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Department of Surgery and Specialties

Surgical Management and Outcome of Giant Inguino-scrotal Hernias in Cameroon: Our experience in a rural setting

Dissertation in partial fulfilment for the award of Diploma of Specialization (DES) in General Surgery

Written and presented by

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2023-2024 Academic Year

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DEDICATION

To my parents,

Late Mr. TEGANKAM Jean Baptiste

Mrs. MADONGUE Rose

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LIST OF THE ADMINISTRATIVE PERSONNEL OF THE FACULTY

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66.	KOWO Mathurin Pierre	AP	Internal Medicine/HepatoGastro-enterology
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113	MBU ENOW Robinson	P	Obstetrics and Gynecology
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131	**DJOMOU François (HD)**	P	ENT
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133	KAGMENI Gilles	P	Ophtalmology
134	NDJOLO Alexis	P	ENT
135	NJOCK Richard	P	ENT
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137	BILLONG Yannick	AP	Ophtalmology
138	DOHVOMA Andin Viola	AP	Ophtalmology
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149	NANFACK NGOUNE Chantal	SL	Ophtalmology
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168	MEGUIEZE Claude-Audrey	SL	Pediatrics
169	MEKONE NKWELE Isabelle	SL	Pediatrics
170	TONY NENGOM Jocelyn	SL	Pediatrics
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174	MBANYA Dora	P	Hematology
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179	TOUKAM Michel	AP	Medical Microbiology
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182	BOUM II YAP	L	Medical Microbiology
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221	GUEWO FOKENG Magellan	L	Biochemistry
222	MBONO SAMBA ELOUMBA Esther Astrid	AL	Biochemistry
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227	DZUDIE TAMDJA Anastase	L	Physiology
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233	EDOUMA BOHIMBO Jacques Gérard	SL	Stomatology/ Surgery
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238	NOKAM TAGUEMNE Marie Elvire	L	Dental Medicine
239	BITHA BEYIDI Thècle Rose Claire	AL	Maxillo-Faciale Surgery
240	GAMGNE GUIADEM Catherine M	AL	Dental surgery
241	KWEDI Karl Guy Grégoire	AL	Bucco-dental Surgery
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243	NKOLO TOLO Francis Daniel	AL	Bucco-dental Surgery
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246	NGOUPAYO Joseph	P	Phytochemistry/Pharmacognosis
247	GUEDJE Nicole Marie	AP	Ethnopharmacology/Plant Biology
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251	MPONDO MPONDO Emmanuel	P	Pharmacy
252	TEMBE Estella épse FOKUNANG	AP	Clinical Pharmacology
253	ANGO Yves Patrick	AL	Chemistry of natural substances
254	NENE AHIDJO épse NJITUNG TEM	AL	Neuropharmacologiy
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259	ABA'A Marthe Dereine	AL	Drug analysis
260	FOUMANE MANIEPI NGOUOPIHO Jacqueline Saurelle	AL	Pharmacology
261	MINYEM NGOMBI Aude Périne épse AFUH	AL	Pharmaceutic Regulation

Key: L = Lecturer; AL = Assistant Lecturer, SL = Senior Lecturer, AP = Associate Professor; P = Professor; HOD= Head of Department

ABSTRACT

Introduction: Inguinal hernia is one of the most common general surgical operation world-wide accounting for 10-15% of all surgical procedures. Giant inguinoscrotal hernias (GISH) have been defined as those that extend below the midpoint of the inner thigh when the patient is in the standing position. Its management represents a challenge due to the risk of developing abdominal compartment syndrome (ACS). There are very few studies on GISH in Africa and in Cameroon. In this study we set out to describe the experience of Association des Competences pour une Vie Meilleure (ASCOVIME) in the management of GISH in rural areas in Cameroon.

Methodology: We conducted a descriptive cross-sectional study in the ten regions Cameroon within 13 years (February 2011 to August 2024). Sampling included patients operated for GISH. Patients were classified such that: **Type I** had their sac reaching the mid-inner thigh; **Type II** with sac reaching a midline between the mid-thigh and the supra-patellar line; **Type III** with sac reaching the supra-patella; and **Type IV** with sac extending below the supra-patella or if associated to other hernias. Data analysis was done using software SPSS version 4.2.2 and Excel version 2016. Results were presented using mean, standard deviation and proportions.

Results: GISH represented **0.39%** of the surgical activities and **0.69%** of groin hernias. We included **62 cases** with a male predominance (**sex ratio 11: 1)**. The average age was **54.7±1.1** [**34 – 79] years**. Majority of the participants were **(66%)** farmers. Most prevailing symptoms were abdominal pains **54(87.1%)** and weight bearing sensation **47 (75.8%).** Type II categories were the most frequent **30 (48.3%) followed by Type I 25(40.3%); Types III and IV represented a minority (5(8%) and 2(3.2%) respectively).** The average length of evolution was **30.8±0.7 years** [**14-50]**. More than half of the participants **55 (88.7%)** had reducible hernia. Lichtenstein was the most practised **56.5% (35)**. The main per operative complications were bowel injury in **9.7% (06)**. Bowel resection in **22.6% (14 cases).** We recorded **2 cases (3.2%)** of ACS with a case fatality rate of **3.2%.**

Conclusion: GISH is a reality in our community. It is frequent in rural areas where populations are involved mainly in land ploughing activities. This condition impacts heavily social integration which can go right up to rejection. Its treatment relies on surgery, depending on the reducibility, and the dissection which can help prevent deadly complications mostly associated to Types III and IV; thus the need for appropriate management in centers of higher categories. Application of appropriate management orientation for the individual patients is the key to success treatment.

Key words: Giant inguino-scrotal hernia; rural setting; surgical management; outcome

RESUME

Introduction : La hernie inguinale est une des interventions en chirurgie générale les plus fréquentes à l'échelle mondiale, représentant entre 10 et 15 % de toutes les interventions. Les hernies inguino-scrotales géantes (HISG) sont celles qui se prolongent en dessous de la mi-cuisse quand le patient est debout. Le risque de développer un syndrome de compartiment abdominal constitue un défi à gérer. Les recherches sur le HISG en Afrique et au Cameroun sont très limitées. Nous avons décrit l'expérience de l'Association des Compétences pour une Vie Meilleure (**ASCOVIME**) dans la gestion des HISG dans les régions rurales du Cameroun.
Méthodologie : Une étude transversale descriptive a été menée dans les dix régions du Cameroun sur une période de 13 ans (de février 2011 à Aout 2024). Elle a inclus des patients qui ont été opérés pour HISG. Ces patients étaient classes tel que : **Type I** sac atteint la mi-cuisse ; **Type II** sac entre la mi-cuisse et une ligne passant par le bord supérieur de la patella; **Type III** sac atteint le bord supérieur de la patella et **Type IV** sac en dessous de la patella ou des formes associées. L'étude des données a été faite avec le logiciel SPSS 4.2.2 et Excel 2016. Les résultats ont été présentés à l'aide de la moyenne, l'écart type et de proportions.
Résultats : La HISG représente **0,39 %** des interventions chirurgicales et **0,69 %** des hernies de l'aine. L'étude a été réalisée sur **62 cas** de HISG, avec prédominance masculine (**11 : 1)**. La moyenne d'âge était de **54,7 ± 1,1 [34 - 79 ans].** La plupart des participants **66%** étant des agriculteurs. Les signes les plus courants étaient des douleurs abdominales **54(87,1 %)** et la sensation de pesanteur **47 (75,8 %)**. La majorité des étaient de **Type II 30 cas (48,3 %).** La durée moyenne d'évolution était de **30,8 ± 0,7 ans.** Plus de la moitie **55 participants (88,7 %)** de notre population, présentaient une hernie réductible. La technique de Lichtenstein était la plus utilisée **56,5% (35).** Les complications peropératoires les plus courantes étaient des plaies intestinales dans **9,7 %** des cas avec **22.6% (14)** cas de résection intestinale. Seuls **2 cas (3,2 %)** de syndrome de compartiment abdominal ont été signalés.
Le taux de mortalité était de **3,2%.**
Conclusion : La HISG est fréquente, dans nos communautés. Elle est fréquente en zone rurale où les populations sont le plus souvent les travailleurs de la terre. Cette situation a un impact considérable sur l'intégration sociale, pouvant même conduire au rejet. Sa prise en charge chirurgicale en milieu rural nécessite une réductibilité facile, présage d'une dissection aisée, mettant à l'abri de complications mortelles. La réussite du traitement repose sur l'application d'une orientation adéquate pour chaque patient et le plateau technique adapté.

Mots-clés : Hernie inguino-scrotale géante ; milieu rural; traitement chirurgicale; résultats.

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LIST OF ABBREVIATIONS

ACS: abdominal Compartment syndrome

ACV: Abdominal Cavity Volume

ASA: American Society of Anesthesiology

ASCOVIME: Association des Competences pour une Vie Meilleure

ASIS: Antero-superior Iliac Spine

BTA: Botilinum Toxine A

CFR: Case Fatality Rate

CT: Computed Tomography

EHS: European Hernia Society

EOA: External Oblique Aponeurosis

GISH: Giant Inguino-scrotal Hernia

HISG: Hernie Inguino-Scrotale Geante

HSV: Hernia Sac Volume

IAP: Intra-abdominal Pressure

LISH: Left Inguino-scrotal Hernia

LOD: Loss of Domain

PMDS: Persistent Mullerian Duct Syndrome

PPP: Pre-operative Progressive Pneumoperitoneum

QoL: Quality of Life

RISH: Right Inguino-scrotal Hernia

TAPP: Trans-abdominal pre-peritoneal

TPV: Total Peritoneal Volume

VR: Volume Ratio

CHAPTER 1: INTRODUCTION

1 Introduction

Inguinal hernia is one of the most common general surgical operation world-wide accounting for 10-15% of all surgical procedures[1]. In part of Africa the incidence of inguinal hernia is as high as 175 per 100.000 people and only 40% of such are operated[2] The estimated prevalence of 7.4 cases of hernia symptoms per 1000 persons with groin hernias representing 85% of all hernias suggests a considerable burden of hernia disease in the Southwest region of Cameroon [3] . Giant inguinoscrotal hernias (GISH) have been defined as those that extend below the midpoint of the inner thigh when the patient is in the standing position or should display an anteroposterior diameter of at least 30 cm or a latero-lateral diameter of about 50 cm with non-reducibility for more than 10 years[4]. They result from neglect and fear of the surgical procedure or from lack of means. Its management represents a challenge due to the risk of developing abdominal compartment syndrome (ACS), produced by suddenly reintroducing the herniated contents into an abdominal cavity with decreased capacity[5]. The large size and chronicity of the hernia, associated with deranged mechanical properties of the abdominal wall, makes the management of these cases unique and interesting[6]. There is no standard procedure for treatment of this condition and literature describes several treatment strategies; the GONI MORENO (Preoperative Progressive Pneumoperitoneum) technique amongst others, has been highly recommended in the past [7,8], but usually it causes expansion of the thin hernia sac rather than the contracted abdominal cavity, thus revealing its limits[9]. This affection greatly alters patients' quality of life, including difficulties with mobility, bowel obstruction and enlarged scrotal skin sometimes with ulceration. The social impact is significant; it can cause social isolation, fear of seeking medical attention, and subsequent worsening of the condition[[10]]. In high-income countries, the diagnosis of inguinal hernia is usually made early, when the patient notices the development of swelling or groin pain[11]. Given the potential hernia strangulation, surgical correction is often carried out without delay. Consequently, giant inguinoscrotal hernias have become extremely rare in Europe and Asia[6,12–14,15] and are currently seen in clinical practice only after years or even decades of self-neglect[16]. Greater populations have been reported in Africa, especially in Nigeria where 134 cases were treated under local anesthesia in 2010 [17] followed by Sierra Leone with 103 cases all in prospective studies and in Ivory Coast where a retrospective study recorded 30 cases [18,19]. However, the limited information about the management of such cases in Cameroon has prompted our zeal to overview the challenges encountered in their management, especially in a setting with limited resources where access to health facilities is considered a luxury[11] and the local human resource not always readily qualified.

1.1 Question of research

What is the outcome of patients managed surgically for giant groin hernias in a rural setting?

1.2 Hypothesis

It is possible to manage a giant groin hernia in a resource limited setting with good short-term outcome if appropriate resources are put in place.

1.3 General objective:

To improve the management of giant inguino-scrotal hernias in a rural setting.

1.4 Specific objectives:

1- To define the socio-demographic parameters of patients with GISH in Cameroon.
2- To describe the clinical presentation of patients with GISH in Cameroon.
3- To describe the various management procedures used in patients with GISH in Cameroon.
4- To evaluate the outcome in the surgical management of patients with GISH in Cameroon.

CHAPTER 2: LITERATURE REVIEW

2 Literature review

2.1 Giant groin hernias:

2.1.1 Definition:

Giant inguinoscrotal hernia (GISH) have been defined as those that extend below the midpoint of the inner thigh when the patient is in the standing position or should display an anteroposterior diameter of at least 30 cm or a laterolateral diameter of about 50 cm with non-reducibility for more than 10 years[4].

2.1.2 Epidemiology:

Little is known on the exact prevalence of giant groin hernias in our context though abdominal wall hernia repair is a highly prevalent surgical operation in Africa which accounts for 15-18% of all surgical procedures at the typical surgical unit. Similarly, an estimated 7 in 10 cases of all abdominal wall hernias occur in the groin, thus making inguinal hernias the most frequently occurring type of hernia. Therefore, the inguinal hernia has an incidence of 175 per 100,000[2,20,21]. However, only a few fractions of these are repaired surgically. In Cameroon, Chendjou et al. reported a prevalence of hernia in general to be 7.4 per 1000 with groin hernias representing 85% of all hernias in the south-west region of Cameroon[3].

2.1.3 Anatomy of the groin:

History of anatomical findings[22]

Table II: History of groin hernia

Anatomical discoveries	
Vesalius (Flemish) and Fallopius (Italy) Poupart (France)	Described the inguinal ligament
Heister	First to describe direct hernias (1724)
Pott (England)	Anatomy of congenital hernias; methods of incarceration
Camper (Holland)	Described the superficial subcutaneous fascia
Scarpa (Italy)	Described deep subcutaneous fascia; anatomic and surgical importance of sliding hernias (En Glissade) (1814)
Sir Ashley Cooper (England)	Described anatomy and surgical treatment of crural and umbilical hernias; anatomy of the groin including the superior pubic (Cooper) ligament; cremasteric fascia and the transversalis fascia
Hunter	Emphasized the role of the processus vaginalis
Morton	Described the conjoined tendon
Cloquet	Noted postnatal closure of the processus vaginalis; made observations of the iliopubic tract
Hesselbach (Germany)	Defined iliopubic tract; described importance of the medial triangle of the groin (included the femoral canal).; described the “corona mortis” (arterial circle formed by the deep epigastric and obturator arteries)
De Gimbernat	Described medial ligament of the femoral canal (lacunar ligament), and division of that ligament in the treatment of strangulated femoral hernias
Richter (Germany)	Described partial obstruction and incarceration of a wall of the bowel in a hernia defect

The Anterior Abdominal Wall Anatomy

The anatomical layers of the abdominal wall include skin, subcutaneous tissue, superficial fascia, deep fascia, muscle, extraperitoneal fascia, and peritoneum. This anatomy may vary with respect to the different topographic regions of the abdomen. The major source of structural integrity and strength of the abdominal wall is provided by the musculofascial layer. The main paired abdominal muscles include the external oblique muscles, internal oblique muscles, transversus abdominis muscles, and rectus abdominis muscles and their respective aponeuroses, which are interdigitated with each other, and provide core strength and protection to the abdominal wall viscera. The integrity of the abdominal wall is essential not only to protect the visceral structures but also to stabilize the trunk and to aid trunk movement and posture[22].

Surface Anatomy

The abdomen can be divided into quadrants or nine abdominal regions. The midline in the sagittal plane is the linea alba. The lateral edge of the rectus sheath is the linea semilunaris. The lower costal margin, the iliac crest and pubic tubercle can be palpated.

Surface lines: For convenience of description of the viscera and of reference to morbid conditions of the contained parts, the abdomen is divided into nine regions, by imaginary planes, two horizontal and two sagittal, the edges of the planes being indicated by lines drawn on the surface of the body. In the older method the upper, or subcostal, horizontal line encircles the body at the level of the lowest points of the tenth costal cartilages; the lower, or intertubercular, is a line carried through the highest points of the iliac crests seen from the front, i.e. through the tubercles on the iliac crests about 5 cm behind the anterosuperior spines. An alternative method is that of Addison, who adopts the following lines:

(1) An upper transverse, the transpyloric, halfway between the jugular notch and the upper border of the symphysis pubis; this indicates the margin of the transpyloric plane, which in most cases cuts through the pylorus, the tips of the ninth costal cartilages and the lower border of the first lumbar vertebra;

(2) a lower transverse line midway between the upper transverse and the upper border of the symphysis pubis; this is termed the trans-tubercular, since it practically corresponds to that passing through the iliac tubercles; behind, its plane cuts the body of the fifth lumbar vertebra.

By means of these horizontal planes the abdomen is divided into three zones named from above, the subcostal, umbilical, and hypogastric zones. Each of these is further subdivided into three regions by the two sagittal planes, which are indicated on the surface by a right and a left lateral line drawn vertically through points halfway between the anterosuperior iliac spines and

the middle line. The middle region of the upper zone is called the epigastric, and the two lateral regions the right and left hypochondriac. The central region of the middle zone is the umbilical, and the two lateral regions the right and left lumbar. The middle region of the lower zone is the hypogastric or pubic, and the lateral are the right and left iliac or inguinal. The middle regions, viz., epigastric, umbilical, and pubic, can each be divided into right and left portions by the middle line. In the following description of the viscera the regions marked out by Addison's lines are those referred to[22].

The Fascia

Below the skin the superficial fascia is divided into a superficial fatty layer, Camper's fascia, and a deeper fibrous layer, Scarpa's fascia. The deep fascia lies on the abdominal muscles. Inferiorly Scarpa's fascia blends with the deep fascia of the thigh. This arrangement forms a plane between Scarpa's fascia and the deep abdominal fascia extending from the top of the thigh to the upper abdomen. Below the innermost layer of muscle, the transversus abdominis muscle, lies the transversalis fascia. The transversalis fascia is separated from the parietal peritoneum by a variable layer of fat, subcutaneous tissue.

1- Superficial Fascia

The superficial fascia of the abdominal wall is divided into a superficial and a deep layer. It may be as thin as half an inch or less or as thick as 6 inches or more. Above the umbilicus, the superficial fascia consists of a single layer. Below the umbilicus, the fascia divides into two layers: The Camper fascia (a superficial fatty layer) and the Scarpa fascia (a deep membranous layer). The superficial epigastric neurovascular bundle is located between these two layers. The abdominal subcutaneous fat, which is separated by the Scarpa fascia, is highly variable in thickness.

2- Deep Fascia

The deep fascia is a thin, tough layer that surrounds and is adherent to the underlying abdominal muscles. Each abdominal muscle has an aponeurotic component that contributes to the deep fascia.

3- Fascia Transversalis

The transversalis fascia (or transverse fascia) is a thin aponeurotic membrane which lies between the inner surface of the transversus abdominis and the extraperitoneal fascia. It forms part of the general layer of fascia lining the abdominal parietes, and is directly continuous with the iliac and pelvic fasciae. It is the most important, and at the same time, most puzzling entity in the infraumbilical space. This fascia has been described as being bilaminal: a superficial

sheet and a deep, translucent, usually tough sheet. The transversalis fascia covers the deep aspect of the musculus transversus abdominis. Medially, it lies deep to the posterior sheath of the musculus rectus abdominis. This sheath however ends abruptly distally, at a distance from the pubis constituting the semilunar line of Douglas.

In the inguinal region, the transversalis fascia is thick and dense in structure and is joined by fibers from the aponeurosis of the transversus, but it becomes thin as it ascends to the diaphragm, and blends with the fascia covering the under surface of this muscle.

Subserous and Peritoneal Fascia: The subserous fascia is also known as extraperitoneal fascia and serves to bond the peritoneum to the deep fascia of the abdominal wall or to the outer lining of the gastrointestinal tract. It may receive different names depending on its location (i.e. transversalis fascia when it is deep to that muscle, psoas fascia when it is next to that muscle, iliac fascia, and so on). The peritoneum is a thin (one cell thick) membrane that lines the abdominal cavity. It is useful in reconstructive efforts because it provides a layer between the bowel and mesh.

Behind, it is lost in the fat which covers the posterior surfaces of the kidneys.

Below, it has the following attachments: posteriorly, to the whole length of the iliac crest, between the attachments of the transversus and iliacus; between the anterosuperior iliac spine and the femoral vessels it is connected to the posterior margin of the inguinal ligament, and is there continuous with the iliac fascia.

Medial to the femoral vessels it is thin and attached to the pubis and pectineal line behind the inguinal falx, with which it is united; it descends in front of the femoral vessels to form the anterior wall of the femoral sheath.

Beneath the inguinal ligament it is strengthened by a band of fibrous tissue, which is only loosely connected to the ligament, and is specialized as the ilio-pubic tract.

Opening: The spermatic cord in the male and the round ligament of the uterus in the female pass through the transversalis fascia at a spot called the deep inguinal ring. This opening is not visible externally, since the transversalis fascia is prolonged on these structures as the internal spermatic fascia.

