, which arises from the first and second lumbar nerve roots, becomes superficial near the internal ring to supply motor fibers of the cremaster muscle and sensation for the scrotum and the medial aspect of the upper thigh.

The intraperitoneal view has the medial umbilical ligament as the lateral border of the bladder, and the lateral umbilical ligament helps identify the inferior epigastric vessels.

The internal inguinal ring is the apex of a triangle formed medially by the ductus deferens and laterally by the testicular vessels. The base of the triangle contains the external iliac vessels, which may be injured during laparoscopic hernia repair. The pubic tubercle, the iliopubic tract, the transversus abdominis muscular arch, the lacunar ligament, the pectineal ligament, and the lateral border of the rectus abdominis usually are easily visualized.

2.4 Epidemiology of inguinal hernias (globally)

A review of surgical literature shows that inguinal hernias are amongst the most common surgical conditions operated by general surgeons in the world. The studies have shown that inguinal hernias are the most common amongst abdominal wall hernias.

In the United States, statistically about 10% of the population develops some type of hernia in their lifetime. More than 1 million abdominal hernia repairs are performed each year, with inguinal hernia repairs constituting nearly 770,000 of these cases (Ruhl & Everhart., 2007).

Approximately 75% of all hernias are inguinal; of these, 50% are indirect (male-to-female ratio, 7:1), with a right-side predominance, and 25% are direct. About 3% of inguinal hernias have a sliding component, most often on the left side (left-to-right ratio, 4.5:1) (Katz., 2001). Frequencies of various types of hernias are as follows:

About 14% of hernias are umbilical and 10% of hernias are incisional or ventral (female-to-male ratio, 2:1) while 3-5% of hernias are femoral (Matthews & Neumayer., 2008). Interparietal, supravesical, lumbar, sciatic, and perineal hernias are rare; interparietal hernias are on the right side in 70% of cases, and a similar percentage of cases involve testicular maldescent.

Data from developing countries are limited. Consequently, accurate determinations of incidence and prevalence are unavailable. Current epidemiologic assessments suggest that gender distribution and anatomic distribution are similar to those in more developed countries.

2.4.1 Demographic characteristics of inguinal hernias

IH are more common in men than women (Jenkins & O'Dwyer., 2008). Another study in India also found that males outnumbered females by ratio of 82:1 (Sangwan et al., 2013). One study found out that most men who are affected by inguinal hernia are those in early adulthood to old age, and also indirect hernia are more common than direct hernia. It also found out that inguinal hernia was more common on the right than left side (Ohene-Yeboah et al., 2009). In Africa and Kenya there is hardly any published statistics for annual hernial repairs, prevalence, demographic distribution, clinical presentations of inguinal hernias, hernial characteristics and their surgical management outcomes due to poor documentation. The burden of the disease is thought to be enormous with increased morbidity and mortality (Kushner et al., 2009). The review of literature shows that the most common type of hernia in Africa is the inguinal hernia (Ohene-Yeboah et al., 2009). In most parts of African continent, inguinal hernia results in high mortality in remote areas across the continent (Nordberg et al., 2002). Estimates from Africa also indicate that 175 inguinal hernia repairs are needed per 100 000 populations per year, but only 25 of the 175 cases are carried out and of the 30 emergency hernia surgeries estimated per 100 000 population only three or four are done (Nordberg., 1984). As a result, in many African communities there are large accumulated pools of untreated inguinal hernias. Therefore, many patients with untreated inguinal hernias die each year from the complications of the disease like strangulation and intestinal obstruction without the benefit of surgical intervention (Ohene-Yeboah et al., 2006). Inguinal hernias cause high mortality in Africa even though the statistics of the disease are sparse. In Sub-Saharan Africa less than 1% of the population is covered by accurate death registration systems and no country has sufficient quality data for the estimation of national mortality rate in inguinal hernias.

For a disease that is anatomic in nature and easily diagnosed clinically with potential for a complete cure if treated early, the mortality should be zero (Weiser et al., 2008).

2.4.2 Age-related demographics of inguinal hernias

The prevalence of all varieties of hernias increases with age.

The incidence of inguinal hernias in children is as high as 4.5%. Indirect hernias usually present during the first year of life, but they may not appear until middle or old age. Indirect hernias are more common in premature infants than in term infants; they develop in 13% of infants born before 32 weeks' gestation. Direct hernias occur in older patients as a result of relaxation of abdominal wall musculature and thinning of the transversalis fascia.

Umbilical hernias occur in approximately one of every six children. They usually develop in infants and reach their maximal size by the first month of life. Most hernias of this type close spontaneously by the first year of life; the incidence in children older than 1 year is only 2-10% (Kapur et al., 1998).

Spigelian hernias are rare and typically occur around the age of 50 years. There is no sex or side predilection reported literature. Primary perineal hernias occur most often in elderly multiparous women. Obturator hernias occur most often in thin, elderly women and are more common on the right side. Richter hernias present late in life, most often in women with femoral hernias. Littre hernias have a much broader spectrum of hernia site and occur across all ages.

2.4.3 Sex-related demographics of inguinal hernias

Inguinal hernias are the most common type in both males and females; approximately 25% of males and 2% of females have an inguinal hernia over the course of their lifetime. The male-to-female ratio for indirect inguinal hernia is 7:1. (Rutkow & Robbins., 1993)

Sliding hernias are much more common in men than in women, and the predominance increases with age.

Femoral hernias occur more frequently in women because of the differences in the pelvic anatomy (female-to-male ratio, 1.8:1). Umbilical hernias are equally common in male and female children but are 3 times more frequent in female adults than in male adults (overall female-to-male ratio, 1.7:1). Incisional or ventral hernias are also more common in females (female-to-male ratio, 2:1), as are obturator hernias (female-to-male ratio, 6:1). Epigastric hernias have a prevalence of 0.5% and are more common in males (male-to-female ratio, 3:1). (Rutkow., 1998).

2.4.4 Race-related demographics of inguinal hernias

Umbilical hernias are much more common in persons of African ethnicity. With respect to the pediatric population, umbilical hernias occur eight times more frequently in black infants than in white infants (Rutkow., 1998).

2.5 Clinical Presentation of inguinal hernias in adults

The clinical presentation of the disease in Africa when compared to Europe is more severe; in that in Africa, inguinal hernias tend to run a more severe form with increased morbidity as a result of large and longstanding condition (Sanders et al., 2008). The other major difference between African and European hernias is that in Africa adult patients present to hospital as emergencies as compared to elective repair (Ohene-

Yeboah et al., 2009). Higher proportions of IH emergency operations were also reported from Uganda (Odula & Kakande., 2004) However, some studies from Nigeria and Sierra Leone have reported lower proportions of emergency operations (Adesunkanmi et al.,2000 and McConkey.,2002) respectively. Rare unusual presentation of inguinal hernia such as entero-scrotal fistula have also been reported in African hernias, as a result of neglected strangulated inguinal hernia (Ohene-Yeboah., 2011).

2.5.1 History

Inguinal hernias present with a lump in the groin that goes away with minimal pressure or when the patient is lying down. Most cause mild to moderate discomfort that increases with activity. Inguinal hernias are at risk of irreducibility or incarceration, which may result in strangulation and obstruction; however, unlike with femoral hernias, strangulation is rare. Older age and longer duration of hernia and of irreducibility are risk factors for acute complications (Jenkins & O'Dwyer., 2008).

2.5.2 Physical examination

In adults, inguinal hernias are usually suspected from just history taking and the diagnosis confirmed by physical examination. A hernia is reducible if it occurs intermittently (such as on straining or standing) and can be pushed back into the abdominal cavity, and irreducible if it remains permanently outside the abdominal cavity. A reducible hernia is usually a longstanding condition and diagnosis is made clinically, on the basis of typical symptoms and signs. The condition may be unilateral or bilateral and may recur after treatment (recurrent hernia). Inguinal hernias are often classified as direct or indirect, depending on whether the hernia sac bulges directly through the posterior wall of the inguinal canal (direct hernia) or passes through the internal inguinal ring alongside the spermatic cord (indirect hernia) (Jenkins &

O'Dwyer., 2008). IH is most commonly seen on the right side than left and indirect cases are mostly encountered than direct and bilateral (Mabula &Chalya., 2012).

2.5.3 Imaging investigations in inguinal hernia

Experienced surgeons can only distinguish a direct from indirect hernia in about 70% of cases by clinical examination. In patients who report symptoms but do not have appropriate signs ultrasonography is indicated (Schumpelick et al., 1994). With ultrasound examination in supine and upright positions supported by Valsalva manouevre, inguinal hernia can be diagnosed with sensitivity and specificity of more than 90% (Schumpelick et al., 1994).

a) Computed Tomography

CT-scan of the abdomen and pelvis with oral and intravenous (IV) contrast can help detect many elusive hernias by demonstrating extracoelomic location of the bowel, bladder, or female internal reproductive organs. CT-scan may be indicated in the diagnosis of a spigelian or obturator hernia and in cases where the patient's body habitus makes it difficult for the physician to perform a good physical examination (Toms et al., 1999).

b) Ultrasonography

Ultrasonography is helpful in narrowing the differential on both scrotal masses and masses below the inguinal ligament. It can also aid in the decision to drain or aspirate a nodal abscess. Like CT, ultrasonography may be indicated when a spigelian or obturator hernia is suspected or when the patient's body habitus hinders physical examination.