At that level, both layers of transversalis fascia separate on their way to the midline. The most superficial one passes anterior to the rectus muscle and blends with other fascial layers constituting the linea alba. The deepest layer of transversalis fascia remains deep to the rectus muscle, thus constituting the only posterior fascial reinforcement of the muscle at that level. The rectus muscle inserts on the pubic bone. The posterior layer of the transversalis fascia blends with the periosteum of the pubis and forms Cooper’s ligament laterally to the insertion

of the rectus muscle. Even more laterally, just where superficial and deep layer of transversalis fascia separate, the deep layer is pierced from posterior to anterior by the epigastric vessels, immediately cephalad to their origin from the iliac vessels. The epigastric vessels therefore run between the 2 sheets of transversalis fascia, but as they run more cranially and medially in close contact with the lateral end of the rectus muscle, they remain adherent to the posterior layer of transversalis fascia.

Bogros' Space

Bogros' space is situated laterally and cranially to Retzius' space. It represents the retroinguinal pre-peritoneum, limited anteriorly by the deep layer of transversalis fascia, enveloping the epigastric vessels, medially by the adherent zone of umbilicovesical fascia, transversalis fascia and peritoneum situated just behind the epigastrics, laterally by the pelvis wall and iliacus muscle and inferiorly by the psoas muscle, with medially to it the external iliac vessels and femoral nerve. Cranially, Bogros' space is in free continuity with the lumbar retroperitoneum. This continuity explains the inferior expansion of perirenal abcesses appearing in the groin. If one insufflates Retzius' space and Bogros' space separately, the adherence of fascia behind the epigastric vessels will give to this part of the retroperitoneum the aspect of an hour glass with long axis running craniallyand laterally.

The Muscles

The abdominal wall includes 5 paired muscles (3 flat muscles, 2 vertical muscles). The 3 flat muscles are the external oblique, internal oblique, and transversus abdominis. The 3-layered structure, combined with extensive aponeuroses, works in a synkinetic fashion not only to protect the abdominal viscera but also to increase abdominal pressure, which facilitates defecation, micturition, and parturition. The 2 vertical muscles are the rectus abdominis and pyramidalis. Fusion of the fascial layers of these muscles form 3 distinct fascial lines: the linea alba and 2 semilunar lines. The linea alba is formed by the fusion of both rectus sheaths at the midline, while the semilunar lines are formed by the union of the external oblique, internal oblique, and transversus abdominis aponeuroses at the lateral border of the rectus abdominis muscle.

1- Rectus Abdominis and Rectus Sheath

The rectus muscle extends from the xiphoid process of the sternum and 5, 6, 7th costal cartilages to the pubic symphysis and pubic crest. The muscle is enclosed within the rectus sheath formed by the aponeuroses of the lateral abdominal muscles. Along the length of this strap muscle there are three fibrous intersections separating the muscle into four segments. The

fibrous intersections are attached to the anterior surface of the rectus sheath, but not to the posterior surface. This allows the superior and inferior epigastric vessels to pass along the posterior surface of the muscle without encountering a barrier. The most important feature from the surgical perspective is that the fibers of the rectus sheath run from side-to-side. Vertical incisions divide fibers while horizontal incisions down closure with sutures encircling fibers rather that between fibers. The posterior rectus sheath has a similar trilaminar criss-cross pattern above the umbilicus, where it is composed of the posterior lamina of the internal oblique and the aponeurosis of the transverses abdominis muscle from either side.

2- External Oblique

The external oblique muscle is the largest and thickest of the flat abdominal wall muscles. It originates from the lower 8 ribs, interlocks with slips of latissimus dorsi and serratus anterior, and courses inferior-medially, attaching via its aponeurosis centrally at the linea alba. Inferiorly, the external oblique aponeurosis folds back upon itself and forms the inguinal ligament between the anterior superior iliac spine and the pubic tubercle. Medial to the pubic tubercle, the external oblique aponeurosis is attached to the pubic crest. Traveling superior to the medial part of the inguinal ligament, an opening in the aponeurosis forms the superficial inguinal ring. The innervation to the external oblique is derived from the lower 6 thoracic anterior primary rami and the first and second lumbar anterior primary rami.

3- Internal Oblique

The internal oblique muscle originates from the anterior portion of the iliac crest, lateral half to two-thirds of the inguinal ligament, and posterior aponeurosis of the transversus abdominis muscle. The internal oblique fibers run superior-anteriorly at right angles to the external oblique and insert on the cartilages of the lower 4 ribs. The anterior fibers become aponeurotic at around the ninth costal cartilage. At the lateral border of the rectus abdominis muscle and above the arcuate line, the aponeurosis splits anteriorly and posteriorly to enclose the rectus muscle to help form the rectus sheaths. However, beneath the arcuate line, the internal oblique aponeurosis does not split, resulting in an absent posterior rectus sheath. The inferior aponeurotic fibers arch over the spermatic cord, pass through the inguinal canal and then descend posterior to the superficial ring to attach to the pubic crest. The most inferior medial tendinous fibers fuse with the aponeurotic fibers of the transversus abdominis muscle to form the conjoint tendon, which also inserts on the pubic crest. The internal oblique is not invariable in its anatomy in the inguinal region. Its origin may commence at the internal ring or at a variable distance lateral to the ring. The muscle may then insert either into the pubic crest and tubercle or into the lateral margin of the rectus sheath a variable distance above the pubis. There

are thus four combinations of origin and insertion of the internal oblique in the groin. The contribution of the internal oblique to groin anatomy and in particular to the defenses of inguinal canal is very variable. The internal oblique muscle in its lateral fleshy part is not uniform in its structure; it is segmented or banded. The muscular bands terminate just lateral to the border the rectus muscle and are most marked in the inguinal and lower abdominal region. The bands are generally arranged like the "blades of a fan" with the interspaces increasing as the medial extremities are reached. Spigelian hernias occur through these defects of the semilunar line, which are more pronounced in the lower abdomen.

4- Transversus Abdominis

The transversus abdominis muscle is the innermost of the 3 flat abdominal muscles. The fibers of the transversus abdominis course predominately in a horizontal orientation. It has 2 fleshy origins and 1 aponeurotic origin. The first fleshy origin is from the anterior three fourths of the iliac crest and lateral third of the inguinal ligament, while the second origin is from the inner surface of the lower 6 costal cartilages where they interdigitate with fibers of the diaphragm. Between the 2 fleshy origins is the aponeurotic origin from the transverse processes of the lumbar vertebrae. These fibers course medially to the lateral border of the rectus muscle. From about 6.6cm inferior to the xiphoid process to the arcuate line, the insertion is aponeurotic and contributes to the formation of the posterior rectus sheath.

5- Pyramidalis

The pyramidalis is a small triangular muscle located anterior to the inferior aspect of the rectus abdominis; the pyramidalis is absent in about 20% of the population. The pyramidalis originates from the body of the pubis directly inferior to the insertion of the rectus abdominis and inserts into the linea alba inferior to the umbilicus to assist in stabilization of the lower midline.

6- Inguinal Ligament

The inguinal ligament is formed by the aponeurotic fibers of the external oblique muscle. The ligament stretches from the anterior superior iliac spine (ASIS) to the pubic tubercle. At the medial end of the inguinal ligament, fibers are reflected backwards to insert into the superior ramus of the pubis, forming the lacunar ligament. The iliopsoas muscles, the femoral vein artery and nerve, all pass below the inguinal ligament. The inguinal canal passes obliquely through the abdominal wall above the ligament. The inguinal canal transmits the vas deferens in the male and the round ligament in the female. The deep ring is the entrance to the inguinal canal on the inside of the abdominal wall. The deep ring is formed in the transversalis fascia.

As the canal passes through the abdominal wall it receives a layer of muscle from the internal oblique, the cremaster muscle. At the superficial ring the inguinal canal passes through the external oblique aponeurosis and receives a layer from the aponeurosis, the external spermatic fascia in the male.

The deep inguinal ring lies lateral to the inferior epigastric vessels. The superficial ring lies above and medial to the pubic tubercle.

Eponym: It is incorrectly referred to as Poupart's ligament, because Poupart gave it its relevance to hernial repair (he called it "le suspenseur de l'abdomen", the suspender of the abdomen). It is also incorrectly termed the Fallopian ligament.

A direct inguinal hernia occurs when a loop of gut pushes peritoneum and conjoint tendon through the superficial ring. An indirect hernia occurs when a loop of gut pushes peritoneum through the deep ring into the inguinal canal.

7- Spermatic Cord:

The spermatic cord passes through the inguinal canal to the testis. The vas deferens, testicular artery and veins, lymph vessels, autonomic nerves, cremasteric artery, artery of the vas and the genital branch of the femoral nerve are covered by three layers of fascia derived from the abdominal wall. The fascial covering of the spermatic cord is formed by the external spermatic fascia derived from the aponeurosis of the external oblique, the cremasteric fascia derived from the internal oblique and the internal spermatic fascia derived from the transversalis fascia.

Conjoint Tendon: It is mainly formed by the lower part of the tendon of the transversus abdominis and the internal oblique muscle, and is inserted into the crest of the pubis and pectineal line immediately behind the subcutaneous inguinal ring, serving to protect what would otherwise be a weak point in the abdominal wall. It forms the posterior wall of the inguinal canal, along with the transversalis fascia.

Clinical Significance

A direct inguinal hernia will protrude through Hesselbach's triangle, whose borders are the linea semilunaris (medially), inferior epigastric artery and vein (superolaterally), and the inguinal ligament (inferiorly). The hernia will lie medial to the spermatic cord.

Variations: The conjoint tendon has a very variable structure and in 20% of subjects it does not exist as a discrete anatomic structure. It may be absent or only slightly developed, it may be replaced by a lateral extension of the tendon of origin of the rectus muscle, or it may extend laterally to the deep inguinal ring so that no interval is present between the lower border of transverses and the inguinal ligament. A shutter mechanism for the conjoint tendon can only

be demonstrated when the lateral side of the tendon, that is transverses and internal oblique muscles, extend onto and are attached to the iliopectineal line.

8- Femoral Canal

The femoral canal lies below the inguinal ligament medially and lies medial to the femoral vessels. The femoral sheath is formed by the transversalis fascia and encloses the femoral vessels and the femoral canal. The lacunar ligament forms the medial border of the femoral canal. The femoral vein lies lateral to the femoral canal.

2.1.4 Pathophysiology

1- Congenital hernia

The embryology of the groin and of testicular descent largely explains indirect inguinal hernias. An indirect inguinal hernia is a congenital hernia regardless of the patient's age. It occurs because of protrusion of an abdominal viscus into an open processus vaginalis. If the processus contains viscera, it is called an indirect inguinal hernia. If peritoneal fluid fluxes between the space and the peritoneum, it is a communicating hydrocele. If fluid accumulates in the scrotum or spermatic cord without exchange of fluid with the peritoneum, it is a noncommunicating scrotal hydrocele or a hydrocele of the cord. In a girl, fluid accumulation in the processus vaginalis results in a hydrocele of the canal of Nuck. The inguinal canal forms by mesenchyme condensation around the gubernaculum, which is Latin for rudder because it guides the testis into the scrotum. During the first trimester, the gubernaculum extends from the testis to the labioscrotal fold. The processus vaginalis and its fascial coverings also form during the first trimester. A bilateral oblique defect in the abdominal wall develops during the sixth or seventh week of gestation as the muscular wall develops around the gubernaculum. The processus vaginalis protrudes from the peritoneal cavity and lies anteriorly, laterally, and medially to the gubernaculum by the eighth week of gestation. The testis produces many male hormones beginning at the eighth week of gestation. At the beginning of the seventh month, the gubernaculum begins a marked swelling influenced by a nonandrogenic hormone, probably a mullerian inhibiting substance. This results in expansion of the inguinal canal and the labioscrotal fold, forming the scrotum. The genitofemoral nerve also influences migration of the testis and gubernaculum into the scrotum under androgenic control. The female inguinal canal and processus is much less developed than the male equivalent. The inferior aspect of the gubernaculum is converted to the round ligament. The cranial part of the female gubernaculum becomes the ovarian ligament. Gonads develop on the medial aspect of the mesonephros during the fifth week of gestation. The kidney then moves cephalad, leaving the

gonad to reside in the pelvis until the seventh month of gestation. During this time, it retains a ligamentous attachment to the proximal gubernaculum. The gonads then migrate along the processus vaginalis, with the ovary descending into the pelvis and the testis being enwrapped within the distal processus, known as the tunica vaginalis.

The processus fails to close adequately at birth in 40 to 50% of boys. Therefore, other factors play a role in the development of a clinical indirect hernia. A familial tendency exists, with 11.5% of patients having a family history. The relative risk of inguinal hernia is 5.8 for brothers of male cases, 4.3 for brothers of female cases, 3.7 for sisters of male cases, and 17.8 for sisters of female cases.

Theories for Hernia Formation

1. Russell's theory—preformed sac.
2. Reid's metastatic emphysema theory—do not smoking.
3. Cloquet's lipoma theory—pile driver action of fat.
4. Fruchaud's theory—big opening in the lower abdomen-between the pubic bone and conjoint tendon. Divided into two by inguinal ligament. Through the upper part passes the inguinal hernia, while through the lower part passes the femoral hernia.
5. Denervation theory—ilioinguinal nerve especially after appendectomy.
6. Oblique pelvis—high arch of the internal oblique inefficient shutter mechanism–prone to inguinal hernia.
7. Wide female pelvis—lower arch of internal oblique more efficient shutter mechanism indirect inguinal hernias are uncommon in females. Results in wider femoral ring–femoral hernias most common in females.
8. Uglavasky theory—chronic increased IAP.
9. Peacock's theory—defective collagen synthesis.
10. Walk's theory—weakness of abdominal wall at exit of neurovascular bundle.
11. Keith's theory—stress related degeneration of connective tissue, especially in the fascia transversalis.
12. Deficient insertion of the conjoint tendon seen in males–especially white males—predisposes to direct inguinal hernia–less support to posterior inguinal canal wall. Attachment quite wide in females–direct hernia almost never occurs in females.
13. Dr Desarda's theory adynamic and weak posterior wall due to absent or deficient aponeurotic extensions is the main cause of hernia formation. Loss of shielding action of the muscles and binding action of the interparietal connective tissue are also important

Factors.

2- Acquired hernia

Inguinal Hernias

The pinchcock action of the musculature of the internal ring during abdominal muscular straining prohibits protrusion of the intestine into a patent processus. Paralysis or injury to the muscle 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 might preclude the buttressing effect. Neuropraxic or neurolytic sequelae of appendectomy or femoral vascular procedures may contribute to a greater incidence of hernia in these patients. Repetitive stress as a factor in hernia development is suggested by clinical presentations. Increased intraabdominal 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. Other conditions with increased incidence of inguinal hernias are extrophy of bladder, neonatal intraventricular hemorrhage, myelomeningocele, and undescended testes. A high incidence (16–25%) of inguinal hernias occurs in premature infants; this incidence is inversely related to weight. The rectus sheath adjacent to groin hernias is thinner than normal. The rate of fibroblast proliferation is less than normal, while the rate of collagenolysis appears increased. Sailors who developed scurvy had an increased incidence of hernia. Aberrant collagen states, such as Ehlers-Danlos syndrome, fetal hydantoin syndrome, Freeman-Sheldon syndrome, Hunter-Hurler syndrome, Kniest syndrome, Marfan syndrome, and Morquio syndrome, have increased rates of hernia formation, as do osteogenesis imperfecta, pseudo-Hurler polydystrophy, and Scheie syndrome. Acquired elastase deficiency also can lead to increased hernia formation. In 1981, Cannon and Read found that increased serum elastase and decreased a1-antitrypsin levels in people who smoke contribute to an increase in the rate of hernia in those who smoke heavily. The contribution of biochemical or metabolic factors in the creation of inguinal hernia remains speculative.

List of Causes of Inguinal Hernia

Following is a list of causes or underlying conditions that could possibly cause inguinal hernia:

- Obesity
- Pregnancy
- Heavy lifting

- Straining to pass stool, urine
- Enlarged prostate

Other conditions that might have inguinal hernia as a complication may, potentially, be an underlying cause of inguinal hernia. List includes the following as having inguinal hernia as a complication of that condition:

- Cutis laxa
- Marfan syndrome
- Whooping cough

Inguinal Hernia as a Symptom

Conditions listing inguinal hernia as a symptom may also be potential underlying causes of inguinal hernia. list includes the following as having inguinal hernia as a symptom of that condition:

- Aarskog syndrome
- Achondrogenesis
- Achondroplasia regional-dysplasia abdominal muscle
- Acrocallosal syndrome (Schinzel Type)
- Acrofacial dysostosis Catania form
- Alport syndrome
- Amyloidosis, familial cutaneous
- Aniridia-absent patella
- Anophthalmia—megalocornea-cardiopathy skeletal anomalies
- Arterial tortuosity syndrome
- Arthrogryposis-ophthalmoplegia-retinopathy
- Arthrogryposis multiplex with deafness, inguinal hernias, and early death
- Blepharophimosis telecanthus microstomia
- Bosma-Henkin-Christiansen syndrome
- Bruck syndrome 2
- Chitty Hall Baraitser syndrome
- Chromosome 1, deletion q21 q25
- Chromosome 1, partial trisomy
- Chromosome 11q duplication syndrome
- Chromosome 12p deletion
- Chromosome 12p deletion syndrome
- Chromosome 13 trisomy syndrome

- Chromosome 15q duplication syndrome
- Chromosome 15q, trisomy
- Chromosome 17, deletion 17q23 q24
- Chromosome 17p, partial duplication
- Chromosome 2 trisomy syndrome
- Chromosome 20p, partial duplication
- Chromosome 21q deletion syndrome
- Chromosome 22q duplication syndrome
- Chromosome 3, monosomy 3p25
- Chromosome 4, trisomy 4q
- Chromosome 4q duplication syndrome
- Chromosome 5q deletion syndrome
- Chromosome 6, monosomy 6q
- Chromosome 6p deletion syndrome
- Chromosome 6q deletion syndrome
- Chromosome 8, monosomy 8p
- Chromosome 8, monosomy 8p2
- Chromosome 8, monosomy 8p21-pter
- Chromosome 8, monosomy 8q
- Chromosome 8p deletion syndrome
- Chromosome 8p duplication syndrome
- Chromosome 8p inverted duplication syndrome
- Chromosome 9, monosomy 9p
- Collins-Pope syndrome
- Davis-Lafer syndrome
- Deafness–epiphyseal dysplasia–short stature
- Dermatocardioskeletal syndrome, Boronne type
- Ectodermal dysplasia, sensorineural hearing loss, and distinctive facial features
- Edward syndrome
- Ehlers-Danlos syndrome Type IX
- Ehlers-Danlos syndrome Type VI
- Ehlers-Danlos syndrome, 6B
- Ehlers-Danlos syndrome, Beasley Cohen Type
- Ehlers-Danlos syndrome, cardiac valvular form

An inguinal hernia may be indirect or direct.

- An indirect inguinal hernia, the more common form, results from weakness in the fascial margin of the internal inguinal ring. In an indirect hernia, abdominal viscera leave the abdomen through the inguinal ring and follow the spermatic cord (in males) or round ligament (in females); they emerge at the external ring and extend down the inguinal canal, commonly into the scrotum or labia. An indirect inguinal hernia may develop at any age, is more common in males, and is especially prevalent in infants younger than age 1. According to the American Academy of Pediatrics, about 5 out of 100 children have inguinal hernias.
- A direct inguinal hernia results from a weakness in the fascial floor of the inguinal canal. Instead of entering the canal through the internal ring, the hernia passes through the posterior inguinal wall, protrudes directly through the transverse fascia of the canal (in an area known as Hesselbach's triangle), and comes out at the external ring[22].

Smoking causes the inguinal hernia. The nicotine is absorbed in blood and weakens the abdominal musculature which reduces the function of shutter mechanism, thereby causing inguinal hernia[22].

Causes of Femoral Hernia

A femoral hernia can simply occur of its own accord, but anything which increases pressure on this part of body can also cause a hernia. This can include:

- Coughing
- Straining to pass feces or to pass urine
- Pregnancy
- Straining to lift heavy objects
- Stresses and straining of muscles due to physical exercise[22].

3- Giant inguino-scrotal hernias:

Usually due to protrusion of the intra-abdominal organs, over time the abdominal muscles retract (due to mechanical unloading), and the hernia gradually enlarges. Due to disuse atrophy, irreversible muscular fibrosis follows, the muscles becoming stiffer and less elastic. These anatomical changes have physiological side effects. As intra-abdominal viscera herniate out of the abdominal cavity, intra-abdominal pressure reduces causing diaphragmatic descent and respiratory dysfunction. Portal venous stasis often occurs, causing mesenteric and bowel wall oedema, swelling the contents of the hernia sac making reduction even more challenging[23].

Venous stasis leads to congested bowel, ischaemic bowel, diarrhoea, and abdominal pain. Lastly, atrophy of the strap muscles, and reduced intra-abdominal pressure results in an unsupported spine, precipitating chronic back pain.

Loss of domain seems to be especially relevant, as it serves to describe the volumetric relationship between the hernia and the residual abdominopelvic cavity[24]. However, its definition not being consensual is based around two equations:

- In the first case, the hernia sac volume (HSV) is defined as a proportion of the abdominal cavity volume (ACV) (the Tanaka method, HSV/ACV)[25].
- The alternative is to describe hernia volume as a proportion of the total peritoneal volume (TPV) (the Sabbagh method, ACV + HSV = TPV, HSV/TPV)[26].

It is presently unclear which of these two definitions would be most appropriate or which operating surgeons feel would be the most meaningful and intelligible. Some authors feel it is more logical and comprehensible to describe hernia volume as a proportion of total peritoneal volume, as this describes the percentage of abdominal viscera that has herniated[24]. Following the **International Delphi Consensus of Expert Surgeons of 2019,** a consensus for the Sabbagh method was achieved. Panelists could not reach consensus regarding a threshold LOD value that would preclude surgery[27].

2.1.5 Classification

Hernia classifications are useful for pre- or intra-operative description of the anatomy and size of a groin hernia which is a prerequisite for adequate surgical indication e.g. suture repair versus mesh repair in small indirect inguinal hernias without attenuation of the posterior wall of the inguinal canal (type L1). Objective hernia classification is also necessary to compare outcome after surgery in specific subgroups[28].

Different classification systems exist with various limits.

The Nyhus classification is one of the most frequently used classifications, but is not so easy to remember, like the Stoppa classification, which is derived from the Nyhus classification, with special attention to the aggravating factors [28,29].

Type 1	Indirect inguinal hernia with a normal ring Sac in the canal
Type 2	Indirect hernia with an enlarged internal ring but the posterior wall is intact; inferior deep epigastric vessels not displaced, sac not in scrotum
Type 3a	Direct hernia with a posterior floor defect only
Type 3b	Indirect hernia with enlargement of internal ring and posterior floor defect
Type 3c	Femoral hernia
Type 4	Recurrent hernia A direct B indirect C femoral D combinations of A-B-C

Aggravating factors: local or systemic, upstage type by 1 (Stoppa 1998)

The Bendavid type, staging, dimension (TSD) classification is very complex, with 20 different subtypes.

Table III: Bendavid Classification

Bendavid classification, 1994		
Type I	Anterolateral	(Indirect)
II	Anteromedial	(Direct)
III	Posteromedial	(Femoral)
IV	Posterolateral	(Prevascular)
Stage 1	Sac in canal	
2	Sac beyond external ring—not in scrotum	
3	Sac in scrotum	
Dimension	Max diameter defect in cm	
Modified Type II by Area		
Medial, lateral, central or entire		
Modifiers		
*R*ecurrence *S*lider *I*ncarcerated *N*ecrosis		

The Gilbert classification lacks the description of femoral hernias or combined hernias (e.g. pantaloon hernia).

Type 1: small, indirect
Type 2: medium, indirect
Type 3 : large, indirect
Type 4 : entire floor, direct

Type 5 : Diverticular, direct

A simple and easy-to-remember classification is the Aachen classification

Table IV: The Schumpelick Aus Arit-Aachen Classification

Schumpelick Aus Arit—Aachen classification			
L	- Lateral (indirect)	*Orifice Size*	
M	- Medial (direct)	Grade I	<1.5 cm
Mc	- Medial combined	II	1.5–3 cm
F	- Femoral	III	>3 cm

Hence an overview of the different classification systems can be shown on the table below

Table V: Overview of the heterogeneity of different inguinal hernia classifications

	Indirect			Direct			Fem	
						Rec		
Gilbert	1	2	3	4		5		
Stoppa	1		2	3		4		
Nyhus	I	II	IIIb	IIIa		IV	IIIc	
Bendavid TDS	I	1	2 3	II		V	III	IV
Alexandre	1	9	L cm	2		R	3	4
TOS		0	Ø cm					
Schumpelick	L I	L II	L III	M I	II	III R	F	
Corcione	1			2			3	
Cost	1	2	3	1	2	3		
Porrero	1	2	3	5		4		

Based on the Aachen classification (1.5 cm is used as reference for the size of the hernia orifice), the EHS proposes the index finger as the reference in open surgery, since the usual size of the tip of the index finger is mostly around 1.5–2 cm. This dimension is also reported to be identical to the length of the branches of a pair of most laparoscopic graspers, dissectors or scissors, enabling the surgeon to use the same classification during laparoscopic surgery. Therefore, the size of the hernia orifice is registered as 1 (≤1 finger), 2 (1–2 fingers) and 3 (≥ 3 fingers). For the anatomic localization, the same criteria are used as in the Aachen classification (L = lateral, M = medial, F = femoral). For a combined hernia it was proposed to mention the different hernias in the table by ticking the appropriate box instead of using the term Mc as in the Aachen classification. In addition, the letter P or R can be encircled to depict, respectively, a primary or recurrent hernia[28].

Table VI: EHS groin hernia classification

EHS Groin Hernia Classification		Primary	Recurrent		
	0	1	2	3	x
L					
M					
F					

Unfortunately, none of these classifications considers the volume of the hernia sac which extends below mid-thigh level.

However, some authors have proposed some classification systems for GISH amongst which Trakarsagna in 2014 in Philippine, who gave a classification with associated ideal procedures.

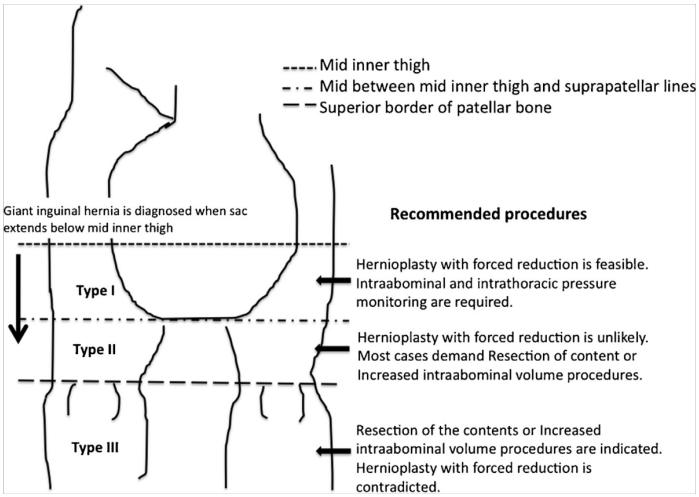

Figure 2: Classification for GISH *(by Trakarnsagna et al. in 2014)[9]*

This classification system was later on modified by Oyewale et al in 2023 based on a metaanalysis review from nine studies. This classification added the notion of radiological evaluation of loss of domain based on the scannographic TANAKA index such that:

Table VII: Proposed modification of Trakarnsanga classification of GIH[30]

Type	Description
1	Sac descends below the mid-thigh, but above an imaginary horizontal line midway between mid-thigh and superior patellar border.
1a	There is no visceromegaly of sac contents and no loss of domain.
1b	There is visceromegaly of sac contents and no loss of domain.
1c	There is visceromegaly of sac contents and loss of domain.
2	Sac descends below the imaginary horizontal line midway between mid-thigh and superior patellar border, but not extending beyond the superior patellar border
2a	There is visceromegaly of sac contents and no loss of domain
2b	There is loss of domain with visceromegaly of sac contents
3	Sac descends extends beyond the superior patellar border
3a	There is visceromegaly of sac contents and no loss of domain
3b	There is loss of domain with visceromegaly of sac contents

2.1.6 Clinical presentation for giant inguino-scrotal hernias

Patients may present with difficulty initiating micturition or acute retention of urine due to voiding difficulties as the scrotum tightens around the penis[14]. The massive size of giant hernias often causes difficulty in walking, sitting, or lying down, with mobility dramatically restricted. The penis may be buried inside the scrotum causing dribbling of urine over the scrotal skin, which is already congested by lymphatic and venous edema, leading to excoriation, ulceration, and secondary infection. Patients may also complain of difficulty in voiding and recurrent urinary tract infections, especially when the bladder is contained within the hernia sac[31]. The patient initially notices a cricket ball-sized swelling and pays no attention, as it is painless and reducible. Then, the swelling increases to become non-reducible but remains painless. Patient defers any medical attention due to his financial condition and lack of confidence toward surgical system[32].

2.1.7 Paraclinical assessment:

Initial imaging studies, including ultrasonography and contrast-enhanced computed tomography (CT) however has shown limitation in accurately diagnosing these hernia types. Due to anatomical variations and overlapping signs and symptoms, distinguishing between femoral and inguinal hernias can be challenging. Scar tissue from previous inguinal hernia repairs can further complicate imaging interpretations. Intraoperative exploration becomes crucial to confirm the diagnosis and facilitate proper surgical repair[33]. The common contents

of an inguinal hernia are omentum and small bowel; although, stomach, cecum, appendix, sigmoid colon, urinary bladder, ovaries and even the entire mesenteric small bowel and colon have been reported and this is usually confirmed by an ultrasound or CT Scan imaging. Though these imaging modalities can be confusing as some authors report a lipoma taken to be a groin hernia[32,34]. The CT scan can be helpful in evaluating loss of domain which is determinant for an effective management [25].

2.1.8 Clinical forms

1- **Topographic forms:**

- Giant inguinal hernias
- Giant femoral usually more frequent in females and can be confused with lipoma[35].

2- **Associated forms:** associated with controlateral inguinal and umbilical hernia[36]

3- **Complicated forms:**

Some authors report a case of acute spontaneous gastric rupture in a giant inguinoscrotal hernia which was managed surgically in a one-stage procedure with primary gastric and hernia repair. A subtotal colectomy was performed due to risk of volvulus as well as allowing for primary closure of the abdominal wall[37].

2.1.9 Diagnosis

- **Positive diagnosis** is based on the definition and clinical evaluation.
- Differential diagnosis:

Testicular tumours, acute epididymo-orchitis, epididymal cysts, and rarely, haematocoeles and gummas. All of these swellings are confined to the scrotum.

- Testicular tumours usually present as painless lumps arising from and rarely replacing the testis.
- Epididymo-orchitis usually causes a painful erythematous swelling of the hemiscrotum. Both the testis and epididymis are swollen and exquisitely tender.
- An epididymal cyst causes a painless epididymal lump palpable separate from the testis.
- Gummas and haematocoeles, like tumours, present as painless scrotal swellings, but unlike tumours, the testis and epididymis cannot be easily defined[14].
- A giant groin lipoma could also be confusing as some authors had to request imaging to clear the doubt[34].

2.2 Management

Essentially surgical though involving some other specialties.

2.2.1 Aims[37]:

The standard reasons for the repair of hernia include

a) relief of symptoms,

b) prevention of progression, and with further weakening of the anterior abdominal wall,

c) preventions of complications such as acute incarceration and strangulation,

d) addressing economic, employment, workers compensation issues, and

e) treatment of incarceration and strangulation.

Contraindications of repair of hernia include

a) the presence of ascites,

b) skin sepsis or other active infections,

c) pregnancy, and

d) reversible causes of increased intra-abdominal pressure—for example, prostatism, acute respiratory exacerbation and severe constipation

2.2.2 Difficulties encountered in Operative Management of Giant Hernia[8,12,14,38]

There are three specific problems arisen from the management of the inguinoscrotal hernia.

1- Firstly, there is loss of domain within the abdominal cavity. With the abdominal cavity adapted to being empty as the abdominal viscera is situated outside the cavity, reduction of the herniated viscera can cause the closure of the fascia not possible. It can lead to high intra-abdominal pressures, fascial dehiscence or abdominal compartment syndrome. Sudden increase in intra-abdominal pressure in addition to postoperative ileus and elevation of diaphragm can provoke fatal cardiorespiratory failure which is associated with high mortality. Thus, preoperative chest physiotherapy and postoperative mechanical ventilation play crucial roles. Post-operative bladder pressures and airway pressure are being monitored to determine the need to enlarge the abdominal compartment. Several techniques have been described to address this loss of domain.

2- The giant inguinoscrotal hernia was stated to have higher risk of recurrence than other inguinoscrotal hernias. The high recurrence rate is contributed by large hernia defect. Repair of defects without the use of mesh graft has been described but most have

preferred the use of mesh. The Lichtenstein technique of repair was shown to be effective in managing giant inguinoscrotal hernia.

3- There will be residual scrotal skin after abdominal wall construction with mesh herniaplasty. Some authors suggested excision of large residual scrotal skin and reconstruction of neo-scrotum for cosmetic reasons. For better cosmetic results, a single stage or double staged scrotal reconstruction can be planned. However, considerable shrinkage of the scrotal skin occurs because of retraction of the dartos muscle. It may be safer to preserve all the redundant scrotal skin to serve as a safety net; in case of failed repair or early postoperative severe respiratory compromise the bowel contents may temporarily return or shifted back into the scrotum. Extensive dissection of a huge sac can worsen lymphatic obstruction which can lead to trophic changes of the scrotum. Reductive plastic surgery of the scrotum, however should be performed if there is insufficient retraction of the dartos muscle as the abnormally huge scrotum will predispose to a form of elephantiasis due to lymphedema, for which an unpleasant surgery needs to be carried out subsequently.

2.2.3 Preoperative considerations

Certain Key factor in the management of giant inguinal hernia:

1- Always preoperative colonic evaluation should be considered as the incidence of malignant tumors within the inguinal hernia sac is reportedly 0.4–0.5% among the cases with excision. This disease is more common among elderly men and frequently involved the sigmoid colon[40]. Moreover, as colonic resection may be required as a part of treatment of giant inguinal hernia, barium enema is more of a preferred method than colonoscopy in the colon within hernia sac, is associated with high risk of colonic perforation [18].

2- Bowel preparation should be considered in all cases, especially the ones where hernia sac extends beyond the imaginary line between superior borders of patellar bone. Colonic resection may be necessary as a part of the treatment[9].

3- Attempts must be made to prevent excessive intra-abdominal and intrathoracic pressure caused by reduction of massive contents in to limited domain of abdominal cavity. Spermatic cord can be easily stretched as a result of long standing of hernia.

4- In some cases, the spermatic cord is twisted, causing testicular atrophy. Therefore, preoperative testicular examination should be performed in all patients and orchidectomy may be needed to prevent undesirable events.

5- Scrotal hematoma is commonly found after the operation. Dense adhesion is usually detected due to the chronicity of the disease. Extensive lysis of adhesion can cause hematoma. Given these circumstances, a closed drainage system should be implemented. It is important to note, though, that such system cannot always prevent postoperative hematoma. Meticulous hemostasis and close observation are the most important steps towards prevention and early detection[9].
6- An informed consent is needed to cover all possible operative procedures because final decision will be made intra-operatively. All of these options must be explained to the patient as well as their family members.

Preoperatively, the use of elemental diets to reduce fecal residues and GI secretion is suggested with a decrease in visceral volume of approximately 2 L over a period of 1 month. the efficacy of this technique in the extremely large hernia remains questionable[40].

Intra-abdominal hypertension

Intra-abdominal hypertension can develop because of the disproportion of abdominal domain of the large amount of content in the hernia sac. Forced reduction of the viscera to the abdominal cavity can produce a sudden increase in intra-abdominal pressure (IAP) and trigger an acute coronary syndrome, defined as a sustained IAP > 20 mmHg associated with multiple organ failure[41].

The high rate of mortality is clearly observed following forced reduction of giant inguinal hernia. Intra-abdominal hypertension can immediately develop after reduction of contents or later in the postoperative period due to ileus of the bowel. Excessive increase of intra-abdominal pressure generally affects regional blood flow in abdominal cavity, other organs outside abdomen, as well as the cardiovascular and respiratory system. Intra-thoracic pressure is raised as a result of cephalic displacement of diaphragm through the increase of intra-abdominal pressure[43].

Venous return, cardiac output and blood pressure are decreased by this phenomenon. Moreover, increase of intra-thoracic pressure causes increase of inspiratory rate and mean airway pressure, while tidal volume and pulmonary compliance are reduced[43].

Therefore, vital signs and urine output should be closely monitored. Respiratory support may be needed until ileus starts resolve[15].

According to previous literatures, hernioplasty with forced reduction is feasible for the treatment of giant inguinal hernias extending below mid inner thigh but above imaginary line at lower thigh, the line between the middle point of inner thigh and suprapatellar[44]. Intra-

abdominal and intra-thoracic pressure must be closely observed after the reduction as mentioned above.

Most hernial sacs, which extend below the imaginary line at lower thigh but above the line between superior borders of patellar bone, require additional procedures rather than simple hernioplasty alone[44,45]. The additional operations were introduced to prevent intra-abdominal hypertension. In cases that the hernial sac extends below the line between superior borders of patellar bone, additional procedures are almost always needed in addition to forced reduction and simple hernioplasty. The two major techniques required are resection of hernia contents and intra-abdominal volume increase procedure.The surgeon's decision regarding the prevention of intra-abdominal hypertension is a crucial stage of overall management[9].

- **Resection of the contents:**

Giant inguinal hernia is a type of hernia with massive contents inside the hernia sac and limited domain of abdominal cavity. The surgeon's decision regarding the prevention of intraabdominal hypertension is a crucial stage of overall management. Forced reduction is feasible in cases with mild form of this disease [type 1]. Resection or debulking of the contents is a portion to prevent intra-abdominal hypertension, with resected organs usually being the colon, the small bowel, or the omentum. The benefit is that it is a single stage operation with good results[14]. The limitations are rate of the failure of anatomosis, the changing of bowel function and the infection of prosthesis from resection of the bowel[9].

- **Intra-abdominal volume increase procedure:**

Loss of domain of intra-abdominal cavity is one of the main problems in the management of giant inguinal hernia. Forced reduction and simple hernioplasty may not be the appropriate procedure for moderate and severely enlarged giant inguinal hernia [type II and III]. Several techniques were proposed to avoid bowel resection, including:

- **In 1940, Goñi Moreno** described the PPP, which consists of placing an intraperitoneal catheter, through which an average of 14,000-20,000 cm3 of ambient air is progressively insufflated to enlarge the abdominal cavity and thus achieve an adequate visceral reduction of the hernial sac. On the other hand, it stabilizes diaphragmatic shape and function and improves ventilatory function by allowing elongation of the abdominal wall muscles, adhesiolysis, and pneumatic dissection of the hernia sac. Goñi-Moreno described that the procedure ends when the abdominal flanks are found

to be prominent and under tension by palpation. On the other hand, **Mayagoitia Gonzalez JC** recommends maintaining the pneumoperitoneum for nine to 15 days for a GISH [7,45].

- **Tanaka** described a technique for calculating the hernia sac volume (HSV) and abdominal cavity volume (ACV) based on abdominal computerized tomography (ACT) scanning that eliminates the need for subjective criteria for inclusion in a PPP program and shows the amount of gas that must be insufflated into the abdominal cavity in the PPP program. The PPP was performed only if the volume ratio HSV/ACV (VR = HSV/ACV) was ≥25% (VR ≥ 25%). The study concluded that ACT provides objective data for volume calculation of both hernia sac and abdominal cavity and also for estimation of the volume of gas that should be insufflated into the abdominal cavity in PPP[25]. The enlargement of the peritoneal cavity by progressive preoperative pneumoperitoneum has been highly recommended in the past, but usually it causes expansion of the thin hernia sac rather than the contracted abdominal cavity, requires prolonged preoperative hospitalization, and fails several times[7,8].
- Combination of Preoperative Progressive Pneumoperitoneum (PPP) and Botulinum Toxin A (BTA) enables the laparoscopic Transabdominal Preperitoneal approach (TAPP) for repairing GIH has also been reported with no post-operative complication and no recurrence reported after 22 months follow-up[47].

However, some authors question the necessity for the creation of a preoperative pneumoperitoneum as they have good results in surgically managing giant hernias without[48].

- **Rotation of viable tissue**

Rotation of viable tissue is the other technique to increase intra-abdominal volume by increasing surface of the abdominal wall. Several techniques have been proposed in the literatures:

1) For scrotal skin flap[8,49], midline anterior abdominal defect was created to increase space of abdominal cavity. Inguinal hernia orifice and midline anterior abdominal wall defect was repaired by prosthetic mesh, then cover midline mesh with myo-cutaneous scrotal flap.
2) A modification was proposed by using hernia sac as peritoneal flap and cover with mesh on top at anterior midline defect[50].
3) Similarly, tensor fascia latae musculocutaneous flap was alternatively used to cover mesh at anterior abdominal wall defect[15].

4) Component separation technique is one used to advance rectus muscle by freeing external oblique muscle from internal oblique muscle. This procedure allows the rectus muscle with the attached internal oblique and transverse abdominis muscles to be advanced approximately 10 cm on either side, which increases the flexibility of the abdominal wall, thereby, reducing the intra-abdominal pressure after closure. The abdomen is closed in a single layer. The hernias can be repaired either through a preperitoneal approach through the same incision or through separate inguinal incisions. This technique has the added advantage of being single-stage and avoiding complications associated with bowel resection, pneumoperitoneum and large skin flaps [45].

The advantage of rotation of viable of tissue is that is a single stage procedure but surgical expertise is required to prevent complication.