Generally, imaging studies are not required in the normal workup of a hernia case as history alone and physical examination are sufficient to achieve the diagnosis. However, imaging studies may be useful in certain scenarios, as follows:

i. Ultrasonography can be used in differentiating masses in the groin or abdominal wall or in differentiating testicular sources of swelling.

ii. If an incarcerated or strangulated hernia is suspected, upright chest films or flat and upright abdominal films may be obtained.

iii. Computed tomography (CT) or ultrasonography may be necessary if a good examination cannot be obtained, because of the patient's body habitus, or in order to diagnose a spigelian or obturator hernia.

2.6 Surgical Management Options of Inguinal Hernias

Inguinal hernias are the most common surgical conditions in the world hence their repair is one of the most common surgical procedures done by surgeons. Their surgical treatment options include mess repair, tissue repair and laparoscopic repair. The most popular surgical techniques among surgeons worldwide at present, are the Shouldice repair (tissue repair), the Lichtenstein repair (mesh repair), and the laparoscopic methods of transabdominal preperitoneal repair (TAPP) and the totally extraperitoneal repair (TEP). The advantages of Shouldice and Lichtenstein repairs are that they can be carried out under local anesthesia and their postoperative complication rates and long-term recurrence rates are low. The Lichtenstein technique has also the added advantage that it is a simpler operation with a shorter learning curve than the Shouldice repair. The advantages of laparoscopic procedures are that they are less painful, patients can return to work in a shorter time, and bilateral repairs are most suitable. The disadvantages of the laparoscopic techniques include significantly higher operative costs, the risks inherent in general anesthesia and longer learning curve (200-250 cases). Moreover, the long-term recurrence rates following laparoscopic repairs are not known. The current gold standard treatment of inguinal hernia in the world is the open tension free mesh

repair and the most popularized technique is Lichtenstein procedure. This type of procedure involves prosthetic mesh used at the hernial site to strengthen the weak area (O'Dwyer et al., 2006). The mesh repair procedure has been proven to be associated with minimal recurrence rate and less morbidity and mortality (Junge et al., 2001). Mesh repair also gives best results in inguinal hernia repair as it is associated with less postoperative pain and early return to work by patients (Lichtenstein et al., 1989). However, this is not the same for Africa because of cost implications and availability of the mesh (Adesunkanmi et al., 2004). Therefore, in Africa the standard surgical treatment of inguinal hernia is Bassini's repair (Archampong., 2006). Nowadays the most preferred method in inguinal hernia repair is laparoscopy because it is less invasive and gives good results (Pisanu et al., 2015).

2.6.1 Indications for inguinal hernia repair

Normally the presence of inguinal hernia, has been considered reason enough for operative intervention. However, some studies have shown that the presence of a reducible hernia is not an indication for surgery and that the risk of incarceration is less than 1%. Patients experiencing symptoms such as pain or discomfort should undergo repair; however, as many as one third of patients with inguinal hernias are asymptomatic. A long-term follow-up study determined that most patients with a painless inguinal hernia will develop symptoms over time and concluded that surgery is recommended for medically fit (asymptomatic) patients (Wantz., 1994)

2.6.2 Contraindications for inguinal hernia repair

Inguinal hernia repair has no absolute contraindications. However, just as in any other elective surgical procedure, the patient's medical status must be optimized. Any underlying medical issues such as upper respiratory tract or skin infection, poorly controlled diabetes mellitus, chronic constipation, urinary obstruction, persisting cough,

obstruction or strangulation, or allergy to local anesthesia or prosthetic devices should be fully addressed and the operation delayed accordingly. Patients with elevated American Society of Anesthesiologists (ASA) scores and high operative risk should undergo a full preoperative workup and determination of the risk-to-benefit ratio.

2.6.3 Basic tissue repair techniques for inguinal hernia

a) Bassini's repair

The basic principle of the Bassini's repair is apposition of the conjoint tendon (internal oblique and transversus abdominis aponeurosis), transversalis fascia, and lateral rectus sheath to the inguinal ligament. This is usually performed by overlapping of the edges.

b) Shouldice repair

The Shouldice technique is a four-layer inguinal hernia repair performed with the patient under local anesthesia. The transversalis fascia is incised from the internal ring laterally to the pubic tubercle medially, and upper and lower flaps are created. These flaps are then overlapped (double-breasted) with two layers of sutures.

The conjoined tendon is then sutured to the inguinal ligament, again in two overlapping layers. This reinforces the posterior wall and narrows the deep inguinal ring. The Shouldice repair is classically done with a continuous suture of 32- to 34-gauge stainless steel wire, but synthetic monofilaments (e.g. polypropylene) can also be used. The external oblique aponeurosis is then closed in a double-breasted fashion in front of the spermatic cord.

c) Cooper repair

The Cooper repair approximates the conjoint area, transversus abdominis, and transversalis fascia to the pectineal (Cooper) ligament. Overlying the vein, these

structures are sewn to the iliopubic tract. This technique also provides a good approach for the repair of femoral hernias.

d) Darn repair

A darn inguinal hernia repair is a pure-tissue tensionless technique that is performed by placing a continuous suture between the conjoined tendon and the inguinal ligament without approximating the two structures.

e) McVay repair

This technique involves suturing of conjoint tendon to the Cooper's ligament with interrupted non-absorbable sutures

f) Acellular dermal implant

Some reports describing the use of an acellular dermal implant e.g. AlloDerm, LifeCell, Bridgewater and others. In cases where the surgical field is contaminated, however, long-term results are not yet available (Martin et al., 2008).

2.7 Surgical Management Outcomes

There are very few studies on the outcome of inguinal hernia repair in Africa. In most parts of the African continent, inguinal hernia is one of the ignored surgical conditions and therefore results in large number of deaths (Ohene-Yeboah & Abantanga., 2011). This high mortality usually happens in remote areas across the continent where there is lack of adequate surgical care for inguinal hernias (Nordberg et al., 2002). Many patients with untreated inguinal hernias die each year from the complications of the disease which include strangulation and intestinal obstruction (Ohene-Yeboah et al., 2006).

Inguinal hernia carries a high mortality in Africa even though the overall statistics of the disease are sparse. Uncomplicated IH has been found to be associated with less

postoperative morbidity (Kimyil et al., 2000). Complicated disease carries higher rates of postoperative morbidity (Fall et al., 2005). Higher mortality rates are reported in complicated IH cases (Mbah., 2007 and Haruna et al., 2000). Postoperative pain is the most notable and often ignored long term sequelae of IH operation (Callesen et al., 1998).

Early postoperative complications include seroma formation and hematoma, urinary retention, and wound infections. Late postoperative complications include sensory loss, hyperesthesia, chronic inguinal pain, mesh-related problems, hydrocele, testicular pain, testicular swelling, atrophy, and recurrence of hernia.

2.7.1 Peri-operative complications

Complications may develop intraoperatively or postoperatively.

a) Intraoperative complications

Intraoperative complications of open inguinal hernia repair include vascular injuries, injuries to abdominopelvic structures, and nerve injuries.

i. Vascular injuries

Superficial epigastric vessels in the incision may bleed. These vessels not only should be identified when the incision is being made but also should be ligated and divided. Inferior epigastric vessels may be injured during dissection of the spermatic cord in the inguinal canal, dissection of an indirect inguinal hernia sac within the spermatic cord, plication of the transversalis fascia, or transfixion of the hernial sac. Therefore, these vessels should be identified at an early stage and protected. External iliac or femoral vessels, especially veins, may be injured during fixation of the mesh to the inguinal ligament in its lateral part. The tissue bites in the inguinal ligament should not be very deep. Vascular injuries are less common than other intraoperative complications but are, however, potentially disastrous. They can be avoided by respecting the proximity

of the femoral vessels, particularly when suturing the mesh to the inguinal ligament. Hematoma formation can result from injury of the inferior epigastric vessels or pampiniform plexus veins or from failure to ligate the superficial subcutaneous veins.

ii. Injuries to abdominopelvic structures

Cord structures like testicular artery, pampiniform plexus of veins, and vas deferens may be injured during opening of the coverings of the spermatic cord or dissection of the indirect hernial sac within the spermatic cord. In particular, the surgeon should always be aware of the vas deferens and should protect it from injury.

Injury to the urinary bladder may occur during plication of the transversalis fascia. In addition, injury to the urinary bladder, cecum, or sigmoid colon may occur during transfixion of the hernial sac in a sliding indirect inguinal. A sliding hernia should be recognized early; if it is present, the entire hernial sac should not be excised.

Injury to the bowel may occur during transfixion of the neck of an indirect hernial sac. The head end of the operating table can be lowered to ensure complete reduction of contents of the sac, the sac can be twisted to push the contents into the peritoneal cavity, and a tissue bite can be taken and the suture tied under vision.

iii. Nerve injuries

- The iliohypogastric nerve, because of its lying on the conjoined tendon outside the inguinal canal, may be injured during dissection of the upper flap of the external oblique aponeurosis or fixation of the mesh to the conjoined tendon. It may also become trapped in sutures during closure of the external oblique aponeurosis.
- The ilioinguinal nerve, because it lies in the inguinal canal along with the spermatic cord, may be injured during dissection of the cord.