- **Hug technique:**

Single para-rectus incision extending from the level of the umbilicus to the groin region and extending down the proximal half of scrotum. Opening of the inguinal channel is achieved starting at the level of the umbilicus with an incision of the lateral margin of the anterior rectus sheet, extending inferiorly to the level of the external inguinal ring with opening of the external oblique aponeurosis. This para-rectus incision includes the medial insertions of the internal oblique muscle fascia to the rectus muscle fascia and, behind these, the deep portion of the transversalis fascia is opened longitudinally. This separation of the lateral margin of the rectus muscle from the internal oblique muscle at the level of the umbilicus is continued distally to the internal inguinal ring and below it. At this level, the fibers of the internal oblique muscle are completely cut and the epigastric vessels separated and ligated. In this way, the entire internal ring was cleared, and a complete opening and communication between the posterior and anterior inguinal region is achieved, allowing the preperitoneal space to be approached widely. Progressive reduction of the viscera without opening the sac using the hug technique, is utilized. The surgeon gently embraces the entire sac with his arms, feeling the abdominal cavity resistance being overcome and allowing the viscera to be gradually and completely reduced. This mechanism induces a slow, progressive, and continuous emptying of bowel content into the distal portion. If not possible, the sac is opened, and a right hemicolectomy with a latero-lateral ileo-transverse colon anastomosis is performed to restore bowel continuity. The space behind the rectus muscle, from the internal part of the pubic symphysis and the contro-lateral Cooper ligament to the umbilicus, is prepared. The Retzius space, the ipsilateral

Cooper ligament, the iliac vein and artery in the Bogros space, the obturator region, and the psoas region are dissected. In this space, one approximately 30 x 30 cm heavyweight polypropylene mesh is placed and fixed with non-absorbable sutures to the fibrous tissue of the internal pubic symphysis and to Coopers ligament (ipsilateral and contro-lateral)[51].

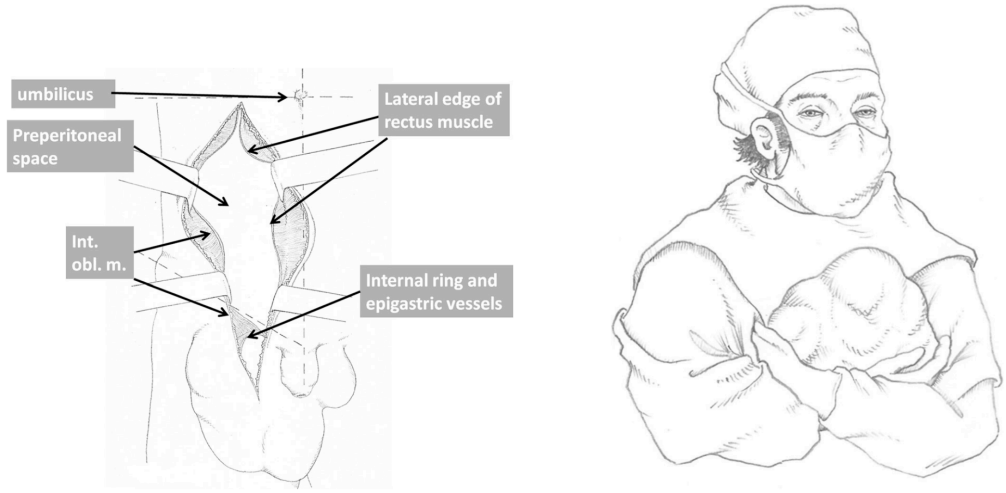

Figure 1: The hug technique of Giant hernia reduction[51].

A compression bandage with adequate drainage should be implemented to prevent the development of a large scrotal hematoma. Additionally, most authors agree that the scrotal skin should be left redundant, as it retracts due to the dartos muscle contractions and acts as a safety net to allow the contents temporarily back into the scrotum if the patient develops postoperative respiratory compromise[14].

2.2.4 Surgical techniques and approaches to hernia repair:

1- **<u>Open herniorraphie:</u>**

Bassini technique

On December 23, 1884, Bassini operated for the first time on an inguinal hernia using his new method. The operation consisted of high ligation and excision of the hernia sac, as well as his new technique of reinforcing the inguinal floor. For the reinforcement of the floor, Bassini separated, from the external oblique aponeurosis above and from the subjacent properitoneal fat, the outer margin of the rectus muscle and the "triple layer" corresponding to the internal oblique muscle, transversus muscle, and "fascia verticalis Cooperi" (transversalis fascia), and sutured the "triple layer" to the shelving edge of Poupart's ligament with interrupted, tension-free silk sutures. The two lowermost medial sutures included the outer margin of the rectus

muscle, so that the obliquity and the length of the canal were restored and the plasty of the musculoaponeurotic posterior wall would resist intra-abdominal pressure.

In his monograph, Bassini reported his astonishing results: an extensive follow-up of more than 90% of his patients for a period of up to 4½ years revealed in, a series of 262 patients an infection rate of only 4%, no mortality, and seven recurrences (2.6%). His postoperative care orders included early ambulation, shortened hospital stay, and, most importantly, no truss—the so-called radical cure[52].

Technique:

- **Position of the Patient:** The patient is placed on the OR table in a supine position with the pelvis elevated ("Paziente col. bacino rialzato."—Bassini). This can be achieved by breaking the OR table or by placing a pillow under the patient's buttocks.
- **Skin Incision:** A parainguinal skin incision is carried out 2 cm medially and parallel to the Poupart ligament from the anterior superior iliac spine (ASIS) to the external inguinal ring.
- **Exposure of the Aponeurosis of the External Oblique Muscle:** After the incision of the skin of the subcutaneous tissue and the fascia superficialis (Scarpa's fascia), and after completion of an accurate hemostasis of the superficial epigastric vessels, the whitish and shiny surface of the aponeurosis of the external oblique muscle, the external inguinal ring, and the hernia sac exiting from it are all well exposed. A self-retaining retractor is applied.

- **Incision of the Aponeurosis of the External Oblique Muscle Opening of the Anterior Wall of the Inguinal Canal and of the External Inguinal Ring:** With a knife, a small incision is performed over the aponeurosis at the superior angle of the wound in correspondence with and parallel to the medial pillar of the external inguinal ring. The two lips of the incised aponeurosis are grasped with a Kelly clamp on each side. With a closed scissor, back of the knife, or a Kittner, the aponeurosis is separated from the underlying tissue, internal oblique muscle, and the iliohypogastric nerve, which invariably lies immediately beneath the aponeurosis. Then the tip of the index finger is inserted in the opening to completely free the aponeurosis from the underlying tissue. The finger is pushed all the way down to the external inguinal ring, breaking through the external spermatic fascia with the fingertip so that the external inguinal ring is completely open; the aponeurosis is served and split with scissors along its fibers,

caudally, all the way down to the external inguinal ring bisecting it, and cranially, about 3 cm the internal inguinal ring.

Note: The incision of the aponeurosis is medial and parallel to the skin incision. The lateral flap of the aponeurosis of the external oblique muscle is larger than the medial flap.

At the superior aspect of the block, in proximity to the internal inguinal ring, the left index and middle fingers on one side, and the right index and middle fingers of the other hand on the other side are positioned under the block, with the thumb of each hand on the surface of the block so that the block is now included between the five fingers. With a special movement of the fingers, digitoclasia, squeezing while sliding the tissue, transversely and longitudinally, the fibers of the cremasteric muscle are dissociated from the cord and the sac easily and completely, in two branches, one lateral and one medial. The hernia block ("tumor") is formed by the spermatic cord, the hernia sac with its content, a lipoma, the cremasteric muscle and tunica, internal spermatic fascia (vaginalis comune), and accessory layers that may be more or less developed and present.

The entire block is grasped with the thumb and middle finger of the right hand with the help of the index finger, in the most distal part just close by the pubic spine, and is elevated perpendicularly.

- **Excision of the Cremasteric Muscle and Suture Ligature of the Stumps:** The dissociated lateral and medial branches of the cremasteric muscle can be united medially as one branch, which is clamped proximally and distally. The part in between is excised and removed, and the two stumps suture-ligated to avoid slipping of the ligature and possible bleeding of the cremasteric vessels.

  Note: The excision of the cremasteric muscle is indicated because: It clearly uncovers the sac and the spermatic cord, enveloped by the internal spermatic fascia (vaginalis comune). "When the cremasteric muscle is dissociated from the internal oblique muscle, it loses its continuity with the internal oblique muscle, losing its function and consequently atrophies" (Bassini). Excision of the sac, the lipoma, and the cremasteric muscles will prepare and clear the area for a clean reconstruction of the internal inguinal ring. With a very small hernia in a young patient, or in small and thin patients, the cremasteric muscle may be left intact and saved.

- **Opening of the Internal Spermatic Fascia:** After the excision of the cremasteric muscle, what remains of the hernia block are the spermatic cord, the sac, and a lipoma, all enveloped by the internal spermatic fascia (vaginalis comune) or transversalis fascia. Keeping the left index and middle fingers under the cord, the internal spermatic fascia is nicked on top of the cord with the tip of the scissor, incised longitudinally, and separated, so that the sac, the lipoma, and the structures of the cord are uncovered, clearly identified, and easily dissociated.
- **Isolation of the Sac:** The indirect sac is invariably located and found at the medial and superior aspect of the spermatic cord, close to the internal inguinal ring.With the same method of digitoclasia used for the separation of the cremasteric muscle, starting from the neck and going down the fundus, the sac is bluntly dissociated from the spermatic cord. If a lipoma (prolapsed properitoneal fat) is present, it is clearly recognized by its yellowish appearance and is easily separated from the sac and the structures of the cord, all the way up to the internal iliac fossa, where it is clamped, severed, excised, and suture-ligated. The sac is now completely free all the way up into the internal iliac fossa.

- **Opening of the Transversalis Fascia:** In the indirect or external oblique hernia, after the isolation of the sac has been completed, the fundus of the sac is pulled upward and laterally by the assistant, who at the same time with the other hand pulls laterally and horizontally the spermatic cord, encircled and protected by a penrose. With this maneuver, the opening of the hernia defect is well exposed and visible—exteriorized. Close to the defect, the deep epigastric vessels are seen in transparence, covered only by the transversalis fascia in continuity with the neck of the hernia sac. Holding two forceps, a smooth one in the left hand and a toothed one in the right hand, the transversalis fascia just adjacent to the medial border of the neck of the sac is grasped and lacerated. This creates a small opening on the transversalis fascia and exposes the properitoneal fat. With prudence and care, this small opening is enlarged just enough to expose the deep epigastric vessels, which are now separated from the transversalis fascia and will fall down on the properitoneal fat, on which they run medially and upward. Next, an Allis clamp grasps the triple layer, i.e., the inferior or caudal margin of the internal oblique muscle, transversus muscle, and transversalis fascia.

  Using the tip of the right index finger, the operator separates the transversalis fascia from the contour of the neck of the sac all the way down to the internal iliac fossa. Proceeding medially and caudally in the direction of the pubis, the detachment of the

transversalis fascia from the properitoneal fat can be accomplished by using a closed scissor, the back of a knife, a Kittner, or a finger, proceeding medially, at least 3–4 cm until the lateral border of the posterior belly of the rectus muscle is palpated or exposed. Originally, Bassini (the Maestro) incised the so-prepared triple layer for all the length of theinguinal canal, and parallel to it, so that the transversalis fascia was completely detached from the inguinal ligament.

Later on, the Maestro omitted this separation for indirect inguinal hernias only to assess a secure mobilization of the triple layer from the underlying tissue (the properitoneal fat and the peritoneum), and as well for the eventual possible presence of another hernia (vesical, sliding, or femoral).

An Allis clamp grasps the three components of the triple layer—the marginal caudal extremity of internal oblique muscle, the transversus muscle (the conjoint tendon when present), and the transversalis fascia—to keep them together as one.

- **Opening of the Sac Ani:** For Bassini, the management of the sac represents one of the most important steps of the operation. This step consists of suture-ligating the neck of the sac as high as possible beyond its very mouth into the iliac fossa through healthy peritoneum. If the ligature is not high enough, a small portion of the sac can be left behind, forming an infundibulum that, under the pressure, can become the site of a new hernia. Therefore, as a rule, the hernia sac, diligently isolated from the transversalis fascia and the pro-peritoneal fat in its totality, must be highly ligated beyond its neck throughout healthy peritoneum. Only in a small hernia, or a hernia with a large neck, such a small direct hernia, the sac can be intro-flected, without opening the peritoneum, over which the posterior wall is reconstructed. In a larger hernia, the opening of the sac is always recommended.
- **Reconstruction of the Posterior Wall of the Inguinal Canal and the Internal Inguinal Ring:** The reconstruction of the posterior wall is achieved by suturing the triple layer (internal oblique muscle, transversus muscle, and transversalis fascia) to the isolated posterior border of the inguinal ligament using a filzetta stitch. The first two stitches medially also include the lateral border of the rectus abdominis muscle.

  1. Triple layer.
  2. Isolated posterior border of the inguinal ligament.
  3. Filzetta stitch.
  4. The first two stitches medially also include the rectus abdominus muscle.

5. Laterally, the first stitch includes the insertion of the inguinal ligament to the pubic spine, just by the periosteum of the pubic spine, and also includes the ligament of the Colles, and the second stitch also includes the Cooper's ligament.

- **The Filzetta Stitch:** Filzetta stitch is an everting stitch applied as a purse-string suture, which includes the triple layer, "in and out," and "in and out". The first "in" starts about 3–4 cm from the outer border of the triple layer and comes "out" including 2 cm of the triple layer, and the second "in-out" is applied at 0.5 cm from the border of the triple layer. The tied filzetta stitch is neither constrictive nor rigid. The filzetta stitch, being an everting stitch, will approximate the transversalis fascia of the triple layer in direct contact with the transversalis fascia of the opposing side, the iliopubic ligament and the inguinal ligament, so that the coaptation is between tissues of the same histologic type. All the knots of the filzetta stitch should be tied on the muscle and not on the inguinal ligament.
- **The First Stitch:** The first stitch is applied at the inferomedial corner of the wound. With the left index finger retracting the properitoneal fat and inserted under the transversalis fascia, the right hand is used to needle-transfix first the rectus muscle, and, when present, also the triple layer from outside in. The needle should come from inside out, including 2 cm of the tissue. Once out, the needle again transfixes the triple layer from outside in 0.5 cm from the outer border, when present, or the lateral border of the rectus muscle. This is the filzetta stitch. At this point, the needle is out. Laterally, the needle transfixes the inguinal ligament just at its insertion to the periosteum of the pubic spine and then comes out. The suture is not tied, and the two free ends are held together with a Kelly clamp.

- **The Second Stitch:** The second stitch is applied 1 cm proximal to the first stitch in the same fashion. Laterally the filzetta stitch includes the rectus muscle 3–4 cm from the border of the triple layer, including 2 cm of the tissue, and then the needle comes out. Then the needle transfixes 0.5 cm of the lateral border of the triple layer, when present, or the lateral border of the rectus muscle, and then comes out. Laterally the tip of the needle is aimed at the pectineal crest, is passed under and includes the ligament of Colles, then transfixes, in total, the isolated posterior border of the inguinal ligament.

- **The Third Stitch:** Medially, the third stitch includes only the triple layer. The rectus muscle is no longer part of the inguinal region. Laterally, the stitch includes the isolated posterior border of the inguinal ligament.
- **The Last Stitch:** The last stitch for the reconstruction of the internal inguinal rings is applied in a slightly different manner. This stitch is not applied in front of the internal opening and parallel to the other stitches but in a more oblique fashion. The needle transfixes obliquely the triple layer, starting at 1 cm above the exit of the cord and at 3–4 cm from its border (filzetta). Medially, the needle transfixes the isolated posterior border of the inguinal ligament, 0.5 cm below the exit of the cord. When this suture is tied, the newly reconstructed internal inguinal ring will be well calibrated (not too loose or too tight); the cord is moved laterally, closer to the anterior superior iliac spine so that the perpendicular direction from back to front is lost, and the cord does not exit directly from the newly reconstructed internal inguinal ring but takes an oblique course surrounded by the triple layer, and then descending medially in a parainguinal direction. The remaining stitches are applied at 1 cm proximal to the previous one in the same fashion, medially and laterally. Usually they are 5–8 in number as needed.

- **Tying the Sutures:** The ends of all replaced sutures are held up by the assistant, who keeps the two lines of sutures separated by a finger passed between them. The operator takes these threads in a pair, tying them successively, while the assistant depresses the underlying properitoneal fat with a closed Kelly clamp, with a finger or a small flat retractor.
    1. Before tying the sutures, the “break” of the operating table is removed; the patient is now lying supine with the legs slightly elevated so that the sutures can be tied with less tension.
    2. The knot should be surgical for a more secure and better calibration of the coaptation of the tissues. Too tight will constrict and compromise the viability of the approximated tissue; too loose will compromise the appropriate healing.
    3. The tying of the sutures will start medially, (the first stitch) continuing laterally (to the last stitch) from the site of less tension to that of more tension. If a stitch accidentally breaks during the tying, it can be reapplied much easier.
    4. All the knots must fall on the muscle and not on the inguinal ligament. This can be easily accomplished if the operator ties the suture from the other side of the operative table, at the assistant position.

As already mentioned, the first two stitches, medially, must also include the lateral margin of the rectus abdominis muscle. The last stitch, the most lateral, is applied more obliquely than the others, as described, for the reconstruction of the internal inguinal ring. When this suture is tied, the spermatic cord is moved slightly lateral, close to the ASIS, and in this way will exit from the neo-formed internal inguinal ring in an oblique fashion. The cord is surrounded by a snuggling of the musculoaponeurotic tissue, well calibrated, not too tight as that would constrict the blood supply of the testis and not too loose as that would jeopardize a recurrence. The freedom of the cord can be tested by moving it, so that it should run freely on the newly formed internal inguinal ring. After the sutures are all tied, the excesses of the sutures can be cut above the knot.

- **Reconstruction of the Anterior Wall of the Inguinal Canal and of the External Inguinal Ring:** A Kelly clamp is applied superiorly at the angle of confluence of the two flaps of the aponeurosis of the external oblique muscle, another Kelly at the lower part of the medial flap, and another at the lower part of the lateral flap of the aponeurosis. The upper Kelly clamp is held up by the operator with his left hand, and the assistant holds up the two lower clamps with one hand, while with two fingers of the other hand depresses and protects the spermatic cord. The free medial flap of the aponeurosis is sutured to the lateral flap in a continuous manner and from lateral to medial starting at the upper corner. The needle should include 2 mm of the margin of the aponeurosis in each side and about 3 mm apart from one stitch to the other. The last stitch should approximate the medial and lateral pillar for the reconstruction of the external inguinal ring. This should accommodate the tip of the little finger, and the cord should move freely throughout the newly formed external inguinal ring. If the ring is too tight, it will compromise the blood supply to the testicle.

- **Closure of the Skin:** The skin is closed with subcuticular stitches. The suture line that approximated the two flaps of the aponeurosis lies medially to the skin suture line and medial to the suture line of the deep repair on the inguinal ligament, so that the three suture lines do not overlap but are scattered, making them more resistant to the increased intra-abdominal pressure.

The Shouldice technique:

The Shouldice repair for inguinal hernia, also referred to as the ‘Bassini-Shouldice’ or the ‘Canadian repair’, was performed for the first time in 1936 by Dr. Edward Earle Shouldice. It

was later modified in 1952, when it finally acquired its current aspect. At the time, the Shouldice repair undoubtedly represented the ultimate milestone of inguinal hernia repair.

The Shouldice repair does not make use of any prosthetic material, and it remains today the gold standard of pure tissue repair for inguinal hernia. This technique applies to both indirect and direct inguinal hernias.

The Shouldice repair revolutionized hernia surgery as it allowed the use of local anaesthesia, the patient's early ambulation and the quick resumption of life routines.

In the Shouldice repair, the principles of the Bassini operation are followed, in particular with regard to the opening of the posterior inguinal wall during the dissection, and to the suture of the true, thin transversalis fascia (which is a part of the endopelvic fascia) and the fasciae, and muscles of the transversalis and internal oblique muscles to the inguinal ligament all together (the so-called triple layer) during the reconstruction.

This suture is performed with four lines. It minimizes the traction and progressively reinforces the new posterior wall of the inguinal canal.

The Shouldice repair corrected several shortfalls of the Bassini technique:

1. The incision of the cribriform fascia distal to the inguinal ligament permits further mobilization of the shelving edge of the inguinal ligament and reduces the traction on suture lines; this incision of the cribriform fascia may reveal a femoral hernia which may otherwise be missed.
2. Continuous suture lines distribute tension and traction on the muscles and fasciae and progressively correct possible imperfections and gaps within the sutured layers.
3. The internal ring is not only reinforced and calibrated by using the lateral cremasteric stump which is swung around the spermatic cord like a scarf.

The careful dissection needed by this technique is one of the very reasons for the improvement of its results.

Local Anaesthesia

The use of local anaesthesia is central to the encouragement of a gentle and atraumatic surgical approach as well as avoiding excessive traction on tissues. Local anaesthesia also allows to test a repair in a cooperating patient.

The anaesthesiologist can associate sedation to maintain the patient in a completely relaxed state. The technique used is called 'sandwich anaesthesia': 10 mL ropivacaine solution for injection 10 mg/mL subcutaneously before entering the operating room, followed by 1% lidocaine up to 60 mL during the dissection, and then again 100 mg in 10 mL of ropivacaine injected subcutaneously to conclude the surgery.

Surgical Technique

Dissection:

The skin incision runs anterior to the inguinal ligament rather than 2–3 cm superior to it. This incision, from experience, provides a better access to the working area of the groin. The incision will be 6–10 cm in length. The external oblique aponeurosis readily appears under the subcutaneous tissue.

One proceeds then with a subaponeurotic infiltration of lidocaine when the external oblique aponeurosis is still intact to block the ilioinguinal and iliohypogastric nerves as well as the genital branch of the genitofemoral nerve.

As soon as the cribriform fascia, in the region of Scarpa's triangle, is opened, the inguinal ligament becomes more mobile. If present, a femoral hernia can now be identified.

Proceed with the incision of the external oblique aponeurosis up to the external inguinal ring, and prolong it 2–3 cm lateral to the internal ring. This incision has to be as medial as possible to preserve a larger lateral flap of the external oblique aponeurosis.

The incision shows the internal oblique muscle, the spermatic cord and the sulcus of the inguinal ligament.

Gently separate the external oblique aponeurosis from these elements with a peanut gauze. It is now that the ilioinguinal nerve can be identified along the cremaster and the iliohypogastric nerve on the internal oblique muscle.

After infiltrating the cremasteric fibres with lidocaine, it is incised longitudinally to obtain two flaps: a medial flap and a lateral one with the spermatic cord lying on top of the longitudinal mid-portion of the splayed cremasteric fascia (muscle). The cord can now be lifted with a Penrose drain. An indirect hernia sac, if present, becomes easily identifiable. The medial flap is resected with adequate haemostasis. The lateral flap is sectioned between two clamps. The ilioinguinal nerve is preferably sectioned and ligated separately, if need be. Two stumps remain: a proximal (lateral) and a distal (medial) one.

The two cremaster muscle stumps are doubly ligated: it is between these two ligatures that the needle will pass throughout at the end of the first suture line.

The external spermatic vessels and the genital branch of genitofemoral nerve can be ligated separately or together with the cremasteric lateral flap, depending on their anatomic configuration.

It is now necessary to search for an internal oblique hernia sac. If a sac is present, it has to be separated from the spermatic cord, isolating it as much as possible inside the internal inguinal

ring in the preperitoneal space. Resection and ligature of the sac are not necessary; furthermore, they could lead to early postoperative pain.

Once the indirect hernia sac disappears deep to the internal inguinal ring, the cord has to be retracted laterally.

Now the posterior wall of the inguinal canal, represented by the triple layer, is in full view.

Whether or not a direct hernia is present, the transversalis fascia must be incised from the internal ring to the pubic tubercle.

The transversalis fascia should be incised closer to the oblique muscle rather than to the inguinal ligament for two main reasons:

- Firstly, in case of accidental lesion of the epigastric vessels, the ligature will be easier if more distal from the iliac vessels, and,
- secondly, in order to leave a larger portion of the fascia towards the inguinal ligament (iliopubic tract).

The fascia's portion closer to the inguinal ligament is the iliopubic ligament (iliopubic tract, Thomson's ligament), and it is generally quite resistant.

In case of a direct hernia, the transversalis fascia is quite thinned out. Any excessive, thin or redundant portion of the posterior wall should be excised.

Once the transversalis fascia is incised, the preperitoneal fat can be seen as a glistening yellow layer.

With the help of a gauze, the fat is separated in order to medially highlight the posterior aspect of the transverse and rectus muscles and laterally the posterior aspect of the iliopubic tract.

Often, a small vein, called by Bendavid 'the iliopubic vein', runs adherent and parallel to the deep portion of the iliopubic tract. This marginal vein can cause disturbing bleedings and must be avoided.

Reconstruction:

The reconstruction of the posterior inguinal wall is done with four continuous lines using two nonabsorbable sutures. The first suture is used for the first two lines and the second suture for the third and fourth lines.

- The first line of continuous suture starts at the level of the pubic tubercle.

Firstly, the needle passes through the more medial corner of the iliopubic tract and then through the so-called triple layer and the lateral edge of the rectus.

The suture continues towards the internal ring. It must include, laterally, the iliopubic tract and,

medially, the posterior aspect of rectus muscle for the first two or three sutures, and then, again, the iliopubic tract and the posterior aspect of the transverse and internal oblique muscles, up to the internal inguinal ring.

This first suture line is correctly done if the border—composed by the transversalis fascia, the transverse muscle, and the internal oblique muscle—is not included in the suture and remains medially free by forming an edge or a flap.
The last bite of the first suture line will incorporate the proximal stump of the cremaster muscle before crossing over to start the second line of suture at the free edge or border just described, just medial to the internal ring.

- The continuous suture (second line) goes back towards the pubic tubercle and includes medially the triple layer left free earlier (the border formed by the transversalis fascia, the transverse muscle and the internal oblique muscle) and the area of the inguinal ligament up to the initial tie. It is then knotted to the tail clamped earlier.

The posterior inguinal wall is now reconstructed.

- The third line of suture starts at the level of the internal inguinal ring where it will be knotted, clamping again the tail of the suture. This suture line continues towards the pubic tubercle remaining slightly more superficial than the previous one. The internal oblique muscle is sutured again to the area of the inguinal ligament, but more superficially than the previous inguinal suture line.

The division of the cremaster may cause a drooping of the ipsilateral testicle. To avoid this event and support the testicle, the most distal stitch of the third suture line can include the distal cremasteric stump previously doubly ligated.

- At the level of the pubic tubercle, the suture returns towards the internal ring (fourth line) remaining even more superficial than the third suture line. Arriving at the internal ring, the fourth line has to be knotted to the suture tail knotted at the beginning of the third line.

The posterior wall is now extremely resistant.
The cord is repositioned in its original site. Now the external oblique muscle aponeurosis can be re-approximated.
To better balance the external ring, it is appropriate to start the suture of the external oblique muscle aponeurosis from the new external inguinal ring and proceed laterally.

The repair ends with another subcutaneous injection of 100 mg of ropivacaine to prolong the effects of local anaesthesia.

At the end of surgery, the patient can get up from the operating table with some assistance.

Shouldice Repair in Female Patients

It is a well-known fact that inguinal hernia occurs in females with a 10 times lower incidence than in males. The posterior wall of the female inguinal canal is generally more resistant than the male ones, resulting in much lower direct hernia occurrence.

In females the Shouldice repair is performed mainly following the same steps used in males, although, the different anatomy demands some distinctions in the surgical approach.

Dissection:

The incision of the external oblique aponeurosis shows the round ligament of the uterus surrounded by fibres and small vessels. Its size varies greatly among patients: it could be just residual or sized almost as a spermatic cord.

If the round ligament is only residual, it can be clamped and accurately ligated. If it is of noticeable size, it should be treated as a spermatic cord and preserved accordingly.

Search for an indirect hernia sac and dissect it from the round ligament up to the internal ring as high as possible as done in male patients.

Open the transversalis fascia using the same criteria applied in male patients.

In the majority of cases, the Hesselbach triangle is narrower than in males because of the female pelvic conformation. The Henle's ligament (that is a reinforcement of the transversalis fascia) is more evident, thus making unnecessary—counterproductive, actually—the complete opening of the posterior wall up to the pubic tubercle.

Preserving the genital branch of the genitofemoral nerve is particularly important in females. In fact, its dissection may impact on the sensitiveness of the labium majus.

Reconstruction:

The reconstruction is done with a similar technique and accuracy (four lines of suture) as in male patients.

2- <u>Open Mesh repair of the defect:</u>

- Meshes can be placed in a pre-muscular position (Lichtenstein's procedure) and in a preperitoneal position, in addition to a reconstruction of the abdominal wall by modified components separation technique[53].

- Tension-free mesh repair for GIH using a standard transverse inguinal incision is feasible and safe and there is no need for abdominal cavity preparation with reported early complication rates (up to 30 days post-operatively) of 62.1% vs. 14.7% in the GIH and control groups respectively. Hernia reduction was facilitated by placing the patient in a Trendelenburg position [54].

Lichtenstein Onlay Mesh Hernioplasty:

Accordingly, in our daily practice, this procedure represents the first approach to inguinal defects except for those cases of bilateral and recurrent inguinal hernia suitable for a laparoscopic repair.

Indications:

In 2009 and 2014, the European Hernia Society published guidelines on the treatment of inguinal hernia in adult patients. Several recommendations were done, and in our practice patients of both sexes complaining of symptomatic primary unilateral inguinal hernia are operated with an anterior approach under local anesthesia.

All those patients not suitable for a general anesthesia or unable to tolerate pneumoperitoneum are offered a Lichtenstein procedure under local anesthesia.

Patients complaining of inguinal pain with or without radiological signs of hernia but no clinically detectable defects are referred for watchful waiting.

Patient Preparation

Before hospitalization, the patient is given information concerning surgery, type of anesthesia, and recovery in dedicated visit.

A dose of subcutaneous low molecular weight heparin is given in patient judged at high risk of thrombosis the night before the procedure. The inguinal region is shaved the day of admission with clipper. The antibiotic prophylaxis is adopted only in cases with predisposing comorbidities.

The patient lies in the supine position, leg adducted, and the surgeon stands on the site of the hernia with the first assistant on the opposite site.

Technique

Anesthesia:

We consider local anesthesia as the “gold standard” technique for the repair of unilateral primary inguinal hernia: it’s simple, easily administered and mastered, well accepted by the patients, and with virtually no side effects.

For its characteristics of high tolerability, it is a formidable tool for the increasing number of

elderly patients with concomitant morbidities: it represents a good solution to the problem of an aging population with high life expectancy, asking for an effective and low-risk treatment to their disability.

Some form of additive light sedation may be asked from the anesthesiologist in cases in which patient's pain or anxiety becomes an obstacle for the surgeon.

On the opposite hand, when general anesthesia is needed, it is indicated mainly for a posterior laparoscopic approach. Its use in the setting of open anterior approach, in our practice, is considered as a "rescue procedure" for those patients not tolerating a local anesthesia or asking for a complete unconsciousness.

Local Anesthesia

Even if very old, mepivacaine, a local anesthetic of the amide type, is the agent of choice. Its pharmacokinetic profile fits well our needs because the fair rapid onset helps save time where no other drug is given outside of the operatory room; on the other hand, its medium duration of action allows us the completion of the procedure and analgesia during the minutes after the end of the procedure. We utilize a solution of mepivacaine 2% (20 mL) neutralized with sodium bicarbonate 8.4% (10 mL) and diluted with saline (30 mL).

We do not use adrenalin because the anesthetic mixture is adequate in the vast majority of cases; the protraction of the procedure beyond 2 h is very rare and in our opinion not advantageous for the patients. We consider this type of event precognizable, and usually we approach it with a general or spinal anesthesia.

We adopt a step-by-step approach in which the mixture is given in subsequent injections of local anesthetic during the procedure.

Before starting the intervention, a single injection with an insulin needle (25 G) is performed in order to obtain an intradermal wheal.

Afterward, using this wheal as an entry mark, we shift to a 22 G spinal needle; the superficial subcutaneous tissue is injected moving forward and backward the needle to obtain an area with 3–4 cm width around the site of the future incision. From the superficial layer, we then move to anesthetize the deep subcutaneous tissue to obtain a preliminary nerve block.

Surgical Dissection:

After the onset of anesthesia, an oblique 6–7 centimeters skin incision is made on the cutaneous projection of Poupart's ligament, in the inguinal fold, using the pubic tubercle (PT) and superior iliac spine (SIS) as landmarks. The line of section falls between the middle and medial third of the aforementioned line.

The dissection of the superficial subcutaneous tissue is carried with monopolar energy, and the epigastric superficial vessels when encountered are ligated and transected.

Scarpa's fascia represents the boundary between superficial and deep subcutaneous tissue. Before division of this thickened connectival structure, we usually perform injection of 2 mL of anesthetic in the deep subcutaneous layer. Another 2 mL of local anesthesia is delivered under the external oblique aponeurosis (EOA) as soon as it is visualized in order to anesthetize the ilioinguinal and iliohypogastric nerves.

The EOA is dissected free to expose its lower part from which the inguinal ligament reflection and the superficial inguinal ring take origin. The aponeurosis is opened following its longitudinal fibers downward to the pubic tubercle and upward for 5 cm in direction of the SIS. The free edges of the aponeurosis are retracted with clamps. The internal oblique, conjoined tendon, and inguinal ligament or Poupart's ligament are gently dissected with scissors or fingertips from the EOA. During this step, it easily can be visualized the ilioinguinal nerve entering the inguinal canal and the iliohypogastric nerve that pierces the EOA. The spermatic cord is freed from the deep floor of the inguinal canal, underpassed at the level of the pubic tubercle, and suspended with a silastic tube.

Firstly 2–3 mL of anesthetic is injected in the space between the cremasteric muscle, the external spermatic fascia, and spermatic cord at the level of the genital branch of the genitofemoral nerve using the "blue line" as anatomical landmark and then some 2 mL on the upper part of the cremasteric fascia to obtain anesthesia of the entire cord.

The suspended cord is retracted and completely freed from its posterior attachments to the inguinal floor. The ilioinguinal nerve is identified at this level and gently isolated from the underlying muscle fibers. The cremasteric muscle is then divided longitudinally from the deep inguinal ring toward the pubic tubercle for 3–4 cm and dissected from the spermatic structure. The resulting medial leaf of the cremaster, usually very thin, is resected with monopolar cautery. In the classic Lichtenstein's description, the lateral leaf which carries also vascular structure is preserved.

Hernia Sac Treatment

This step of the procedure can cause several problems to the operating surgeon depending on the grade of inflammation, the length of the sac, and the nature of the hernia (congenital vs. acquired). All these features determine tight adhesions of the cord structures to the peritoneal sac; thus, the dissection maneuvers can produce lesions to the vas deferens, nerve branches, and vascular structures which can turn in serious complications, namely, reproductive dysfunction, pain syndromes, and ischemic orchitis followed by testicle atrophy.

1- Medial Hernia Sac

For non-scrotal hernia, the so-called direct sac does not represent a surgical challenge, and it's easily visualized medially to the cord covered by the medial leaf of the cremaster muscle. It's dissected and inverted, and care must be taken when reducing the part near to the internal inguinal ring since several times the epigastric vessels can be dislocated and inadvertently injured during dissection or reconstruction of the inguinal floor.

2- Lateral Hernia Sac

To truly access the plane containing this type of hernia, it is very important to open the external spermatic fascia, a thin layer of unorganized connective tissue arising from the innominate fascia at the cord emergence from the internal ring.

We usually look first for the distal end of the sac and dissect it proximally to the neck. In case of a long sac or a particular type of sac, namely, those entering in the middle of the spermatic cord, we adopt the technique of dissecting circularly the sac halfway in the spermatic cord, in the place where it is most accessible, and subsequently the distal end is retrieved and the proximal dissection is finalized. During this step, the patient can feel pain originating from excessive traction on the peritoneal sac or inadvertent stimulation of the genital branch of the genitofemoral nerve with monopolar energy. We advise infiltration of the neck of the sac with 1–2 mL of anesthetic mixture when approaching the deep inguinal ring to reduce this occurrence particularly in presence of an inflamed field.

Except for some scrotal hernia and emergent cases to check the bowel for vitality, the sac, once dissected completely, is never opened or excised since it's well known that this maneuvers can cause postoperative pain.

According to Lichtenstein, the hernia content is reduced in the abdominal cavity: in case of lateral hernias, few resorbable stitches are required to narrow the patent deep inguinal ring, and for medial sac, we use inverting continuous resorbable suture. These maneuvers of reconstruction of the anatomy have the only purpose of keeping in place the hernia content during placement of the mesh and do not represent a support for the repair.

The Mesh: Material

Today, after several years have passed and study performed, the mainstay of every inguinal hernia repair is represented by the mesh as recommended by current guidelines. The material originally adopted was polypropylene, but also polyester and PVDF meshes have shown their efficacy in the treatment of this disease[52].

Sterilized polyester mosquito net has also proven to be efficacious with good long term results in resource limited settings[55].

The mesh is tailored on table, not pre-shaped but trimmed according to the patient's inguinal floor, and the dimensions are 7 × 13 cm. The mesh is tailored to look like the outline of a foot with the toe covering medially the angle between the inguinal ligament and the anterior rectus sheath. The mesh has a slit, along its major axis, at the level of the internal ring to allow the passage of the spermatic cord forming two tails of different dimension: the lateral thinner and the medial wider. These tails are crossed and solidarized with non-resorbable sutures behind the spermatic cord to avoid recurrence lateral to the internal ring. Suturing the tails together in a parallel position, without crossing, is a known cause of recurrence in the internal ring area.

The mesh is bigger to cover all the inguinal floor, with a 2 cm overlap over the pubic tubercle and 5–6 cm lateral to the internal inguinal ring. After fixation, it should be kept in a relaxing configuration, somewhat redundant to overcome the problem of polypropylene shrinkage possible, as known, as far as 25%. Using interrupted resorbable sutures and keeping the nerves together with all cord structures helped in reducing pain generated by suture entrapment.

The main principle of tension-free hernia repair relies on accurate mesh fixation: no tension must be introduced in the sutures while tying the knots and on the mesh. According to the original technique, the mesh is fixed with a running nonabsorbable suture (USP 2/0 polypropylene) to the inguinal ligament and with interrupted resorbable sutures (USP vicryl 2/0) on the aponeurotic layer of the transverse and internal oblique muscle.

Closure of the Surgical Wound

In the original, Lichtenstein advised the closure of the external oblique aponeurosis deep to the spermatic cord to offer some additive strength to the repair, but actually it is simply closed over the cord not to introduce too much tension on the repair.

Re-approximation of the deep subcutaneous tissue solidarizing with EOA is done. The cutaneous incision is closed with intra-cuticular sutures. When used, stitches are removed at the first postoperative visit occurring 1 week after surgery.

Patient Discharge and Aftercare

The patient is discharged in the early afternoon after checking the surgical wound and testicle for local complications. In our practice, causes of unplanned prolongation of hospital stay are pain not manageable with common painkillers, urinary retention, and fever. Postoperative painkillers are prescribed the night of the intervention and then on patient's request.

Lichtenstein stated that encouraging immediate postoperative ambulation "prevents muscle spasm that initiate the pain cycle," so at our center all patients are instructed to resume their normal activity as soon as possible, to walk immediately after the procedure without restriction. We adopt a "do what you feel you can do" attitude, and we only prescribe no heavyweight lifting for 3 weeks. Postoperative bindings are not prescribed.
The first outpatient visit occurs 1 week after surgery to assess the surgical wound, and then patients are followed at 6 months and yearly up to the second postoperative year.

3- <u>Laparoscopic approach:</u>

- Laparoscopic transabdominal preperitoneal (TAPP) repair performed in patients with type 1 giant hernias has shown to have good outcomes with the most frequent complication being scrotal seromas. These are generally managed conservatively[56].
- A new method of hernioplasty for treatment of large and gigantic oblique inguinal hernias. The method envisages plasty of front wall of inguinal canal with lateral "excess" flap of abdominal external oblique muscle aponeurosis. According to the offered method the edges of the excess flap are sewn on to iliopubic cord, which first strengthens inguinal ligament before sewing to it of the edge of medial flap and then, after its redoubling, the flap is fastened to the surface of aponeurosis by means of interrupted suture. During 12 years period 80 patients suffering from large and gigantic inguinal hernias were operated with the suggested method. In the post-operation period 8 (10,0%) complications occurred, one (1,2%) of them with lethal outcome. 30 patients were examined in the remote period. None of them had recurrence of the disease[55].

2.3 Monitoring: Complications in hernia surgery

Despite this being a common procedure and technically straightforward, postoperative complications are common.

- Immediate complications include
  - Bleeding (which may be due to accidental damage to the inferior epigastric or iliac vessels)
  - Scrotal hematoma is commonly found after the operation. Dense adhesion is usually detected due to the chronicity of the disease. Extensive lysis of adhesion can cause hematoma. Given these circumstances, a closed drainage system is recommended. It is important to note, though, that such system cannot always

prevent postoperative hematoma. Meticulous hemostasis and close observation are the most important steps towards prevention and early detection[9].

- Urinary retention that may require catheterization.
- Over the next week, seroma formation: seroma is due to an excessive inflammatory response to sutures or mesh and cannot be prevented. In most cases the fluid resolves spontaneously but may require aspiration. After laparoscopic surgery, a seroma may be misdiagnosed as an early recurrence.
- Wound infection is not uncommon. Many surgeons use routine prophylactic antibiotics but recent studies suggest little benefit even when mesh is used[58].
- Testicular pain and swelling: It occurs due to excessive dissection of a sac from the cord structures, especially a complete sac. Reported incidence is of 0.9 to 1.5%. Most are transient[59].

- In the longer term, hernia recurrence and chronic pain are the main concerns. No operation can be guaranteed to be recurrence free. Evidence shows that mesh repairs have lower recurrence rates than suture repairs, but there is no difference between the various mesh repairs and no difference between open and laparoscopic surgery. There is very strong evidence that specialist hernia surgeons will have lower recurrence rates whatever technique they use.

- Chronic pain, **defined as pain present 3 months after surgery,** is common after all forms of surgery. It is less common and less severe after laparoscopic surgery. Different types of pain have been described but the most severe is neuralgic pain due to nerve irritation. This may be the result of nerve injury at the time of operation or chronic irritation of nerves by suture material or mesh. Careful identification and protection of all three nerves passing along the inguinal canal reduces the incidence of neuralgic pain. This type of pain is also very uncommon after laparoscopic surgery that is performed at a deeper level away from the nerves. Some contribution to chronic pain may be due to the mesh, which can become embedded in a dense collagenous reaction with shrinkage. This causes tissue tension and rigidity.
- Rarely, damage to the testicular artery can lead to testicular infarction, perhaps the most serious complication of inguinal hernia surgery. There is no good evidence that hernia surgery has an effect on male fertility despite extensive study in this area[58].