- The genital branch of the genitofemoral nerve, because it lies within the spermatic cord, may be injured during dissection of the hernia sac.

b) Postoperative complications

i. Urinary retention

Urinary retention may occur after open inguinal hernia repair, especially in middle-aged and elderly male patients with prostatic enlargement. Have been observed to range from 0.37% to 3% and such retention is said to be due to the inhibitory effect of regional and general anesthesia on bladder function. "International guidelines for groin hernia management." Hernia 22 (2018): 1-165.

ii. Seroma

Most seromas disappear spontaneously within 6-8 weeks, however, if it persists it may be aspirated. Seroma formation can be minimized by careful dissection and achieving adequate hemostasis.

iii. Hematoma

A small hematoma may be treated conservatively. For larger hematomas, which are asymptomatic, evacuation under anesthesia should be considered. Meticulous dissection with adequate hemostasis will reduce the incidence of hematoma formation.

iv. Infection

Deep and persistent infection may necessitate removal of the mesh. Wound infection can also weaken the repair and may be responsible for recurrence of the hernia.

v. Pain

Postoperative chronic pain has become one of the most important primary endpoints in hernia surgery. In published reports, the incidence of postherniorrhaphy pain has ranged

from 0% to more than 30%. Chronic inguinodynia is defined as pain persisting more than 3 months post herniorrhaphy, after the process of wound healing is complete.

Non-fixation or inadequate mesh fixation results in folding and rolling of the mesh, which can cause chronic pain and recurrence of the hernia.

Chronic pain after mesh hernioplasty also results from neuroma formation after accidental division of the nerves. The ilioinguinal, iliohypogastric, and genitofemoral nerves are visualized and protected throughout the operation. They should not be dissected free from their natural bed as doing so can lead to perineural fibrosis and resulting in chronic pain postoperatively. Deliberate sectioning of the nerves intraoperatively to prevent chronic groin pain has been described but it is still controversial. Current recommendations consist of nerve identification, minimal handling, and preservation. Prevention of nerve injury is very important because treatment of chronic neuralgias may not be successful. The nerve entrapment by suture or mesh is also an important cause of postoperative pain. The groin nerves should be identified and protected. Fibrin or biologic glues may be used instead of sutures to secure the mesh. Cyanoacrylate glue may be used an alternative to sutures, and it is anticipated that the use of fewer sutures may be associated with less inguinodynia (Hakeem & Shanmugam., 2011).

Another cause of significant postherniorrhaphy pain is the placement of a stitch into the periosteum at the pubic tubercle for fixation of the mesh medially. This is often the point of maximal tenderness postoperatively. Therefore, one should avoid taking a deep bite through the periosteum of the pubic tubercle; tough, fibrous tissue in that region should instead be used for fixing the mesh.

The use of a low-density macroporous mesh with semiresorbable, self-fixing properties during tension-free repair may be a satisfactory solution to the clinical problems of pain and recurrence after inguinal herniorrhaphy (Chastan., 2009).

vi. Scrotal edema

Scrotal edema due to venous and lymphatic damage during dissection within the spermatic cord may also occur.

vii. Ischemic orchitis and thrombosis

Ischemic orchitis leading to testicular atrophy is a rare but well-known complication of inguinal hernia surgery. The patient may complain of pain and testicular swelling postoperatively. Symptoms may last for 2-3 months, and testicular atrophy may occur.

Thrombosis is caused by surgical trauma to the delicate veins of the pampiniform plexus and disruption of the collateral blood supply to the testes during an attempt at complete removal of a large hernia sac. It is also more likely in operations for recurrent hernia. It is therefore advisable not to attempt complete dissection and excision of a large hernia sac.

viii. Recurrence

Recurrence may be more frequent in the presence of comorbid conditions such as chronic obstructive pulmonary disease or obesity or with the use of steroids. Other contributing factors may be the use of too-small pieces of mesh placed flat under tension, failure to achieve adequate overlap (medially, 2 cm beyond the pubic tubercle; laterally, 5-6 cm beyond the internal ring), or failure to cross the tails of the mesh.

The recurrence rate for Lichtenstein hernioplasty at specialized clinics in the United States is consistently less than 1%. In an audit of Lichtenstein hernioplasty performed

with local anesthesia by surgical residents, the recurrence rate was 2.1% over a 10-year follow-up period.

Recurrence in Lichtenstein hernioplasty may be due to inaccurate execution of the technique like inadequate size or improper fixation of the mesh or to an overlooked hernia at the primary operation. To avoid the latter, the patient should be asked to cough, and the region should be carefully examined for an indirect hernia, a direct hernia, a femoral hernia, or a combined hernia.

CHAPTER THREE: METHODOLOGY

3.1 Study design

This was a hospital based descriptive prospective study of adults (18 years and above) who presented with and operated on for inguinal hernia at MTRH. These patients were then followed up for one month after surgery.

3.2 Study site

Moi Teaching and Referral Hospital is a tertiary medical institution situated along Nandi road, in Eldoret town. It is the second biggest referral hospital in the country of 47 million people. The town is Kenya's fifth largest town and is the headquarters of Uasin Gishu County in the North Rift Valley. It is approximately located 320 kilometres North West of Nairobi, the capital city of Kenya.

MTRH has a bed capacity of 1000 and has varied surgical specialties that handle both outpatient and inpatient services. It serves as the teaching hospital for Moi University and other educational institutions offering different health professional training.

It also serves as referral health institution with a wide catchment area including Western part of Kenya, Eastern part of Uganda and Southern Sudan with at least 20 million people; almost half of Kenya population.

3.3 Study period

The study was conducted for 12 months with 1 month follow up of each patient. The study commenced in March 2018 and ended in February 2019.

3.4 Study Population

All adult patients admitted to MTRH with a diagnosis of inguinal hernia and who were operated on.

3.5 Sampling method and Sample size calculation

This was a prospective study where all adult patients with inguinal hernias and who met the eligibility criteria between 1st of March 2018 and 28th February 2019 were included. These participants were recruited from accidents and emergency department, surgical wards and clinics where data was collected. The patients were recruited consecutively till the end of the study period.

A sample size was initially calculated using the Cochran (1963) sample determination formula for populations >10,000 which gave a sample size of 186 participants.

Below is the Cochran (1963) sample size determination formulae for populations >10,000

$$n_0 = \frac{Z^2 * p * (1 - p)}{e^2}$$

Equation 3.1: The Cochran formula

- Z = Standard normal deviation set at 1.96, corresponding to 95% confidence interval.
- p = proportion of the population presumed to have the characteristic of study (38.7% SSI by Mabula & Chalya, 2012) = 0.387
- 1 – p = 0.613
- e = desired level of precision (i.e. the margin of error), set at 0.05
- n0 = 186

After looking at the documented records of patients with inguinal hernia at the hospital registry who had been admitted between Jan 2015 to Dec 2017, it was determined that the average for the three years was 88 per year.

Based on recommendations for such small and finite population (populations <10,000), the sample size was further subjected to a modified Cochran formula which returned a new sample size of 66 participants after adjusting for non-responders.

Below is the Cochran sample size determination formulae for populations <10,000.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Equation 3.2: The modified Cochran formula

- n0 = Cochran's sample size recommendation
- N = The population size for finite populations (Average of 88 patients per year who were operated for inguinal hernias between 2015 and 2017)
- n = The new, modified sample size = 60, and with 10% adjustment for non-responders = 66 participants

The researcher therefore required to recruit a minimum of 66 participants to be able to make correlations and draw conclusions from this study but decided to incorporate all seen in the one year period; totaling 103 participants.

3.6 Eligibility Criteria

3.6.1 Inclusion Criterion

All adult patients diagnosed with inguinal hernia and who underwent surgical treatment at MTRH.

3.6.2 Exclusion Criteria

Patients who declined to participate in the study.

3.7 Study Procedure

3.7.1 Recruitment of patients

The starting point of data collection was at three places depending on time of contact: accident and emergency department, surgical wards and clinics. All patients diagnosed with IH at Accident and Emergency and were scheduled for herniorrhaphy were recruited in the study. Detailed history taking was conducted and data on demographics, clinical presentation and duration of symptoms as well as the surgical treatment plan were all documented in data collection form. This was followed by physical examination to determine the site of IH, reducibility status and any associated symptoms including abdominal pain and distension, vomiting, fever and inability to pass stools. These findings were further documented on the data collection form. Postoperatively, relevant data on intraoperative findings and definitive procedure done as per case notes were all entered in the data collection form. Primary outcome measures were postoperative complications, length of hospital stay and death. Patients were also evaluated at second and fourth week postoperatively. These data were recorded at discharge and up to four weeks postoperatively or in-hospital death, either of which was taken as the study end point. All filled questionnaires were checked for completeness and coded accordingly. Data was then entered into access database and exported to STATA version 15 statistical software for analysis.

3.7.2 Assessing outcome parameters

Surgical site/wound infection-Infection within 30 days after the operation characterized by at least one of the following: 1) Purulent drainage with or without laboratory confirmation, 2) Organisms isolated from an aseptically obtained culture of fluid or tissue from the incision or 3) At least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat and superficial

incision deliberately opened by surgeon, unless incision is culture-negative (CDC Procedure-associated Module, January 2017).Patient satisfying the criteria were considered to have surgical wound infection.

Wound haematoma: defined as the collection or pooling of blood under the skin, in body tissues or an organ. Haematoma is characterized by painful swelling, inflammation, feeling of fullness in the affected area, along with the overlying skin turning blue or purple. It usually appears within first 24 hours but can arise after three weeks as well. Haematoma when present in the scrotum is referred to as scrotal haematoma and when present around surgical wound is wound haematoma

The patient with the above findings on examination were recorded as having haematoma in the data collection form.

Seroma formation: is collection of serous fluid under the surface of the skin. Seroma will have the appearance of a swollen lump, like a large cyst which is tender or sore when touched. A clear discharge from the surgical incision is common when a seroma is present.

The patient with above findings on examination were considered to have seroma.

Postoperative urinary retention: inability to void urine eight hours after the end of surgery, and the bladder is distended and patient is uncomfortable (Baldini et al., 2009). Patients satisfying the above criteria were recorded in the data collection form as having postoperative urinary retention.

Prolonged ileus: lack of movements in the intestines beyond three days following abdominal surgery leading to build up or blockage of food materials (Bauer & Boeckxstaens., 2004).

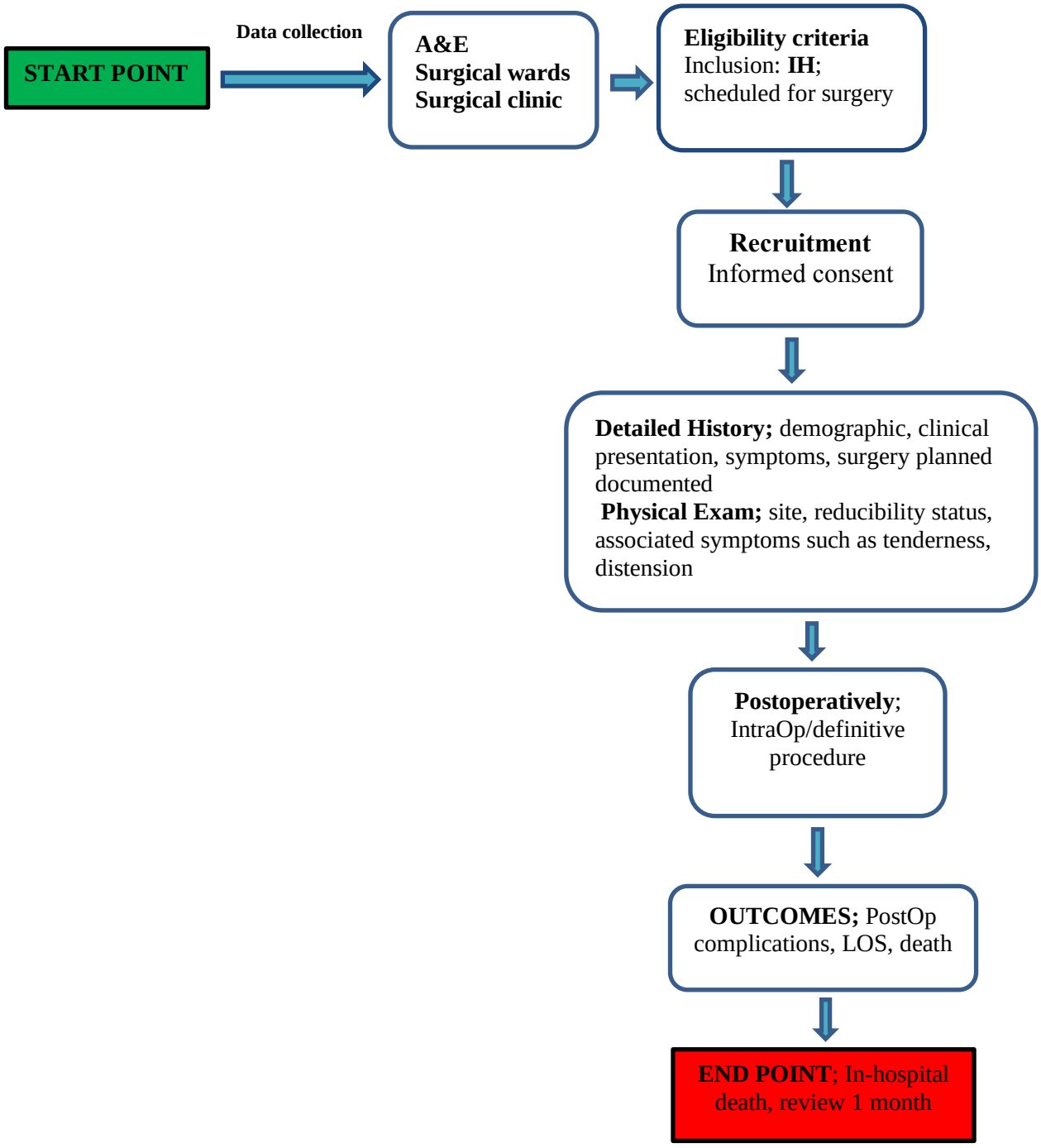
Patient with the above findings in this study were considered to have prolonged ileus.

Wound dehiscence: a surgical complication in which the wound ruptures along surgical incision. Symptoms of wound dehiscence include spontaneous opening of the wound, bleeding, pain, and inflammation.

Patients found to have the above findings on examination were recorded to have wound dehiscence in the data collection form.

Postoperative pain level: this was a key parameter assessed at the fourth week. Visual analogue scale tool was used to determine different levels pain; mild, moderate and severe.

3.8 Study Flow Chart



3.9 Data Management

3.9.1 Data Collection

The starting point of data collection was at accident and emergency department, surgical wards and clinics for all those patients diagnosed with IH and were scheduled for herniorrhaphy and who also fulfil the inclusion criterion. Data was collected using a data abstraction form (Appendix I). The following variables were assessed for each patient: age, gender, residence, referral status, diagnosis (type and side of inguinal hernia) and the method of treatment (planned surgery) and duration of symptoms and complications.

3.9.2 Data Analysis and Presentation

Data on patient demographics, clinical presentation of inguinal hernias, surgical management options as well as postoperative complications were coded and summarized using descriptive statistics with results displayed on graphs and tables. The data was analysed using STATA Version 15. Descriptive statistics such as frequency listings and percentages were used for categorical variables while median and interquartile range were used for continuous variables.

3.9.3 Data storage

Data collected was digitalized and stored in a personal computer with password protection. Information was backed up on a second hard drive to guard against data loss in case of equipment malfunction. All originals and copies of project plans, forms error list and other documentation were and still are preserved in a secured storage point, throughout the entire study duration.

3.10 Ethical consideration

Approval to conduct the study was sought and granted from the Institutional Research and Ethics Committee (IREC) prior to onset of study. Permission to access patient

records was sought from MTRH administration. Informed consent was sought from eligible patients and confidentiality assured (Appendix II English and Appendix III Kiswahili). No coercion or inducement was done to ensure enrollment in the study and all patients were made to understand that they are free to withdraw from the study without compromising quality of care. All data was password protected and accessible to the investigator and supervisors only. Dissemination of results was done through oral defense of the thesis and thereafter the results may be presented at relevant seminars and conferences. In addition, the author will submit an abridged version of the thesis for publication in a peer reviewed scientific journal.

3.11 Study limitation

Surgery by different surgeons might have affected the surgical outcomes. To mitigate this the assessment tool took into account the outcomes for the entire team rather than individual surgeons. There may also have been memory recall bias especially with regard to symptoms. The study also recruited a selected group of participants who visited MTRH and hence may not be generalizable to the population even though the hospital is the only major facility in the county and the referral system in the region is not strictly adhered to.

CHAPTER FOUR: RESULTS

A total of 103 adult patients presenting with inguinal hernia at MTRH were recruited in the study. The number of those who were admitted as emergencies was 58(56.3%) while the rest were patients for elective surgeries.

4.1 Sociodemographic characteristics of adult patients with inguinal hernias at MTRH

The socio demographic characteristics that were included in this study were age, sex, occupation and referral status. The age of patients ranged from 18 to 93 years, with a mean and standard deviation of 49.6 ±19.6 years. It was observed that IH was more common in men than woman. The male to female ratio was 33:1. The study also found out that farmers were more predisposed to developing IH than any other occupation as seen in table 1 below.

Table 1: Socio demographic characteristics

Variable	**Median**	**IQR**
Age in years	48	30, 68
Sex	**Frequency**	**%**
Female	3	2.9%
Male	100	97.1%
Occupation		
Casual labourer	24	23.3%
Formal employment	13	12.6%
Farmer	48	46.6%
Self-employed	10	9.7%
Unemployed	8	7.8%
Referral status		
Facility-referred	20	19.4%
Self-referred	83	80.6%

4.2 Clinical presentation of inguinal hernias among adult patients at MTRH

4.2.1 Clinical presentation of IH

Majority of IH presented as emergencies 58(56.3%) from various counties of catchment area of MTRH. The overall emergency to elective ratio was 1.3:1. Table 2 below summarizes the distribution of nature of IH presentation in the study.