- Recurrence: It is the most important endpoint of any hernia surgery. It requires a proper and thorough knowledge of anatomy and a thorough technique of repair to help keep the recurrence rate to a minimum[59].

Repair of a giant inguinal hernia is a real challenge, even for experienced surgeons. Abrupt and forced reduction of massive contents of the hernia sac into the limited space of the peritoneal cavity leads to a sudden increase of intraabdominal and intrathoracic pressures. This can cause abdominal compartment syndrome, resulting in compromised respiratory and cardiac function due to splinting of the diaphragm and reduction of venous return[44]. Forced reduction of the viscera to the abdominal cavity can produce a sudden increase in intra-abdominal pressure (IAP) and trigger an acute coronary syndrome (ACS), defined as a sustained IAP > 20 mmHg associated with multiple organ failure[41]. This syndrome is associated with a worsening of morbidity and mortality rates. In addition, reintroduction of the intestine into the abdomen may also cause intestinal obstruction, wound dehiscence, and hernia recurrence[15]. Acute complications post-hernia surgery increases the risk of long-term recurrence and chronic pain. Proper management of acute complications is vital to minimize long-term risks[59].

CHAPTER 3: METHODOLOGY

3 Methodology

3.1 Study design:

We conducted a descriptive cross-sectional study with retrospective and prospective collection of data.

3.2 Study area:

The study was carried out through the ten regions of Cameroon during health campaigns organized by ASCOVIME, precisely in 39 villages as shown on the table below:

Table VIII: showing the different villages involved in the study

Region	**Village local health facilities**
Adamawa	Tibati, sambolambo
Center	Afanayo, Bikop, Evodoula, Minta, Ngouantet, Nkolmebanga, Mpagne
Far North	Bogo, Datcheka, Kalfou, Yagoua, Kongola
East	Meloundou, Mindourou, Abong bang
Littoral	Moya, Nkongsamba
West	Bangou, Bazou, Didango, Foumban, Bassamba, Babouatou
South	Ambam, Avebe, Mekas, Meyomadjom, Mpolongwe, Ngoanzip, Nkolebo'o, Nkoulganga,
North	Guider, Demsa, Gachiga
North West	Belo, Foundong
South West	Nguti

3.3 Study period:

The study was carried out through 13 years from February 2011 to August 2024, with patient follow up of at least 3 years.

3.4 Sampling:

We did a consecutive non-probabilistic sampling.

3.5 Study population:

We recruited patients operated for GISH during ASCOVIME (Association des Competences pour une Vie Meilleure) health campaigns free of charge and who filled in the selection criteria such that:

- **Inclusion criteria:** every adult patient presenting with a GISH living in a rural setting who accepted surgical management and signed a consent form.
- **Non-inclusion criteria:** patients with inguino-scrotal hernia who do not meet up the diagnostic criteria by definition.
- **Exclusion:** patients lost to follow up; considered when at least 3 appointments were missed during the first three years of follow up, and patients presenting important comorbidities

3.6 Procedure :

Recruitment of patients was done during the ASCOVIME health campaigns in the health facilities of the various villages after obtaining patients' agreement and from the archives of the association. During the free rural medical missions' programs for hernia treatment, the team moved in rural communities. The patients were taken in charge in local health facility (sub- divisional, divisional and district centers) for free. The surgical team of the local hospital was invited to join our team so that the patients were managed together. At the end of the mission the local surgical team ensured the patients follow up at the following frequency:

- Every 48 hours for the first 14 days;
- Once a week for 3 months;
- Once a month for 2 years, and
- Every 6 months during the next campaign in the locality by the association>

A structured questionnaire was designed including for each patient,

- **Sociodemographic parameters:** region of origin, age, sex, year of surgery, profession, marital status.
- **Clinical parameters:** time delay since appearance (congenital Vs acquired), consumption of alcohol or tobacco, existing comorbidities, life style (sexual activity, altered gait, bowel motions); localization (unilateral Vs bilateral), classification, reducibility (total, partial or irreducible); local skin modifications (ulcers, fistula) were assessed.

Quality of life before surgery was evaluated using acceptance by the community, sexual activity and ability to perform activities of daily living (ADL) such as dressing independently and gait functions.

- **Surgical management:**

Operability was evaluated based on reducibility of the hernia which will enable to anticipate on

- Possibility of immediate management
- Evaluation of potential risk of bleeding with need for transfusion given the level of dissection required
- The necessity of bowel resection considering the volume of irreducible organs.

Patients were classified according to the **The American Society of Anesthesiologists (ASA) physical status classification system** preoperatively[60] such that:

ASA 1: A normal healthy patient. **Example:** Fit, nonobese (BMI under 30), a nonsmoking patient with good exercise tolerance.

ASA 2: A patient with mild systemic disease. **Example:** Patient with no functional limitations and a well-controlled disease (e.g., treated hypertension, obesity with BMI under 35, frequent social drinker, or cigarette smoker).

ASA 3: A patient with a severe systemic disease that is not life-threatening. **Example:** Patient with some functional limitation due to disease (e.g., poorly treated hypertension or diabetes, morbid obesity, chronic renal failure, a bronchospastic disease with intermittent exacerbation, stable angina, implanted pacemaker).

ASA 4: A patient with a severe systemic disease that is a constant threat to life. **Example:** Patient with functional limitation from severe, life-threatening disease (e.g., unstable angina, poorly controlled COPD, symptomatic CHF, recent (less than three months ago) myocardial infarction or stroke.

ASA 5: A moribund patient who is not expected to survive without the operation. The patient is not expected to survive beyond the next 24 hours without surgery—**examples:** ruptured abdominal aortic aneurysm, massive trauma, and extensive intracranial hemorrhage with mass effect.

ASA 6: A brain-dead patient whose organs are being removed with the intention of transplanting them into another patient.

Patients were also classified based on surgical site infectious risk using the **ALTEMEIER CLASSIFICATION [61]** such that:

Class I. clean surgery: Intervention on sterile area, with no skin lesion. No opening of the digestive, respiratory, urogenital or oro-pharyngeal tracts involved. La peau est primitivement intacte.

Class II. Clean-contaminated surgery: Intervention with opening of the digestive, respiratory, urogenital or oro-pharyngeal tracts involved. Well controlled milieu without unusual contamination (sterile urine, non-infected bile).

Class III. Contaminated surgery: important contamination by massive involvement of bowel content, opening of urogenital tract or biliary tract in the presence of an infection. Recent traumatic wound (< 4 hours)

Class IV. Infected or dirty surgery: intervention in an infected area with pus, foreign bodies, stool, perforation of viscera or traumatic wound > 4 hours.

Other parameters considered were:

- **Type of anesthesia:** Surgery was done either under local, loco-regional or general anesthesia.
- **Method of peroperative reduction re-integration:** manual Vs surgical; bowel resection or not)
- **The chosen surgical procedure** was either a herniorraphie with shouldice technique, Bassini technique or hernioplasty with a polypropylene mesh following Lichtenstein technique; or a differed hernioplasty after a raphie (6 months after).

Surgical procedure:

Under local, spinal or general anesthesia.

Patients were installed in a supine position.

Incision was a lower abdominal transverse incision.

Exposure of the Aponeurosis of the External Oblique Muscle: After the incision of the skin of the subcutaneous tissue and the fascia superficialis (Scarpa's fascia), and after completion of an accurate hemostasis of the superficial epigastric vessels, the whitish and shiny surface of the aponeurosis of the external oblique muscle, the external inguinal ring, and the hernia sac exiting from it are all well exposed.

Incision of the Aponeurosis of the External Oblique Muscle Opening of the Anterior Wall of the Inguinal Canal and of the External Inguinal Ring: With a knife, a small incision is performed over the aponeurosis at the superior angle of the wound in correspondence with and parallel to the medial pillar of the external inguinal ring. The aponeurosis is served and split with scissors along its fibers, caudally, all the way down to the external inguinal ring bisecting it, and cranially, about 3 cm the internal inguinal ring.

With a special movement of the fingers, digitoclasia, squeezing while sliding the tissue, transversely and longitudinally, the fibers of the cremasteric muscle are dissociated from the cord and the sac easily and completely, in two branches, one lateral and one medial.

Excision of the Cremasteric Muscle and Suture Ligature of the Stumps

Isolation of the Sac: The indirect sac is invariably located and found at the medial and superior aspect of the spermatic cord, close to the internal inguinal ring.

Opening of the Transversalis Fascia: In the indirect or external oblique hernia, after the isolation of the sac has been completed, the fundus of the sac is pulled upward and laterally by the assistant, who at the same time with the other hand pulls laterally and horizontally the spermatic cord, encircled and protected by a penrose.

With this maneuver, the opening of the hernia defect is well exposed and visible—exteriorized. Close to the defect, the deep epigastric vessels are seen in transparence, covered only by the transversalis fascia in continuity with the neck of the hernia sac. Holding two forceps, a smooth one in the left hand and a toothed one in the right hand, the transversalis fascia just adjacent to the medial border of the neck of the sac is grasped and lacerated.

The sac content was assessed reduced or resected was reduced and its neck was ligated at the base close to the epigastric vessels. Associated procedures were orchidectomy, scrotoplasty.

Reconstruction:

1- In shouldice technique:

The reconstruction of the posterior inguinal wall is done with four continuous lines using two nonabsorbable sutures. The first suture is used for the first two lines and the second suture for the third and fourth lines.

- The first line of continuous suture starts at the level of the pubic tubercle.It must include, laterally, the iliopubic tract and, medially, the posterior aspect of rectus muscle for the first two or three sutures, and then, again, the iliopubic tract and the posterior aspect of the transverse and internal oblique muscles, up to the internal inguinal ring.
- The continuous suture (second line) goes back towards the pubic tubercle and includes medially the triple layer left free earlier and the area of the inguinal ligament up to the initial tie. It is then knotted to the tail clamped earlier.
- The third line of suture starts at the level of the internal inguinal ring where it will be knotted, clamping again the tail of the suture. This suture line continues towards the pubic tubercle remaining slightly more superficial than the previous one. The internal oblique muscle is sutured again to the area of the inguinal ligament, but more superficially than the previous inguinal suture line.
- At the level of the pubic tubercle, the suture returns towards the internal ring (fourth line) remaining even more superficial than the third suture line. Arriving at the internal ring, the fourth line has to be knotted to the suture tail knotted at the beginning of the third line.

The posterior wall is now extremely resistant.

The cord is repositioned in its original site. Now the external oblique muscle aponeurosis can be re-approximated.

2- Bassini technique:

The reconstruction of the posterior wall is achieved by suturing the triple layer (internal oblique muscle, transversus muscle, and transversalis fascia) to the isolated posterior border of the inguinal ligament using a filzetta stitch. The first two stitches medially also include the lateral border of the rectus abdominis muscle.

- **The First Stitch:** The first stitch is applied at the inferomedial corner of the wound. The suture is not tied, and the two free ends are held together with a Kelly clamp.
- **The Second Stitch:** The second stitch is applied 1 cm proximal to the first stitch in the same fashion.

- **The Third Stitch:** Medially, the third stitch includes only the triple layer. The rectus muscle is no longer part of the inguinal region. Laterally, the stitch includes the isolated posterior border of the inguinal ligament.
- **The Last Stitch:** This stitch is not applied in front of the internal opening and parallel to the other stitches but in a more oblique fashion. When this suture is tied, the newly reconstructed internal inguinal ring will be well calibrated (not too loose or too tight); the cord is moved laterally, closer to the anterior superior iliac spine.
- The remaining stitches are applied at 1 cm proximal to the previous one in the same fashion, medially and laterally. Usually they are 5–8 in number as needed.

Tying the Sutures: The operator takes these threads in a pair, tying them successively, while the assistant depresses the underlying properitoneal fat with a closed Kelly clamp, with a finger or a small flat retractor.

3- Lichtenstein reconstruction:

Reconstruction is done with a 7 x 15 cm polypropylene mesh. The mesh is tailored on table, not pre-shaped but trimmed according to the patient's inguinal floor. The mesh is tailored to look like the outline of a foot with the toe covering medially the angle between the inguinal ligament and the anterior rectus sheath. The mesh has a slit, along its major axis, at the level of the internal ring to allow the passage of the spermatic cord forming two tails of different dimension: the lateral thinner and the medial wider.

These tails are crossed and solidarized with non-resorbable sutures behind the spermatic cord to avoid recurrence lateral to the internal ring. The mesh is bigger to cover all the inguinal floor, with a 2 cm overlap over the pubic tubercle and 5–6 cm lateral to the internal inguinal ring. After fixation, it should be kept in a relaxing configuration, somewhat redundant. Using interrupted resorbable sutures and keeping the nerves together with all cord structures helped in reducing pain generated by suture entrapment.

The main principle of tension-free hernia repair relies on accurate mesh fixation: no tension must be introduced in the sutures while tying the knots and on the mesh. According to the original technique, the mesh is fixed with a running nonabsorbable suture (USP 2/0 polypropylene) to the inguinal ligament and with interrupted resorbable sutures (USP vicryl 2/0) on the aponeurotic layer of the transverse and internal oblique muscle.

Reconstruction of the external oblique aponeurosis

Skin closure and dressing.

Post operatively, the patients were put on systematic ant biotherapy (amoxicillin and metronidazole) and pain killers (Paracetamol and ibuprofen). They were monitored for 24 hours. First dressing was done on the second day following surgery.

- **Outcome:** They were followed up for short-term (30 days) and long term (3 years) periods for evaluation of outcome. We assessed complication presented, cases of death.

Pre and post-operative management were free for every patient.

Quantitative data were expressed in mean and median.

Qualitative data were expressed in proportions and percentages.

3.7 Ethical and administrative considerations:

- An ethical clearance was collected from the institutional ethical committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaounde1;
- and patients' consent was obtained after explaining to them the importance of our study.
- We equally had to get an agreement from the president of ASCOVIME.

3.8 Definition of operational terms:

- Giant inguinoscrotal hernia (GISH) have been defined as those that extend below the midpoint of the inner thigh when the patient is in the standing position or should display an anteroposterior diameter of at least 30 cm or a laterolateral diameter of about 50 cm with non-reducibility for more than 10 years.
- Patients were classified using the following grouping system:

Type I: sac reaches the mid-thigh.

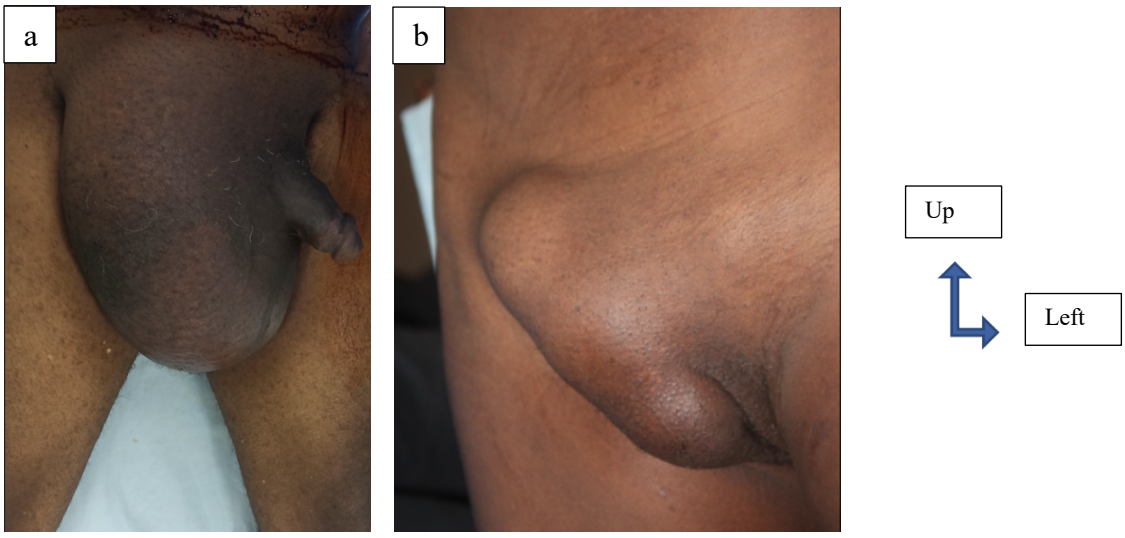

Figure 2: Type I a-giant inguinoscrotal hernia; b- giant inguino-labial hernia, using our proposed classification *(Pictures taken during ASCOVIME campaign with permission from the participants).*

Type II: sac is between two imaginary lines through the mid-thigh and through the supra-patella.

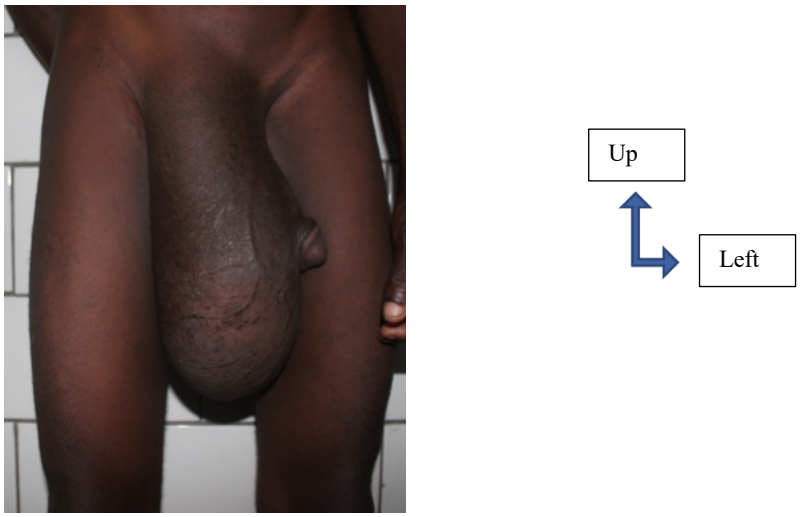

Figure 3: Type II giant inguinoscrotal hernia using our proposed classification *(Pictures taken during ASCOVIME campaign with permission from the participants).*

Type III: sac reaches the supra-patellar line.

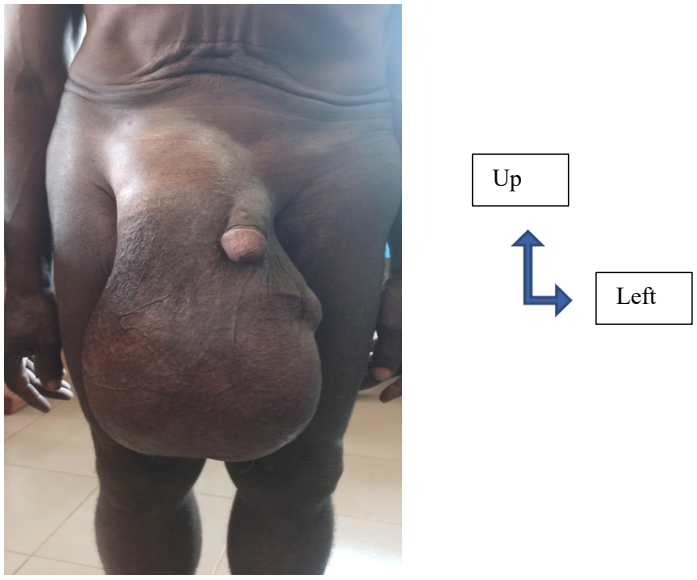

Figure 4: Type III giant inguinoscrotal hernia using our proposed classification *(Pictures taken during ASCOVIME campaign with permission from the participants)*

Type IV: Sac passes over the supra-patellar line, or other types associated to another hernia (contro-lateral inguinal, femoral or umbilical).

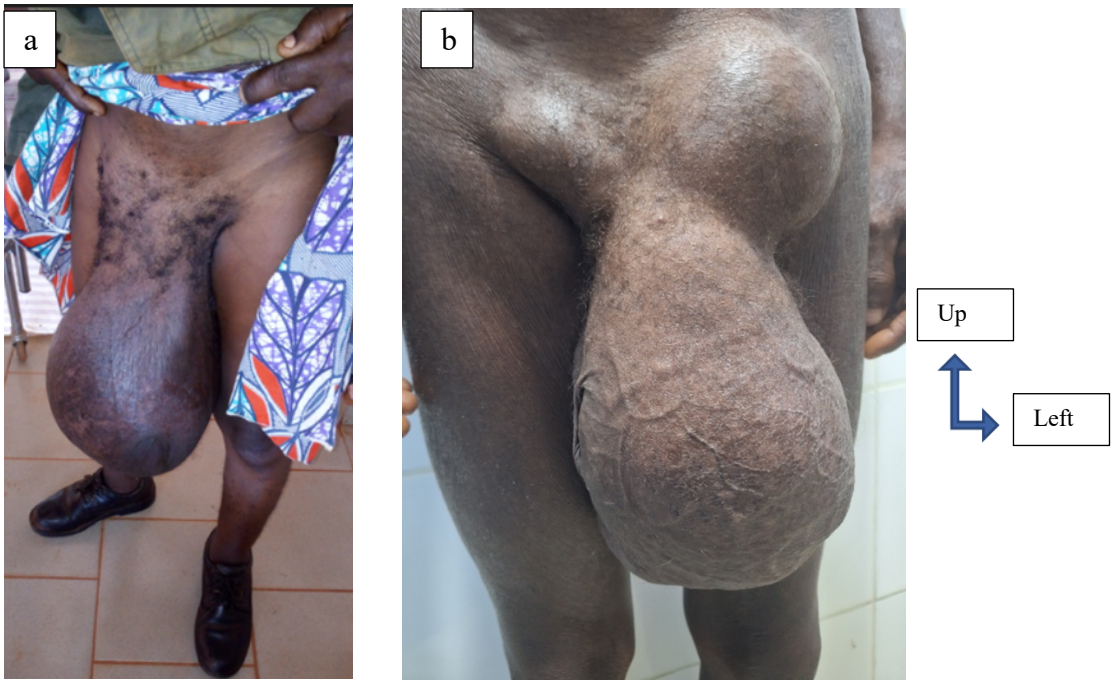

Figure 5: Type IV giant inguinoscrotal hernia. a- isolated form; b- associated to bilateral femoral hernias, using our proposed classification *(Pictures taken during ASCOVIME campaign with permission from the participants)*

CHAPTER 4: RESULTS

4 Results

Participants selection

During the 11 years period, **17567** patients had surgical indications, out of which **90.4 % (15893)** were actually operated.