Table 2: Clinical presentation of IH

County	Emergencies	Electives	Emergency/Elective Ratio	Total
West Pokot	**7**	**2**	**3.5:1**	**9**
Uasin Gishu	17	20	0.9:1	37
Nandi	7	8	0.9:1	15
Kakamega	3	3	1:1	6
Marakwet	**10**	**4**	**2.5:1**	**14**
Kisumu	2	2	1:1	4
Busia	2	2	1:1	4
Kisii	2	1	2:1	3
Kericho	2	1	2:1	3
Turkana	**6**	**2**	**3:1**	**8**
Total	58	45	**1.3:1**	103

4.2.2. Site of the hernia swelling

Figure 3 shows the summary of location of mass or swelling. It was observed that majority of patients had the swelling on the right side.

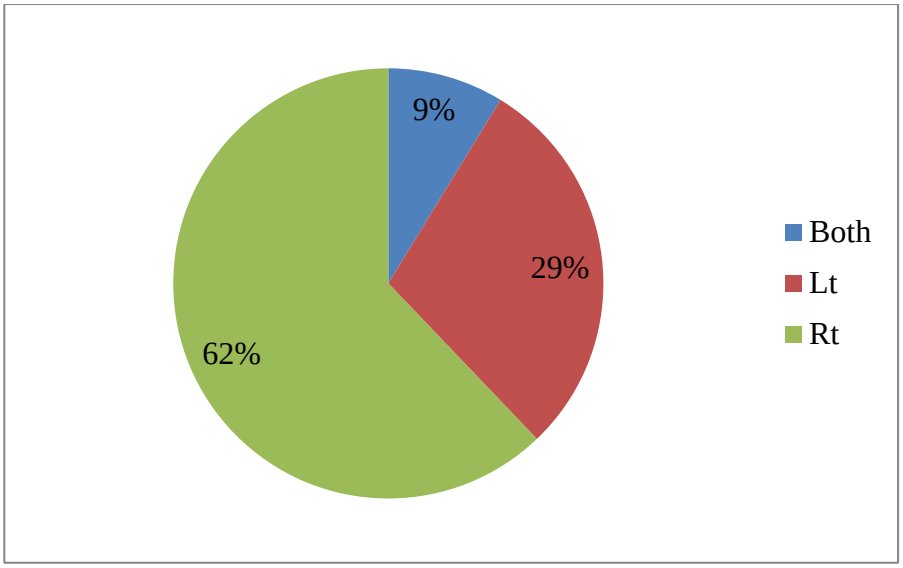


Figure 3: Site of the swelling

4.2.3. Pre-operative symptoms and signs

Patients who were diagnosed with IH and recruited in the study presented with diverse symptoms. Table 3 below illustrates the predominant symptoms and signs that these patients exhibited at the time of admission to the hospital.

Table 3: Pre-operative symptoms and signs

Variable	Frequency	%
Clinical features		
Vomiting	**52**	**50.5%**
Abdominal pains	48	**46.6%**
Constipation	**52**	**50.5%**
Tender swelling	**50**	**48.5%**
Fever	32	31.1%
Abdominal distension	32	31.1%
Reducible	45	43.7%
Irreducible	**58**	**56.3%**

As illustrated in Table 3 above majority of patients (56.3%) presented with irreducible groin mass prior to surgery. Other predominant symptoms and signs observed in emergency cases included vomiting, constipation, tender groin lump and abdominal pains.

4.2.4. Duration of symptoms prior to surgery

Most of the emergency cases were those with longer duration of symptoms (existence of hernia itself) as compared to elective cases; IQR of 2-10 years for incarcerated hernias, 5-50 years for strangulated hernias and 2 months to 5 years for elective cases. Table 4 below captures these events.

Table 4: Duration of symptoms prior to operation

Type of IH	**Number of cases**	**Symptoms duration Median (years)**
Incarcerated (emergency)	26	5 (2, 10)
Strangulated (emergency)	32	10 (5, 50)
Elective (planned)	45	2 (2/12, 5)

4.2.5. Associated comorbidities

Prostatism was the commonest associated comorbid illness followed by hypertension and chronic cough as depicted in table 5 below.

Table 5: Associated comorbidities

Variable	**Frequency**	**%**
Diseases		
Hypertension	12	11.7%
Diabetes mellitus	4	3.9%
Prostatism	**17**	**16.5%**
Respiratory illnesses (chronic cough)	10	9.7%

4.2.6. The reasons for late presentation to hospital

The top four main reasons for late presentation were unawareness (not knowing the dangers of not seeking medical help), being scared of surgery, lack of transport and financial difficulties. Others are as seen in Table 6 below.

Table 6: Reasons for late presentation to hospital

Variable	Frequency	%
Reasons for late presentation		
Financial difficulties	65	63.1%
Referral system	27	26.2%
Hospital limitations	30	29.1%
Traditional medicine	52	50.5%
Lack of transport	68	66.0%
Unawareness	84	81.6%
Scared of surgery	84	81.6%

4.2.7. Preoperative laboratory investigations

Elevated white blood count, electrolytes derangement and raised creatinine were the leading laboratory findings as shown in Table 7 below.

Table 7: Preoperative Laboratory Investigation

Variable	Strangulated	Incarcerated	Electives	Frequency	%
Urea					
High	14	1	0	15	14.6%
Normal	18	25	45	88	85.4%
Creatinine					
High	15	2	0	17	16.5%
Normal	17	24	45	86	83.5%
Electrolytes					
Deranged	15	3	0	18	17.5%
Normal	17	23	45	85	82.5%
WBC					
High	30	5	0	35	34.0%
Normal	2	21	45	68	66.0%
HB					
Low	7	0	0	7	6.8%
Normal	25	26	45	96	93.2%

4.3 Surgical treatment

Surgical treatments done in this study is summarized in Table 8 below. The most common procedure done was open mesh repair followed by tissue repair.

Table 8: Surgical Techniques

Variable	Emergencies	Electives	Frequency n=103	Percentage %
Mesh				
Open repair	52	41	93	**90.3%**
Laparoscopic repair	0	4	4	3.9%
Tissue repair	6	0	6	5.8%

4.4 Early surgical management outcomes

4.4.1. Early postoperative complications

The total number of patients who got complications postoperatively was 37 (35.9%). The top three commonest complications were prolonged ileus 9 (8.7%), urinary retention 8 (7.8%) and seroma formation 6 (5.8%). Emergencies recorded the higher numbers of complications than electives 34 (33.0%) versus 3 (2.9%) respectively. Table 9 shows the different postoperative complications as well as their relation to the type of hernia.

Table 9: Complications and their relation to hernia type

Variable	Frequency n=37	Emergencies n=34	Electives n=3	%
Complications				
Scrotal hematoma	4	4	0	3.9%
Seroma formation	**6**	5	1	**5.8%**
Wound infection	5	5	0	4.9%
Prolonged ileus	**9**	8	1	**8.7%**
Urinary retention	**8**	7	1	**7.8%**
Wound dehiscence	2	2	0	1.9%
Wound hematoma	3	3	0	2.9%

4.4.2. Postoperative complications by surgical techniques

The number of patients with complications from open mesh repair, laparoscopic mesh repair and tissue repair was 30 (29.1%), 4 (3.9%) and 3 (2.9%) respectively. Table 10 shows the different postoperative complications in relation to the surgical method used.

Table 10: Complications by Surgical Techniques

Variable	Frequency n=37	Tissue Repair n= 3	Mesh Open n=30	Mesh Lap n=4	%
Complications					
Scrotal hematoma	4	1	3	0	3.9%
Seroma formation	**6**	0	5	1	**5.8%**
Wound infection	5	1	4	0	4.9%
Prolonged ileus	**9**	0	7	2	**8.7%**
Urinary retention	**8**	0	7	1	**7.8%**
Wound dehiscence	2	1	1	0	1.9%
Wound hematoma	3	0	3	0	2.9%

4.4.3. Postoperative Mortality

The number of deaths was 3 patients out of 103 giving a mortality rate of 2.9%. They all occurred in strangulated hernias as seen in table 11 below.

Table 11: Mortality

Hernia type	Frequency	Deaths	Mortality %
Emergencies			
Strangulated	32	3	2.9%
Incarcerated	26	0	0
Electives	45	0	0

4.4.4. Duration of hospital stay postoperatively

Emergency cases stayed longest in the hospital post operatively as shown in Table 12 below.

Table 12: Duration of hospital stays (days)

Hernia type	Frequency	Median (IQR)
Emergency		
Incarcerated	32	7 (5,8)
Strangulated	26	8 (7,10)
Electives	45	3 (2,4)

4.4.5. Postoperative pain level

At four weeks of follow up, all patients reported pain at site of operation. The percentages for mild, moderate and severe pain were 36%, 45% and 19% respectively as shown in Figure 4 below.