Abdominal wall hernias represented **61.4% (9754)** of the cases with **92% (8981)** being groin hernias.

There were **68** cases of giant inguinoscrotal hernias of which **62** underwent surgery representing **0.39%** of surgical activities and **0.69 %** of groin hernia.

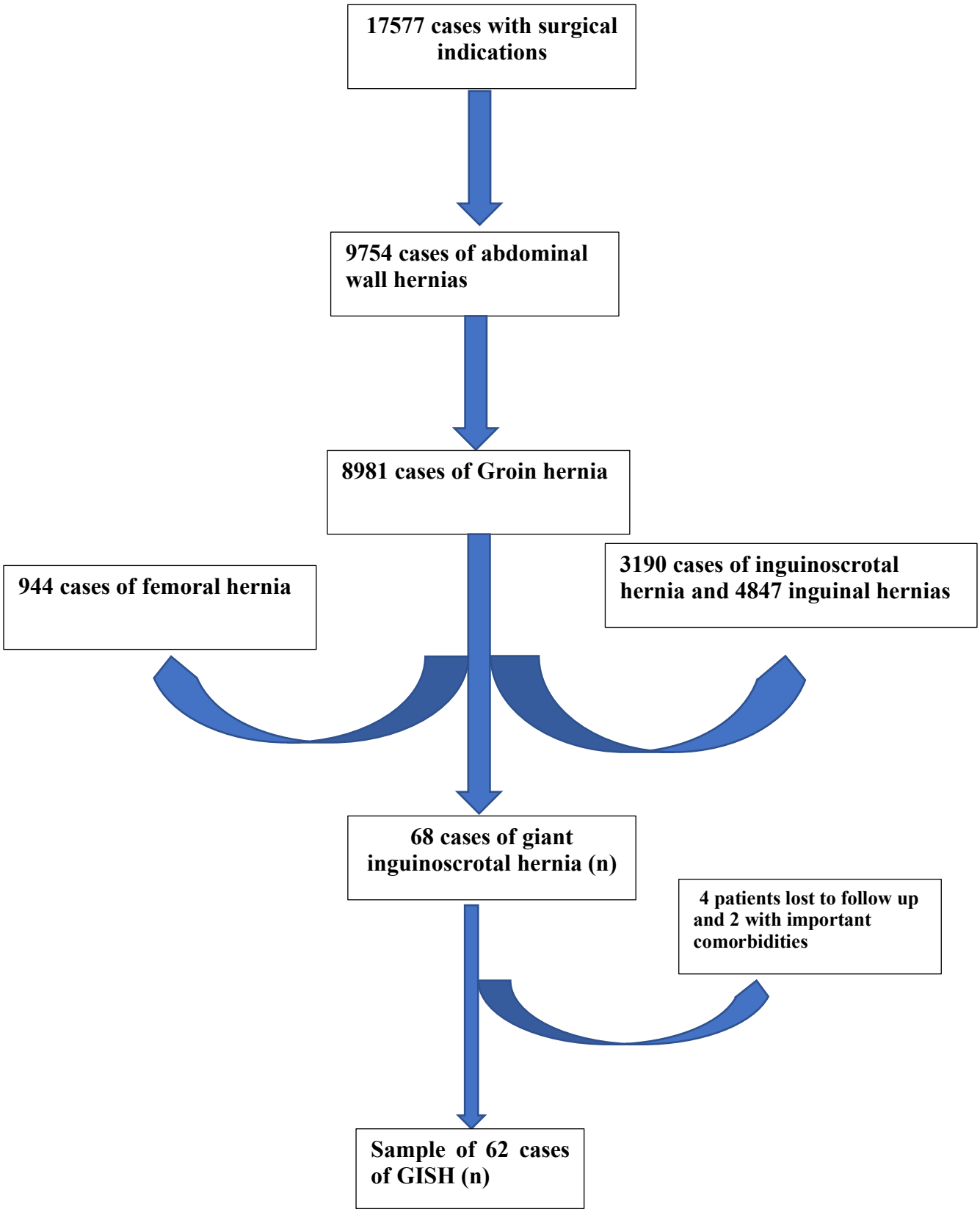

Figure 6: Flow diagram for sampling

1- Socio-demographic parameters

Age and Sex Distribution

Giant inguinoscrotal hernia represented **0.39%** of the surgical activities and **0.69%** of groin hernias.

The **62 cases** of giant inguinoscrotal hernia were included in the study over the **11 years period** giving an average of **5-6 cases** of giant inguinoscrotal hernias in a year.

The patients came from all over Cameroon with most of the patients coming from the **East region (30.6%, 19).**

There was a male predominance of **57** males to **5** females giving a **sex ratio 11: 1**.

The average age was **54.7±1.1** years with a range of **34 – 79 years**.

The most represented age group was **51 – 70 years (46.8%).**

Table IX: Showing age distribution

Age range	Frequency	Proportion (%)
<50 years	24	38.7
51 – 70 years	29	46.8
>70 years	9	14.5

Level of education and occupation

Majority of the participants **(71%)** level of education was primary.

All the participants were from rural areas and were involved in physical activities as a source of livelihood, the majority **(66%)** being farmers.

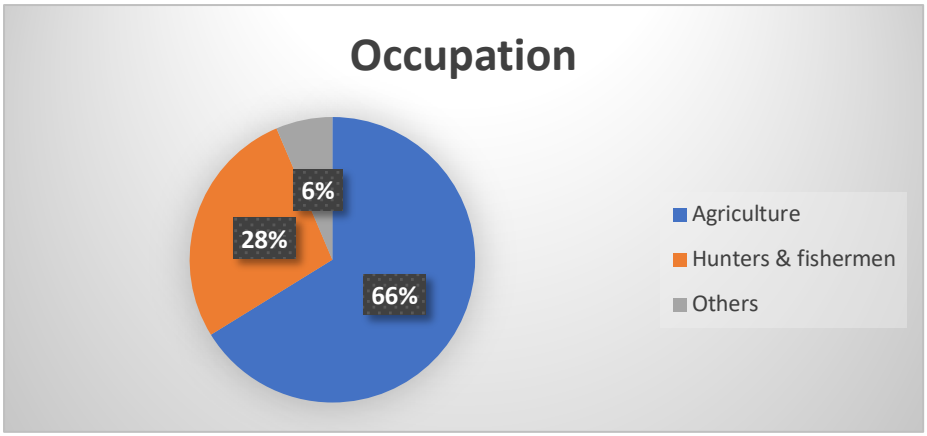

Figure 7: Distribution of participants according to occupation

Marital status

Most of our participants were single **32 (51.6%).**

2- Clinical presentation

Presentation and classification

The participants presented with varying symptoms; predominantly abdominal pains **54 (87.1%)** and weight bearing sensation **47(75.8%).** All had an altered sexual activity.

Table X: Symptoms at presentation of the participants

Presentation	Number	Percentage
Altered gait	43	69.4
Abdominal pains	**54**	**87.1**
Weight bearing sensation	**47**	**75.8**
Altered bowel habits	25	40.3
urinary symptoms	9	14.5
Entero-scrotal fistula	1	41.9
Social deprivation	26	41.9
Impaired sexual activities	62	100

Classification

These hernias were classified using a classification system we proposed under methodology as shown on the bar chart. Type II categories were the most frequent **30 (48.3%).**

All the five female participants had class I hernia

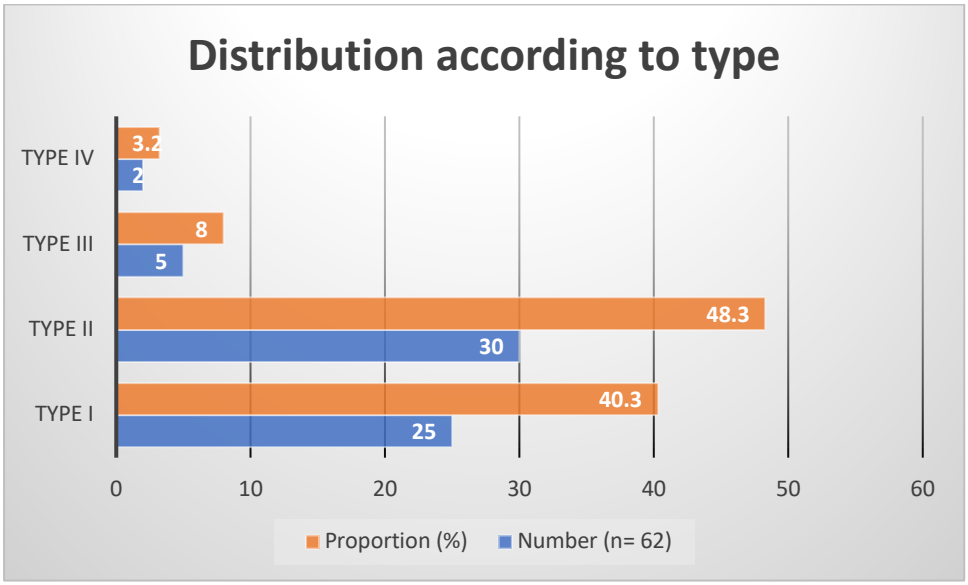

Figure 8: Bar chart showing the classification of the hernia into four different classes

The hernia was predominantly on the right side with **48(77.4%)** participants having right giant inguinoscrotal hernia (RISH) and **14(22.6%)** had left giant inguinoscrotal hernia (LISH).
As trophic modification, there was **01(1.6%)** case of entero-scrotal fistula found in a Type IV patient.

All the five female participants had right inguino-labial hernias.

Table XI: clinical findings on upon assessment.

Clinical presentation	Type I N = 25	Type II N = 30	Type III N = 5	Type IV N = 2	Frequency N = 62	Proportion (%)
RISH	**20**	**25**	**01**	**02**	**48**	**77.4**
LISH	**05**	**05**	**04**	**-**	**14**	**22.6**
Hydrocele	**01**	**-**	**01**	**-**	**02**	**3.2**
Entero-scrotal Fistula	**-**	**-**	**-**	**01**	**01**	**1.6**

Congenital hernia was found in **4(6.4%)** participants of which all the **2 from Type IV, 01 from Type III and 01 from Type II.**

Amongst those with acquired hernia, the average length of evolution was **30.8±0.7 years** ranging between **14 and 50 years**.

Cases of recurrences were in **13** participants with a variation in the time lapse since previous intervention being **5 to 27 years** with an average of **16±1.1 years**.
More than half of our population **55 (88.7%)** had hernia that was either spontaneously or manually reducible, **all those of type I and type II.**

Manual reduction was done by applying a posterior pressure with the hand when the patient is seated with both inferior limbs flexed at 90 degrees in a sitting position.

Table XII: Distribution of hernias based on reducibility.

Sex	**spontaneous reduction**	**complete manual reduction by personnel or patient**	**Incomplete manual reduction by personnel or patient**	**More than 1/2 of the sac remaining despite reduction**
Male	9	41	4	3
Female	4	1	0	0
Total	13(21%)	42 (67.7%)	4(6.5%)	3(4.8%)

Associated commodities

As shown on table, about a 3rd of the participants had hypertension, almost half were smokers and almost ¾ consumed alcohol regularly. Other commodities included diabetes, HIV and hepatitis.

Table XIII: Distribution of various comorbidities

Comorbidity	**Type I N = 25**	**Type II N = 30**	**Type III N = 5**	**Type IV N = 2**	**Frequency N = 62**	**Proportion (%)**
Recurrence	6	4	3	-	13	20.9
Hypertension	12	6	4	-	22	35.5
Diabetes	8	1	2	-	11	17.7
Smoking	14	12	3	-	29	**46.8**
Alcohol	20	17	5	2	44	**71.0**
COPD	5	3	-	-	08	12.9
LUTs	08	12	2	-	22	35.5
Chronic constipation	2	12	5	2	21	33.9
HIV	1	-	-	-	01	1.6
Hepatitis B	2	1	-	-	03	4.8
Hepatitis C	-	1	-	-	01	1.6

Impact on Quality of life (QoL) before surgery

All the participants had an altered gait with development of new patterns of movement.

All the participants admitted having their sexual activities altered.

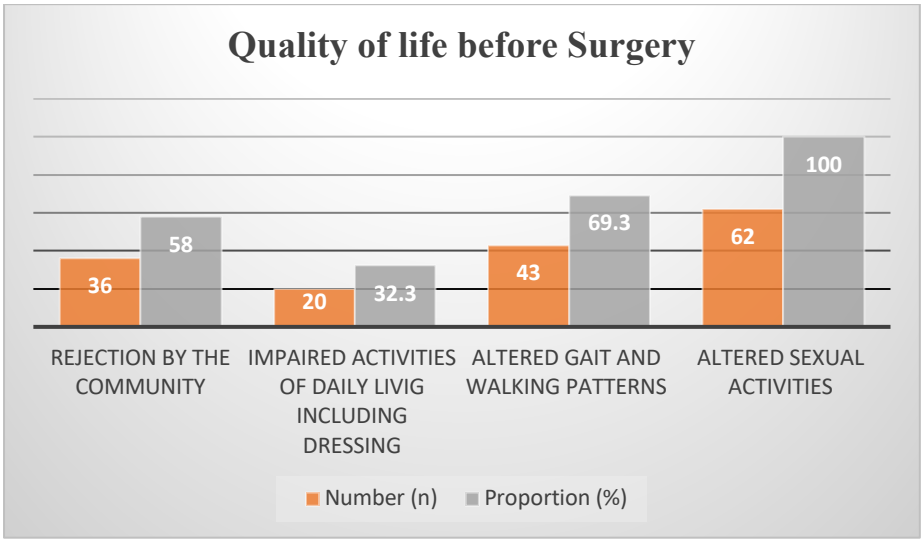

Figure 9: Assessment of Quality of life (QoL) of the participants before surgery

The level of alteration of sexual activities were further evaluated and **two of the participants with congenital inguinoscrotal hernia (all Type IV) admitted no sexual activities since birth**. Others admitted varying sexual activities with almost half of the population declaring having intercourse once a month.

Table XIV: Quality of life assessment measured by sexual activities

Sexual activity	**Greater than one time per week**	**One time per week**	**one time per month**	**None in the last five years**	**None since birth**
Males	8	10	27	10	2
Females	0	2	2	1	0
Total	8(13%)	12(19.3%)	**29 (46.8%)**	11(17.7%)	**02(3.2%)**

3- Management

Anesthesia

According to the physical status scale of American Society of Anaesthesiologists (ASA class) majority of the patients were class I and II; **18 (29.0%)** patients had ASA class I, **28 (45.2%)** patients had ASA class II.

According to Altemeier classification grading the risk of infection, one patient had an entero-scrotale fistula and was Altemier IV and the rest classified as Altemier I before surgery.

Table XV: American Society of Anaesthesiologists (ASA) physical status classification

ASA class	**Frequency**	**Percentage**
Class I	18	29.0
Class II	28	45.2
Class III	16	25.8

Type of anesthesia

The main type of anesthesia used was spinal which was used in **58% (36)** of the participants and general anesthesia in **39% (24)** of the participants whereas in **18% (11)** of the participants there was conversion from locoregional to general anesthesia.

Surgery

The approach was anterior approach by an incision in the groin in the lower abdominal fold in all the patients.

Findings in the majority of cases were a fused spermatic cord **83.9% (52)** with an oedematous omentum **77.4% (48)**.

The content of the sac varies from omentum to bowel and to colon with the omentum and small bowel being present in the majority of cases.

Orchidectomy was performed in half of the population **32 (51.6%)** and a scrotoplasty was performed in **38.7% (24) of cases 3 months later.**

Table XVI: showing findings and content of the sac during giant inguinoscrotal hernia repair

Description	Frequency(n=62)	Percentage (%)
Findings and sac description.		
Fused spermatic cord	52	83.9
Sac length greater than 30cm	41	66.1
Hidden testis	47	75.8
Oedematous omentum	48	77.4
Entero-scrotal fistula	01	1.6
Thickened sac wall	62	100.0
Contents of the sac		
Omentum only	20	32.3
Small bowel, caecum and omentum	26	42
Right Colon and omentum	12	19.4
Right colon, small bowel and omentum	3	4.8
Sigmoid colon	1	1.5
Associated procedures		
Omentectomy	12	19.4
Segmental bowel resection	8	13
Right colectomy	6	9.7
Orchidectomy	32	51.6
Scrotoplasty	24	38.7
Contralateral hernia repair	04	6.5

Shouldice repair was done in **37% (23)** of the participants and Lichtenstein was done in **56.5% (35)** of the participants.

In **29.0% (18)** of the participants an initial Shouldice repair was done which was later converted to Lichtenstein. This conversion from Shouldice to Lichtenstein was done 6 months later.

Shouldice technique was used following bowel resection in **22.6% (14)** of the cases of which 8 small bowel segmental resection and 6 colectomies.

Table XVII: distribution of cases according to technique of repair

Technique of repair	Frequency (n = 62)	Proportion (%)
Shouldice	23	37
Bassini	4	6.4
Lichtenstein	**35**	**56.5**
Shouldice then Lichtenstein	18	29

A scrotal drain was used in 2 cases; a compressive bandage was left in place for all the other cases.

4- Outcome

Morbidity: The main per operative complications were bowel injury in **9.7% (06)** of the cases and bladder injury in **1.6% (01)** of the cases.

Bladder injury was treated by suture and insitu urinary catheter kept for 10 days meanwhile, bowel injuries were treated by resection and anastomosis.

We recorded only **2 cases (3.2%)** of abdominal compartment syndrome; known to be the most dangerous complication in giant hernia surgery.

Pain occurred in a short run in **18 (29%)** patients and persisted only in **6 (9.7%)** patients after follow up.

We equally had **15 (24.2%)** cases of seroma and **2 (3.2%)** cases of surgical site infection. Urinary retention occurred in **16 (25.8%)** patients resolved spontaneously after a one time transurethral catheterization.

There was no case of recurrence after 3 years.

Table XVIII: Evaluation of short- and long-term outcome after surgery

Description	Frequency(n=62)	Percentage (%)
Per-operative complications		
Bladder injury	01	1.6
Small bowel injury	06	9.7
30 – days post-operative complications		
Pain	18	29
Abdominal compartment syndrome	02	3.2
Urine retention	16	25.8
Seroma	15	24.2
Surgical site infection	02	3.2
Death	02	3.2
Long term complications (3 years)		
Recurrence	00	00
Chronic Pain	06	9.7
Testicular atrophy	07	11.3

We recorded **a Case fatality rate (CFR) of 3.2%,** the **two cases of death** in the post-operative period from abdominal compartment syndrome (Type IV) and perioperative bleeding (Type III).

After surgery, all patients declared having an improvement in quality of life especially concerning sexual activities, daily chores, dressing and acceptance by the community.

Table XIX: General summary of our outcomes according to the type of hernia found

Type	Reducibility (spontaneous or manual)	Bowel resection	Need for blood transfusion	Short term complication (30 days)	Cases of death
I (n=25)	25 (100%)	-	-	12(48%)	-
II (n=30)	30(100%)	07(23.3%)	03(10%)	10 (33.3%)	-
III (n=5)	**-**	**05(100%)**	**05(100%)**	**04(80%)**	**01(20%)**
IV (n=2)	**-**	**02(100%)**	**02(100%)**	**01(50%)**	**01(50%)**
Total (n=62)	55(88.7%)	14(22.6%)	10(16.1%)	26(42%)	02(3.2%)

CHAPTER 5: DISCUSSION

5 Discussion

Inguinal hernia is a public health problem in Africa as a whole and in Cameroon in particular[3]. However a few cases of GISH have been reported in Cameroon, proof of their existence in our community[62].

1- Socio-demographic parameters

The 62 cases of giant inguinoscrotal hernia were included in the study over the 11 years period giving an average of **5-6 cases** of GISH in a year. There was a slight decrease over the years. This could be explained by the regular activity of the association, reducing the number of cases after each campaign.

The patients came from all over Cameroon with most of the patients coming from the **East region (30.6%, 19)** whereas the least represented regions were the west and littoral regions that had one patient each. This could be explained by the limited access to health facilities in those regions compared to the littoral and west which are more urbanized as they are considered to be commercial turning points for the country.

There was a male predominance of **57** males to **5** females giving a **sex ratio 11: 1,** similar to literature[58].

The mean age in our study was **54.7±1.1** years with a range of range **34 – 79 years** with the most represented age group being **51 – 70 years (46.8%);** appears closer to studies done on a series of 103 in Sierra Leone and Ivory Coast (46 and 48.5 years respectively)[18,19] . This could be due to the fact that the rural population is aging as the youths move to the cities searching for greener pastures.

Majority of the participants **(71%)** level of education was primary. All the participants were from rural areas and were involved in physical activities as a source of livelihood, the majority **(66%)** being farmers. Others, which made up **6%** of the participants included teachers, business men and electricians. Therefore, Giant inguinoscrotal hernia affected mainly the illiterate manual laborers. This is similar to Lebeau et al. in Ivory Coast [19]; Abdalla et al. identified long standing heavy weight bearing as risk factor (59.2% of all risk factors)[18].

Most of our participants were single **32 (51.6%),** as this medical condition impacted greatly their sexual activity (100% of cases), similar to Lebeau et al. in Ivory Coast with a majority of the population with difficulty in penetrating their partner[18] as this condition causes a buried penis.

2- Clinical presentation

The participants presented predominantly with abdominal pains **(87.1%)** and weight bearing sensation/discomfort **(75.8%).** This is similar to Osifo et al. in Nigeria and Abdalla et al. in Sierra Leone [17,18] and could be explained by the fact that the bowel tries to physiologically adapt to their new environment during the process of digestion and the important content causes the weight bearing sensation.

Type II categories were the most frequent **30 (48.3%).** All the five female participants had Type I hernia. This is contrary to the results from Sierra Leone where the majority of participants presented with sacs extending below knee level (corresponding to Type IV in our study) [18], probably because they had a larger population size.

The hernia was predominantly on the right side with **48 (77.4%)** participants as in majority of studies[18,19,63].

The average duration of evolution was **30.8 ± 0.7 years** ranging between 14 and 50 years. This is quite higher than the result from Nigeria (average of 14.5 years). This could be explained by their greater sample for a study conducted in private medical health facilities located in sub-urban communities where the population should be younger, and early management of hernia is possible[17].

Cases of recurrences were in **13(21%)** participants with a variation in the time lapse since previous intervention being **5 to 27 years** with a **mean of 16 ± 1.1 years**. This is almost thrice the number of recurrences reported in Ivory Coast, probably because of their smaller sample size[19].

More than half of our population **55 (88.7%)** had hernia that was either spontaneously or manually reducible, same as in west Africa[17,18]. This especially as Type I and II predominated in all populations.

Smoking was a relevant comorbidity as it was present in almost half of our population 29 (46%). The nicotine is absorbed in blood and weakens the abdominal musculature which reduces the function of shutter mechanism, thereby causing inguinal hernia[22].

All the participants had an altered gait with development of new patterns of movement. All the participants admitted having their sexual activities modified. The level of modification of sexual activities were further evaluated and **2(3.2%)** of the participants with congenital inguinoscrotal hernia admitted no sexual activities since birth. Others admitted varying sexual activities, with almost half of the population declaring having intercourse once a month. And hence, **36 participants felt rejected by their community**. This correlates with the results of

Lebeau et al. in Ivory Coast who found that all patients had cosmetic and functional problems affecting their everyday lives going from difficulty in finding suitable clothes, in standing, walking, sitting or lying down to difficulty to penetrate their partners during sexual intercourse[19].

3- Management

According to the physical status scale of American Society of Anesthesiologists (ASA class) majority of the patients were class I and II; **18 (29.0%)** patients had ASA class I, **28 (45.2%)** patients had ASA class II, different from the study in Ivory Coast[18] probably because we had a larger proportion of smokers.

The main type of anesthesia used was spinal which was used in **58% (36)** of the participants. This is same as Lebeau et al in Ivory Coast but who had no shift to general anesthesia[18].

Findings in the majority of cases were a fused spermatic cord **83.9% (52)** with an edematous omentum **77.4% (48)**. This is due to portal venous stasis often associated, causing mesenteric and bowel wall edema, swelling the contents of the hernia sac making reduction even more challenging[23].

Orchidectomy was performed in half of the population **32 (51.6%)**. This is due to the fact that the long standing hernia has prompted fusion of the sac to the cord which generally makes dissection difficult hence condemning the spermatic cord to inevitable section to prevent unexpected complications[9].

The content of the sac was the omentum, caecum and small bowel in the majority of cases which is similar to Lebeau et al[19].

Bowel resection and anastomosis was done in **14 (22.7%)** patients, of which 8 small bowel segmental resection and 6 colectomies. This was generally because of edematous bowel, and loss of domain respectively which made reduction difficult and in some cases there was injury to the bowel **(6 cases)** in the strive to reduce the hernia content as described by literature[23].

Shouldice repair was done in **37% (23)** of the participants and Lichtenstein was done in **56.5% (35)** of the participants. In **29.0% (18)** of the participants an initial Shouldice repair was done which was later converted to Lichtenstein 6 months later. This is with respect to the European Hernia Society (EHS) recommendations which advocates for Mesh repair as best choice or a Shouldice repair in case mesh is unavailable[64]. This is in contrast with most studies in West Africa where a modified Bassini technique was preferred sometimes with “Darning”[18,63].

A compressive scrotal bandage was used in **60 cases (96.8%),** this was to avoid seroma or hematoma formation given the extensive dissection usually required. The compressive bandage

prevents hematoma formation by realizing appropriate hemostasis which is not the case with drainage used by some authors[65].

4- Outcome

We recorded only **2 cases (3.2%)** of abdominal compartment syndrome; known to be the most dangerous complication in giant hernia surgery[9] probably because a majority of our participants had reducible hernias.

We equally had **15 (24.2%)** cases of seroma and **2 (3.2%)** cases of surgical site infection. These results are similar to Lebeau et al in Ivory Coast who reported **9.52%** of seroma but rather had **57.14%** of scrotal hematoma which was not reported in our study. This was probably facilitated by the compressive scrotal bandages which were used post-operatively[19].

Pain occurred in a short run in **18 (29%)** patients and became chronic only in **6 (9.7%)** patients after 3 years follow up. Pain is usually related to nerve trauma or compression during the surgical repair[58].

Urinary retention occurred in **16 (25.8%)** patients probably due to the spinal anesthesia as described in literature[66], this all resolved spontaneously.

We recorded **a Case fatality rate (CFR) of 3.2% (2 cases),** the two cases of death in the post-operative period from abdominal compartment syndrome and perioperative bleeding. This is comparable to literature as reported by a meta-analysis made in 2023 which recorded 4 cases of death out of the 9 studies involved [30].

There was no case of recurrence after 3 years similar to Ivory coast after 29.19 months follow up [19].

Following these results, the limits of the various classification systems can be outlined. The c;lassification proposed by Trakarsagna in 2014 is limited in the fact that it requires sophisticated tool for preparation such as preoperative abdominal volume increase procedures, especially for Type III[9]. In the same line, Oyewale modified this by including the use of Scannographic indices (Tanaka Index) to predict and anticipate on the risk of compartment syndrome[30]. These tools are out of reach for these patients in the rural areas. Therefore, based on these realities, we thought interesting to review the classification systems so as to provide an efficient tool based on clinical assessment, for management of GISH in a resource limited milieu as the rural areas of Cameroon. This proposed classification based on our results will help predict on outcome, so as to encourage upgrading of rural centers for management of some cases and to refer the more difficult cases to urban centers for a more secured management. We therefore suggest that;

Table XX: Our proposed Classification for GISH

Type	Description	Peculiarity	Management
I	sac reaches the mid-thigh	Spontaneously or Manually reducible by patient	Can be operated with limited resources
II	Sac is between two imaginary lines through the mid-thigh and through the supra-patella.	Spontaneously or Manually reducible by patient	Can be operated with limited resources
III	Sac reaches the supra-patellar line.	Reducible	Can be operated with limited resources
		Irreducible	Referral is advisable
IV	Sac passes over the supra-patellar line, or other types associated to another hernia (contro-lateral inguinal, femoral or umbilical).	Irreducible with higher risks of a compartment syndrome	Referral is advisable

Table XXI: Comparing our results with other studies on GISH

Study	Reducible	ACS	Transfusion	Technique	Bowel resection	Death
Our study (n=62)	55 (88.7%)	02 (3.2%)	10 (16.1%)	Lichtenstein	14 (22.6%)	02(3.2%)
Osifo et al. 2010 (n=134) [17] Nigeria	91 (67.9%)	00	-	Bassini	00	00
Lebeau et al. 2015 (n=30) [19] Ivory Coast	17 (56.7%)	03(10%)	-	Goni Moreno	01(3.33%)	01(3.33%)
Savoie et al. 2012 (n=25) [39] Ivory Coast	25 (100%)	00	00	Bassini	00	00
Abdalla et al. 2018 (n=103) [18] Sierra Leone	-	00	-	Nylon Darning	03(2.91%)	00

Most studies with good results took precaution by selecting cases with reducibles hernias. Our limits resided in the fact that we did not have access to imaging modalities which could enable a better evaluation, the aspect of scrotoplasty was not done in our study. However, our strength came from the free accessibility of surgical management and follow up of patients which made them faithful to our calls for follow up. Also, the absence of blood banks in some of the rural health centers according to their levels, though a weakness came to be a benefit as freshly collected blood was readily transfused to patients in need. Especially in cases where extensive dissection and bowel resection was done.

Conclusion

Giant inguino-scrotal hernia is a reality in our community. It is frequent in rural areas where populations are involved mostly in land ploughing activities. This condition impacts heavily social integration which can go right up to rejection. The treatment of this condition is mostly surgical. It greatly relies on the reducibility, and the dissection which can help prevent abdominal compartment syndrome, orchidectomy and bleeding which can all lead to death. The surgical challenges related to blood transfusion, bowel resection due to the visceromegaly and chronicity of the disease should enhance reference to centers of higher categories. Application of appropriate management orientation for the individual patients is the key to success treatment.

Recommendations

Clinicians and researchers

- Continue acquisition of skills in hernia surgery.
- Encourage critical clinical evaluation (make sure the hernia is totally reducible, ensure respiratory tolerance) before attempting surgery of giant inguino-scrotal hernias.
- Carry out on the psychological impact of this condition.
- Improvement of referral systems and increasing the use of mesh repair will improve access and quality of the management.

Rural health facilities

- Upgrade of the technical plateau to ease management of these patients' cases
- Accelerate in the process of universal health coverage (UHC) in our health system so as to make management of hernia accessible at affordable cost for all
- Educate communities and community health workers around the symptoms of hernias for early diagnosis and treatment.
- Establishing referral pathways might facilitate timely evaluation by a surgeon.

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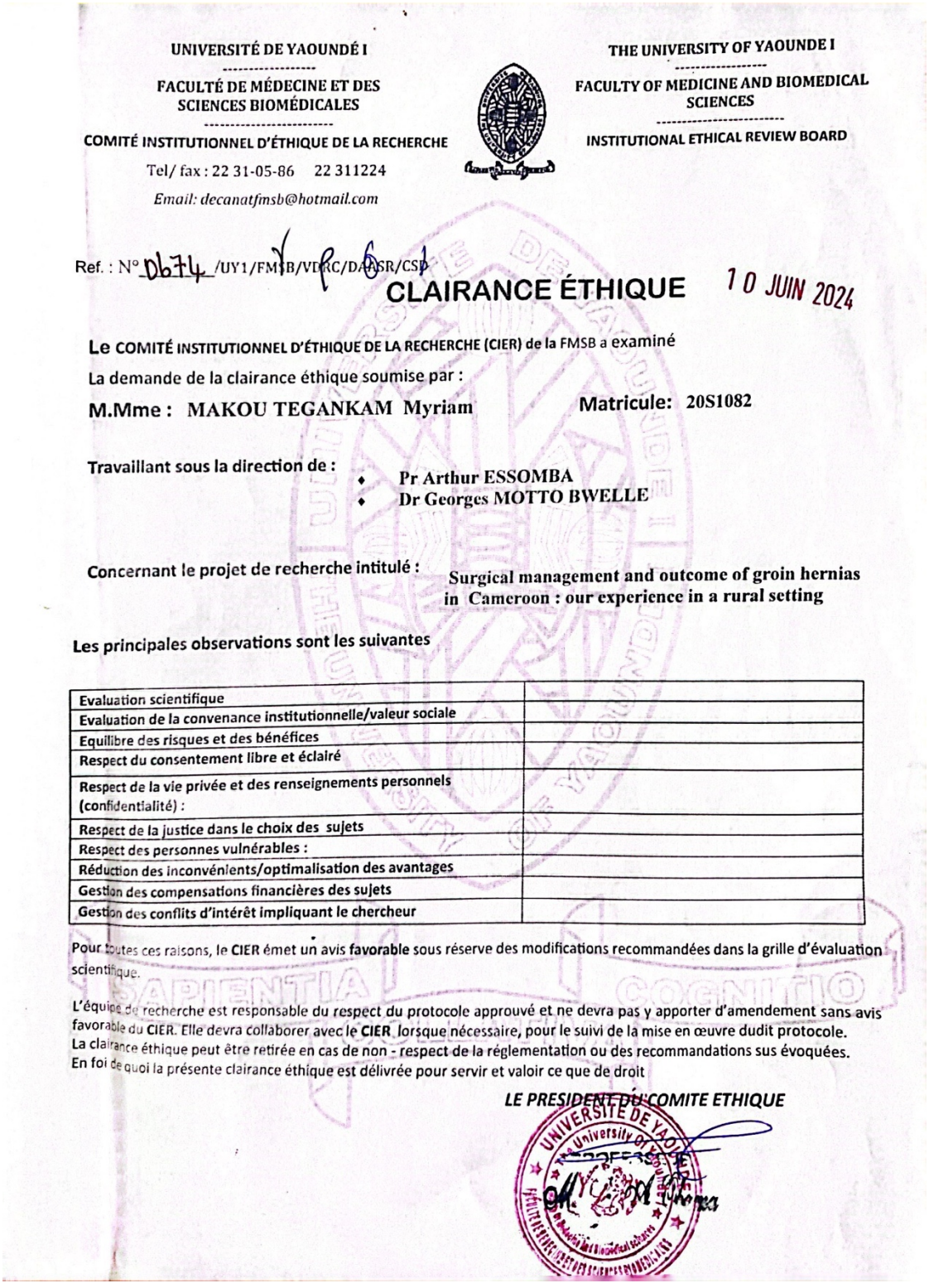
ANNEX

ANNEX

Annex 1: Ethical clearance



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THE UNIVERSITY OF YAOUNDE I
FACULTY OF MEDICINE AND BIOMEDICAL SCIENCES
INSTITUTIONAL ETHICAL REVIEW BOARD

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CLAIRANCE ÉTHIQUE 10 JUIN 2024

Le COMITÉ INSTITUTIONNEL D'ÉTHIQUE DE LA RECHERCHE (CIER) de la FMSB a examiné
La demande de la clairance éthique soumise par :
M.Mme : MAKOU TEGANKAM Myriam Matricule: 20S1082

Travaillant sous la direction de :
- Pr Arthur ESSOMBA
- Dr Georges MOTTO BWELLE

Concernant le projet de recherche intitulé : Surgical management and outcome of groin hernias in Cameroon : our experience in a rural setting

Les principales observations sont les suivantes

Evaluation scientifique	
Evaluation de la convenance institutionnelle/valeur sociale	
Equilibre des risques et des bénéfices	
Respect du consentement libre et éclairé	
Respect de la vie privée et des renseignements personnels (confidentialité) :	
Respect de la justice dans le choix des sujets	
Respect des personnes vulnérables :	
Réduction des inconvénients/optimalisation des avantages	
Gestion des compensations financières des sujets	
Gestion des conflits d'intérêt impliquant le chercheur	

Pour toutes ces raisons, le CIER émet un avis favorable sous réserve des modifications recommandées dans la grille d'évaluation scientifique.

L'équipe de recherche est responsable du respect du protocole approuvé et ne devra pas y apporter d'amendement sans avis favorable du CIER. Elle devra collaborer avec le CIER lorsque nécessaire, pour le suivi de la mise en œuvre dudit protocole.
La clairance éthique peut être retirée en cas de non - respect de la réglementation ou des recommandations sus évoquées.
En foi de quoi la présente clairance éthique est délivrée pour servir et valoir ce que de droit

LE PRESIDENT DU COMITE ETHIQUE

Annex 2: Collecting form

1- Socio-demographic parameters

Name_____

Date of birth|__|__| |__|__| |__|__|__|__| Age |__|__| Sex □ Masculin □ Féminin

Town of residence _____

Phone number |__|__| |__|__| |__|__| |__|__|

Other person to contact: Name _____ Number |__|__| |__|__||__|__| |__|__|

Profession: _____

2- **Clinical parameters**

Personal past history_____

Consumption of tobacco □ No □ yes

Consumption of alcohol □ No □ yes

Duration of the hernia: |__|__|__| years

Acquired □ No □ yes

Congenital □ No □ yes

Recurrence □ No □ yes

Delay from previous intervention: |__|__|__| months

Marital status:

Number of children |__|__|

Lifestyle:

Sexual activity: Greater than one time per week □ One time per week □ one time per month□

None in the last five years □ None since birth□

Altered gait □ No □ yes

Evaluation of quality of life

Pre and post-operative evaluation after 3 years

Criteria	Pre-operative	Post-operative 3 years
Pain Min = 0 Max = 10		
Working capacity Good = 2		

Reduced = 1 Null = 0		
Walking capacity Good = 2 Reduced = 1 Null = 0		
Local comfort Normal = 6 Uncomfortable = 3 Total discomfort = 0		
Micturition Good = 1 Reduced = 0		
Sexual function Good = 2 Reduced = 1 Null = 0		
Appetitis Good = 1 Reduced = 0		
Esthetic satisfaction Good = 2 Medium = 1 Null = 0		
General mood Very good = 3 Good = 2 Bad = 0		
Riding a bicycle Good = 2 Reduced = 1 Null = 0		
Social activities Good = 2 Reduced = 1 Null = 0		

Constipation □ No □ yes

Laterality left □ right□ bilateral□

Class type I □ type II □ type III □ type IV □

Reducibility: totally by patient □ totally by medical personnel □partially □ irreducible □

Local skin modification ulcers□ fistula □ others_____

3- **Surgical management:**

The American Society of Anesthesiologists (ASA) physical status classification system

ASA 1 □ ASA 2 □ ASA 3 □ ASA 4 □ ASA 5 □ ASA 6 □

ALTEMEIER CLASSIFICATION

Class I □ Class II □ Class III □ Class IV □

The chosen surgical procedure was either a herniorraphie with shouldice technique, Bassini technique or hernioplasty with a polypropylene mesh following Lichtenstein technique; or a differed hernioplasty after a raphie (6 months after).

Date of intervention: |__|__| |__|__| |__|__|__|__|

Type of anesthesia: locale □ locorégionale □ générale □ conversion □

Intervention difficulty: _____

Per operative incident: _____

Associated action: bowel resection □ successful per-operative reduction □ orchidectomy □

Technique of repair: Bassini □ Shouldice □ Lichtenstein □ Shouldice followed by Lichtenstein 6 months later □

4- Outcome:

- Immidiate post op complication:

simples □ bleeding □ urinary retention □ pain □ infection □ hematoma □ seroma □ altered bowel motion □ compartment syndrome □ death □

- Short term outcome (1 month):

Pain □urinary retention □ infection □ hematoma □ seroma □ altered bowel motion □ foreign body sensation □ recurrence □

- Long term outcome:

Chronic pain □ recurrence □ others …….

Annex 3: Consent form

INTRODUCTION: I am **MAKOU TEGANKAM Myriam**, a 4th year resident of General surgery in the Faculty of Medicine and Biomedical Sciences of the University of Yaounde 1, As a requirement for the award of the post graduate diploma in surgery, I am carrying out a research entitled: **Surgical Management and Outcome of Giant Groin Hernias in Cameroon: Our Experience in a Rural Setting**. This study will be carried out under the supervision of **Professor Arthur ESSOMBA** and co-supervised by **Dr Georges Bwelle.**

PROCEDURE: During the study information will be collected from ASCOVIME records regarding your illness and you will be interviewed during your follow up.

POTENTIAL RISK: This procedure might be time consuming as it will require at least 10 minutes of your time to fill in the questionnaire.

POSSIBLE BENEFITS: You will not be paid and you will not pay for participating in this study. However, you could benefit from:

CONFIDENTIALITY: You will not be identified in this study. All the information will be collected with codes and entered into a computer software only with codes

PARTICIPATION: Your participation in this study is voluntary. You are free to withdraw from the study at any time. If you decide your questionnaire will either be handed over to you or destroyed.

CONTACTS: If you have any questions concerning the study, you can contact the following people:

• MAKOU TEGANKAM Myriam; Principal investigator,
• Dr Georges BWELLE
• Professor Arthur

SECTION II: CONSENT

I ..... , after having the study thoroughly explained to me, haven been given the opportunity to ask questions, time to consider my participation in the study and the decision to withdraw from the study at any time it so pleases me, do hereby accept to participate in this study.

Signature of participant