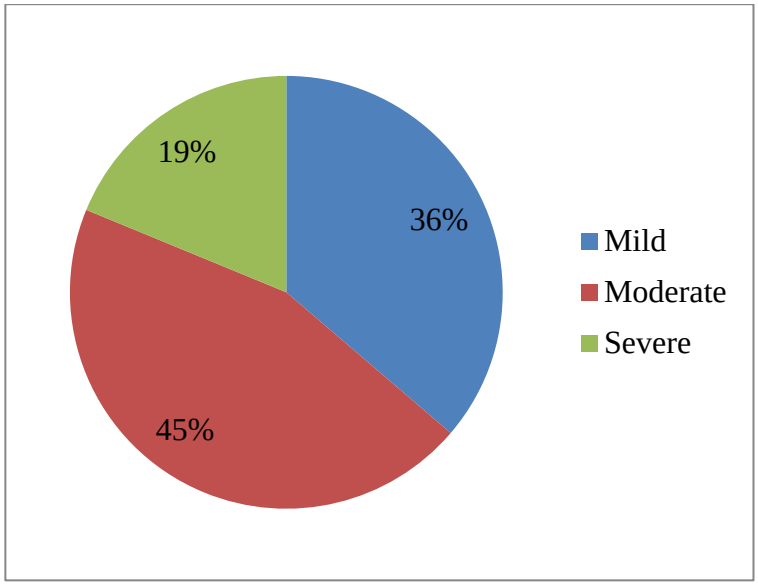


Figure 4: Pain level

4.5. Factors associated with complications and early outcomes

Table 13: Association between complications and hernia type

Variable	Complications		Fischer's exact test *p*-value
	YES	NO	
Emergency	34(58.6%)	24(41.4%)	< 0.001
Elective	3(6.7%)	42(93.3%)	

There was a higher proportion of complications in those who presented as emergencies as opposed to electives and this was statistically significant with *p*-value <0.001 as shown in table 13 above.

Table 14: Association between complications and surgical technique

Variable	Complications		Fischer's exact test *p*-value
	YES	NO	
Tissue repair	3(50.0%)	3(50.0%)	<0.009
Mesh open	30(32.3%)	63(67.7%)	
Mesh laparoscopy	4(100%)	0(0%)	

A high proportion of those undergoing laparoscopic mesh repair had complications (100%), followed by tissue repair (50%) and mesh open repair (32.3%) and the difference was statistically significant *p*-value <0.009 as depicted in Table 14 above.

Table 15: Association between duration of symptoms and the state of hernia at presentation

Type of IH	Number of cases	Symptoms duration IQR (years)	Median	Kruskal Walli's test *p*-value
Incarcerated (emergency)	26	2, 10	5	<0.0001
Strangulated (emergency)	32	5, 50	10	
Elective (planned)	45	2/12, 5	2	

There was a strong association between duration of symptoms and the state of hernia at presentation (emergencies vs electives). Those with longer duration of symptoms presented more as emergencies and this was statistically significant with *p*-value <0.0001.

Table 16: Association between hospital stay and state of hernia

Hernia type	**Frequency**	**Hospital stay Median (days)**	**Kruskal Walli's test *p*-value**
Emergencies	58	7 (5,10)	<0.0001
Electives	45	3 (2,4)	

There was statistically significant difference in the median length hospital stay amongst emergencies (7 days) compared to electives (3 days) with *p*-value <0.0001.

CHAPTER FIVE: DISCUSSION

5.1. Socio demographic characteristics of adult patients with inguinal hernias at MTRH

The age of patients ranged from 18 to 93 years with a mean of 49.6 years and a standard deviation of ±19.6 years. In this study, male to female ratio was 33:1. The study also found out that farm workers were more predisposed to developing IH (46.6%) than any other occupation.

In a similar study by Jenkins & O'Dwyer., (2008) IH was found to be more common in men than women with life time risk of 27% for men and 3% for women. In another study by Sangwan Mukesh et al., (2013) in India, they found out that majority of their patients were about 40-70 years concurring with the mean and SD in this study. They also found that males outnumbered females by ratio of 82:1 for IH cases in their study. Similar study in Nigeria Adesunkanmi et al., (2004) showed that over 60% of IH were farmers.

This male preponderance in IH could be due the fact that in African continent and perhaps in many other developing countries like India males are more involved in strenuous agricultural activities while females are mostly entitled to household duties which are less labour intensive.

5.2. Clinical presentation of inguinal hernias in adult patients at MTRH

5.2.1. IH nature of presentation at MTRH

Majority of IH patients presented more as emergencies from various counties of catchment area of MTRH. Overall emergency to elective ratio was 1.3:1. In this study 56.3% cases were done as emergency operations.

These results concur with studies by Odula & Kakende., (2004) in Uganda and Ohene-Yeboah et al., (2009) in Ghana where they found emergency operations of IH to be 76% and 65% respectively. The reason for this finding is due to late presentation to the hospital of long standing and complicated disease as a result of limited surgical services across the continent. However, the above findings differ with studies by Adesunkanmi et al., (2000) Nigeria and McConkey., (2002) in Sierra Leone where emergency operations were of lower proportions, 25% and 33% respectively. This difference could be attributed to poor documentation of operated cases across African continent or regional differences in utilization of healthcare.

5.2.2. Site of the mass or swelling

The majority of the patients had the swelling on the right side (62%) while on the left and both sides were 29% and 9% respectively. The ratio of right to left IH in this study was 2.1:1. The Indirect IH 64.0%, Direct 26.2%, Bilateral 9.7%.

These findings are comparable to a study by Mabula & Chalya., (2012) in Tanzania where they observed right sided IH in 53.1% of cases. They also noted indirect, direct and bilateral IH in 65.5%, 22.6% and 11.9% respectively. Similar findings were also reported in India by Sangwan et al., (2013) where they found the ratio of the right to left to be 1.45:1.

The reason for the right IH to be more common than left IH could be explained by late descent of the right testes from abdomen to scrotum during its development and more frequent failure of closure of the right processus vaginalis (Mabula & Chalya., 2012)

5.2.3. Pre-operative symptoms and signs

Majority of patients presented with irreducible groin mass 56.3% prior to surgery and they were all emergency cases. Other predominant symptoms and signs observed in emergency cases included vomiting, constipation, abdominal distension and pains.

The similar clinical picture was also noticed by Adesunkanmi et al., (2004) in Nigeria who reported symptoms of hernia complications such irreducibility of hernia, abdominal pain and distension, vomiting and tenderness over the hernia all occurring in various proportions ranging from 21 to 29%.

This clinical spectrum of symptoms and signs is most likely due to intestinal obstruction. Obstructed hernial contents signal early onset and progression of a complicated disease requiring urgent surgical intervention (Ohene- Yeboah., 2003).

5.2.4. Associated comorbid illnesses

Prostatism was the commonest associated comorbid illness in this study with 16.5% followed by hypertension and chronic cough.

The results of this study compare well with previous studies that reported significant relationship between prostate enlargement and inguinal hernia development. Adesunkanmi et al., (2004) in Nigeria reported 22.6% cases of benign prostate hyperplasia in 425 patients with inguinal hernia. Another study by Sangwan et al., (2013) in India also reported 15.93% cases of prostatism in patient with abdominal wall hernias. Dickey et al., (1961) also reported 68 patients with hernias in a group of 309 prostatectomies giving an incidence of 22.3%. Similarly, Jasper et al., (1974) also reported an incidence of 24.8% IH in 891 prostatectomies.

This is probably due to increased intraabdominal pressure during straining while passing urine as a result of bladder outlet obstruction due to enlarged prostate.

5.2.5. Duration of symptoms prior to surgery

The duration of symptoms ranged from 2months to 50 years. Median duration of symptoms for electives, incarcerated and strangulated hernia was 2, 5 and 10 years respectively. Cases with longer duration of symptoms presented more as emergencies.

Similar trend was also observed by Adesunkanmi et al., (2004) in Nigeria where he reported duration of symptoms ranging from 1 day to 25 years with a median of 1 year and with long standing cases presenting more as emergencies.

This is attributable to long standing and neglected cases from large pools of inguinal hernia cases in the African continent which present late and mostly as emergencies to the health facilities. Studies have shown reasons similar to findings in this studies: thoughts that the condition could not be corrected ignorance and fear of surgery.

5.3 Surgical management of inguinal hernias in adult patients at MTRH

Most common procedure done was open mesh repair 90.3%, followed by tissue repair (Bassini's repair) 5.8% and laparoscopic mesh repair 3.8%.

The results of this study are in contrast with studies elsewhere in the African continent. Odula & Kakande., (2004) Uganda reported popular technique in their study being modified Bassini's in 68.2% cases, followed by herniotomy 16.9% others nylon darn, inguinal obliteration simple closure defect and Shouldice in 11.3%, 2.1%, 1.0% and 0.5% respectively. The use of open mesh repair was not reported in their study. In yet another similar study by Mabula & Chalya., (2012) in Tanzania, they reported popular

technique used in IH repair being modified Bassini's in 79.9% and Lichtenstein mess repair in only 0.2% cases.

However, the results of this study at MTRH are in keeping with studies in the western developed countries by Jenkins & O'dwyer., (2008) whereby metanalysis from EU Trialists Collaboration compared use of mesh with sutured techniques from 58 trials and found out the mesh was much superior in reducing recurrences and also open mesh repair was the preferred technique by 96% of UK surgeons, 99% of Japanese surgeons, 95% of Danish surgeons and 86% of USA surgeons. This study's finding could be due to geopolitical differences between Kenya and the other African countries where the studies were done with the Kenyan experience leaning towards the developed countries' practices on IH surgical treatments.

The more popular use of mesh repair in this study compared to other African studies could be due to the fact that use of mesh is considered expensive in Africa and hence patients cannot afford it as compared to developed world. It is pleasing that in Kenya the use of mesh is popular as these meshes are covered by health insurance policies. The Ugandan and Tanzanian studies were also done at a time when the use of mesh had not become popularized.

5.4. Early surgical outcomes of inguinal hernias in adult patients at MTRH

5.4.1. Early postoperative complications

The proportion of patients who got complications postoperatively was 35.9%. The commonest complications were prolonged ileus 8.7%, urinary retention 7.8% and seroma formation 5.8%. Most of the complications were observed more in emergencies than electives; 33.0% and 2.9% respectively.

Similar study by Ramyil et al., (2000), reported uncomplicated hernia to be associated with less postoperative complications. In another study by Fall et al., (2005) in Senegal, they noticed postoperative complications of IH to be 21%. A study by Mbah., (2007) in Northwesten Nigeria on complicated IH showed a mortality rate of 20%. Adesunkanmi and colleagues in 2004 in Nigeria also reported commonest postoperative complication in their study to be scrotal complications and wound infections at 18.8% and 13.6% of cases respectively.

The relatively higher postoperative complications in the study at MTRH could be due to the fact that the patients had longer duration of symptoms (2months-50years) and mostly presented as emergencies.

5.4.2. Postoperative Mortality

The overall postoperative mortality was 2.9% and this occurred in elderly patients with strangulated hernias that presented as emergencies.

These findings were comparable to studies done elsewhere in the African continent. Mba., (2007) in Nigeria reported IH mortality of 5.3% while Ohene-Yeboah., (2003) in Ghana recorded IH mortality of 6.2%. Adesunkanmi et al., (2004) in Nigeria also reported IH mortality of 4.5% in elderly patients with strangulated hernias. However, some studies in Africa recorded significantly higher IH mortality, Mbah., (2007) in Northwesten Nigeria and Haruna et al., (2000) in Niger recorded 20% and 40% respectively.

The low mortality in this study could be due to prompt and urgent attention given to complicated inguinal hernia cases at MTRH, while elsewhere could be multifactorial from lack of expertise to unavailability of surgical services which are serious problems across the African continent.

5.4.3. Duration of hospital stay postoperatively

Length of hospital stay increased with the severity of the hernia type. Strangulated hernia, incarcerated hernia and electives stayed a median of 8(IQR 7,10), 7(IQR 5,8) and 3(IQR 2,4) days respectively. Therefore, emergency cases stayed longer compared to elective surgeries.

These findings are similar to a study by Adesunkanmi et al., (2004) in Nigeria which reported length of hospital stay after hernia operation ranging from 1-56 days with a mean of 4 days for elective cases and 7 days for emergency operations. In another similar study by Mabula and Chalya., (2012) in Tanzania reported the length of hospital stay to range from 4 to 34 days (median 8 days). In their study the length of hospital stay was significantly longer with increased severity of disease, advanced age and associated premorbid conditions.

This could be due to the fact that the longer the duration of disease the higher the probability of complications and subsequently longer hospital stay.

5.4.4. Postoperative pain level

At the fourth week of follow up, pain was the key parameter assessed and mild, moderate and severe pain were reported in 36%, 45% and 19% of patients respectively.

These findings contrast with a study by Callesen et al., (1998), who reported some degree of postoperative pain four weeks after surgery. In their study, patients reported slight, moderate and severe pain in the 66%, 33%and 11% respectively at four weeks. In another study by Pierideset all., (2016) the overall rate of chronic postherniorrhaphy pain was 11.5%. At one-year postherniorrhaphy their patients reported at least some moderate pain at rest, bothersome pain, and chronic severe pain requiring medications in 6.6%, 7,5% and 2.2% respectively.

Postherniorrhaphy pain is one of the debilitating effects of mesh repair herniorrhaphy, and thought to be caused by nerve injury, mesh ingrowth, nerve entrapment during healing and such pain is still known to persists for years after surgery. This study did not have long term follow-up beyond the early postoperative period of 4 weeks.

5.5. Factors associated with complications and early outcomes

5.5.1. Association between complications and hernia type

There was a higher proportion of complications in those who presented with emergencies than electives and this was statistically significant with *p*-value <0.001.

In a similar study by Mabula & Chalya., (2012) in Tanzania it was reported that the complication rate was significantly higher in emergency herniorrhaphy as opposed to elective herniorrhaphy with a *p*-value <0.001.

This suggests emergency herniorrhaphy to be likely to present as an advanced disease that if not treated promptly could lead to greater morbidity.

5.5.2 Association between complications and surgical technique

A high proportion of those who underwent laparoscopic mesh repair had complications (100%), followed by tissue repair (50%) and open mesh repair (32.3%) and the difference was statistically significant *p*-value <0.009.

In a similar study by Odula & Kakande., (2004) in Uganda reported that the surgical technique used had a very significant statistical relationship postoperative complications *p*-value <0.009.

In this study laparoscopic mesh repair had more complications contrary to studies across the world which showed it to be associated with less complications as compared to other surgical techniques; this could be explained by the low number of patients 4(3.8%) who underwent laparoscopic mesh repair hence giving an exaggerated picture

compared to other studies. It could also suggest the stage the surgeons are at in the learning curve as it requires greater dexterity than the rest of the operative modes.

5.5.3. Association between duration of symptoms and the state of hernia

There was a strong association between duration of symptoms and the state of hernia that is emergency versus elective, with those with longer duration of symptom presenting more as emergencies and this was statistically significant with *p*-value <0.0001. In a similar study by Sanders et al., (2008), Plymouth UK, when comparing African versus European hernias reported that African hernias tend to run a more severe disease due to long standing cases and also present more as emergencies to the hospital than European hernias.

This could be due to the fact that longer duration of symptoms leads to increased chances of complication or severity of the disease hence long standing cases being seen more as emergencies. Other factors like utilization of facilities and economic status may also lead to delays that will end up presenting as the inevitable emergencies that give them no room for further delays.

5.5.4. Association between length of hospital stay and hernia type

There was statistically significant difference in the median length hospital stay amongst those with emergency (7 days) compared to electives (3 days) with *p*-value <0.0001.

In similar study by Mabula and Chalya., (2012) in Tanzania, the median length of hospital stay was 8 days and it was significantly longer in patients with advanced age, delayed admission, concomitant medical illness, and in those with surgical repair performed under general anesthesia ($p< 0.001$).

This could be due to the fact that emergencies signify an advanced disease that is associated with more complications and subsequently longer length of hospital stay.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

IHs were seen predominantly in males, occurred more on the right side, majority presented as emergencies and were associated with more postoperative complications than elective cases.

The popular surgical management technique for IH at MTRH is open mesh repair.

The most common early postoperative complications included paralytic ileus, urinary retention and seroma formation. All patients complained of varying degrees of postoperative pain at four weeks after surgery.

6.2. Recommendations

Community health education should be done to enlighten patients with IH so as to preempt complications necessitating emergency surgeries that lead to greater morbidities and avoidable deaths.

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APPENDICES

Appendix 1: Consent Form

ENGLISH CONSENT FORM:

My name is Leatile Winston Motsiane. I am a qualified doctor, registered by the Kenya Medical Practitioners and Dentists Council. I am currently pursuing a Master of medicine degree in General Surgery at Moi University. I would like to recruit you into my research study on the pattern and early surgical outcomes of inguinal hernias.

INFORMATION ABOUT INGUINAL HERNIAS

Inguinal hernia has been defined as a bulge of the peritoneum through a congenital or acquired defect in the mascular and fascial structures of the abdominal wall. Inguinal hernias are one of the most common surgical conditions and their repair is also one of the most common surgical procedures done by surgeons worldwide. Symptoms of inguinal hernias include a bulge on either or both sides of pubic bone which becomes more visible when standing upright or coughing or straining, a burning or aching sensation at the bulge, pain and discomfort in the groin region which is felt more on bending over, coughing or lifting heavy weights, a heavy or dragging sensation in the groin area, a weakness or pressure in the groin and occasionally painful swelling around the testicles when the protruding intestines descends into the scrotum. More severe symptoms which may signal onset of complications of inguinal hernias include; nausea, vomiting, fever, sudden pain that intensifies, hernia bulge that turns red, purple or dark and inability to open bowels or pass gas.

Diagnosis is based on history, complete physical examination, which may include ultra-sonography (USG) scan. Several surgical techniques and approaches are used to correct the hernia. All your information will be kept confidential. Treatment does not depend

on your participation in this study and will be offered according to the results of all the necessary tests and investigations. There will be no rewards for participating in the study.

This study has been approved by the Institutional Research and Ethics Committee (IREC) of Moi University/Moi Teaching and Referral Hospital. If you need further clarifications, please contact IREC using the address below.

The Chairman IREC,

Moi Teaching and Referral Hospital,

P. O. Box 3, Eldoret. Tel: 07877236

YOUR consent:

Adults (18 years andabove)

I have been adequately informed that I am being recruited into a study on the pattern and early surgical outcomes of inguinal hernias. The investigator has also informed me that my participation in this study is voluntary and will not affect treatment should I opt to pull out. I have been assured that my confidentiality will be respected. No benefits/rewards have been promised to me as a result of my participation in the study.

Sign: …… Witness signature…….

Name: …… Witness name…….

Date: …… Date: …….

Appendix 2: Kiswahili: Fomu Ya Kibali

MADA YA UTAFITI: Pattern and Early Surgical Outcomes of Inguinal Hernia Repair in Adults at the Moi Teaching and Referral Hospital, Eldoret, Kenya.

MTAFITI – Dr Leatile Winston Motsiane

RUNUNU: 0791387440

Mimi _____ wa Sanduku la Posta _____, Nambari ya Simu_____ najitolea kwa hiari yangu mwenyewe kutoa kibali cha kujihusisha katika utafiti uliotajwa hapo juu unaendelezwa katika kaunti ya Uasin Gishu. Nimepokea maelezo ya tafsili kuhusu utafiti huu kutoka kwa Daktari Leatile Winston Motsiane (au mtafiti msaidizi wake) katika lugha, kanuni na masharti ninayoelewa vyema. Nimehakikishi ya kuwa, sita adhirika kamwe kutokana na kujihusisha kwangu katika utafiti huu. Ilibainishwa kwa kujihusisha katika utafiti huu ni kwa hiari nani na uhuru wakujiondoa wakati wowote ule bila ya kuhujumiwa. Zaidi ya hayo, nilihakikishi wakuwa, kanununi zote za maadili ya utabibu, uhuru, haki, na manufaa zitazingatiwa katika utafiti huu.

Jina la Mhojiwa_____

Sahihi _____

Tarehe _____

Jina la shahidi _____

Sahihi _____

Tarehe _____

Appendix 3: Time Frame

Activity	**Duration**
Selection of topic –In December 2016	2 months
Literature review –In February 2017	3 months
Writing proposal – In May 2017	1 month
Submission to IREC – In November 2017	1 month
Approval by IREC	2 month
Data collection January 2018-June2019	18 months
Writing the thesis report July2019 - December 2019	6 months
Submission of thesis February 2021	1 month
Oral defense of thesis; To be determined, expected May 2021	
Submission of final edited Thesis; To be determined, expected August 2021	

Appendix 4: Budget

Code	Item	Cost (Kshs)
1	Eight Reams of plain and ruled paper @ 500	4,000.00
2	Pens, pencils, folder and other stationery	3,000.00
3	Three Computer Flash discs	6,000.00
4	Printing research proposals	6,000.00
5	Printing thesis, six copies	7,000.00
6	Binding thesis	4,000.00
7	IREC fee	2,000.00
8	Data handling	24,000.00
9	Miscellaneous	8000.00
10	Add 10% contingency	6400.00
	TOTAL	**70,400.00**

Appendix 5: Data Collection Sheet

Code……..

DEMOGRAPHIC CHARACTERISTICS

1. IP NO……..... Date: ……
2. Age ……
3. Sex: Male ☐ Female ☐
4. Height: …… Weight: …… BMI: ……..
5. Address……
6. Mobile no: ……
7. Profession: …… …….
8. Referral status…… SELF……

   REFERRED…….

CLINICAL PRESENTATION

9. Preoperative Symptoms

Groin mass/swelling: Yes ☐ No ☐

Side of mass/swelling: Lt ☐ Rt ☐ Both ☐

Groin mass painful: Yes ☐ No ☐

Abdominal swelling: Yes ☐ No ☐

Abdominal pain: Yes ☐ No ☐

Any discoloration over swelling Yes ☐ No ☐

Bowel opening/gas: Yes ☐ No ☐

Vomiting: Yes ☐ No ☐

Fever: Yes ☐ No ☐

Constipation: Yes ☐ No ☐

Others specify……

10. Duration of symptoms……

11. Time from onset of illness to presentation to hospital……

Time from presentation to operation ……

12. Reason for late presentation (if apparent): …….

Financial difficulties: YES ☐ NO ☐

Referral system: YES ☐ NO ☐

Hospital limitations (resources/skilled manpower): YES ☐ NO ☐

Traditional medicine: YES ☐ NO ☐

Lack of transport: YES ☐ NO ☐

Unawareness: YES ☐ NO ☐

Scared of surgery: YES ☐ NO ☐

Other reasons specify, …….....

13. Physical Examination: Signs

<u>Abdominal Examination</u>

Abdominal distension: Yes ☐ No ☐

Abdominal tenderness: Yes ☐No ☐generalized….localized….

Inguinal mass: Yes ☐No ☐ If yes, side…… Tender: Yes/ No

Reducible: ……. Non-reducible…….

Direct hernia……. Indirect……..

Peritonitism (guarding/rigidity): Yes ☐ No ☐

DRE finding……

Other signs: if yes, state …….

PRE-OPERATIVE INVESTIGATIONS

14. Laboratory Investigations

a) Urea, electrolytes, creatinine

i. Creatinine…….

ii. Urea…….

iii. Electrolytes…….

b) Full blood count

i. WBC

ii. Hb

iii. RBC

15. Radiology: Yes ☐ No. ☐

If yes, Findings……

SURGICAL MANAGEMENT PRACTICES AND HERNIAL CHARACTERISTICS

16. Surgical operative management:

Procedure done……

Findings (including contents of the sac)…….

Final diagnosis……

Any intra-operative complications YES ☐ NO ☐

If yes state,

……

SURGICAL MANAGEMENT OUTCOMES

17. Duration of hospital stay:……

18. Postoperative complications

- Scrotal hematoma YES ☐ NO ☐
- Seroma formation YES ☐ NO ☐
- Wound infection YES ☐ NO ☐
- Prolonged ileus YES ☐ NO ☐
- Urinary retention YES ☐ NO ☐
- Wound dehiscence YES ☐ NO ☐
- Wound hematoma YES ☐ NO ☐
- Other complications Yes ☐ No ☐

If yes, state them ……..

19. Dead: Yes ☐ No ☐

If yes, state the cause of death……

20. FINAL EXAMINATION AT FOUR WEEKS

FINDINGS

……

……

……

……

21. FEEDBACK FROM PATIENTS AT STUDY END PERIOD (FOUR WEEKS)

i) Did you have any problem with the wound following hernia operation? YES / NO

If yes, explain……..

ii) If you were discharged same day as your operation, did you need to consult the general practitioner within the first week? YES ☐ NO ☐

If yes, explain……..

iii) Do you have any pain or discomfort in relation to hernia operation? YES ☐ NO ☐

If yes does the pain interfere with your daily work activities?

…….....

.....

iv)Are you satisfied with the outcome of your surgery? YES ☐ NO ☐

If no explain

…….....

.....

.....

.....

Appendix 6: IREC Approval

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471/2/3

MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
P.O. BOX 4606
ELDORET

1st March, 2018

Reference: IREC/2017/236
Approval Number: 0002052

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
01 MAR 2018
APPROVED
P. O. Box 4606 - 30100 ELDORET

Dr. Leatile Winston Motsiane,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Motsiane,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"Pattern and Early Surgical Outcomes of Inguinal Hernia Repair in Adults at the Moi Teaching and Referral Hospital, Eldoret, Kenya".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 2052*** on 1st March, 2018. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 28th February, 2019. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc CEO - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD

Appendix 7: Hospital Approval (MTRH)

An ISO 9001:2015 Certified Hospital

MOI TEACHING AND REFERRAL HOSPITAL

Telephone:(+254)053-2033471/2/3/4
Mobile: 722-201277/0722-209795/0734-600461/0734-683361
Fax: 053-2061749
Email: ceo@mtrh.go.ke/directorsofficemtrh@gmail.com

Nandi Road
P.O. Box 3 – 30100
ELDORET, KENYA

Ref: ELD/MTRH/R&P/10/2/V.2/2010

7th March, 2018

Dr. Leatile Winston Motsiane,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

APPROVAL TO CONDUCT RESEARCH AT MTRH

Upon obtaining approval from the Institutional Research and Ethics Committee (IREC) to conduct your research proposal titled:-

"Pattern and Early Surgical Outcomes of Inguinal Hernia Repair in Adults at the Moi Teaching and Referral Hospital. Eldoret, Kenya".

You are hereby permitted to commence your investigation at Moi Teaching and Referral Hospital.

MOI TEACHING AND REFERRAL HOSPITAL
CEO
APPROVED
07 MAR 2018
SIGN P.O. BOX 3 - 30100, ELDORET

DR. WILSON K. ARUASA, *MBS*
CHIEF EXECUTIVE OFFICER
MOI TEACHING AND REFERRAL HOSPITAL

cc - DCEO, (CS)
- Director of Nursing Services (DNS)
- HOD, HRISM