THE ANATOMY OF PELVIC CORONA MORTIS VESSELS IN BLACK AFRICANS: A CADAVERIC STUDY

A DESCRIPTIVE CROSS SECTIONAL STUDY CARRIED OUT AT THE HUMAN ANATOMY LAB IN MOI UNIVERSITY

BY

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DECLARATION

This thesis is the researcher's original work. It has not been submitted for another degree in any institution of higher learning. Views expressed herein are the researchers unless stated otherwise, and where such is the case, the reference has been cited. No part of this thesis proposal may be reproduced without prior written permission of the author and or Moi University.

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BACKGROUND-The ‘‘corona mortis’’ is an anatomical variant, an anastomosis between the obturator and the external iliac or inferior epigastric arteries or veins. It traverses the superior pubic ramus at a variable distance from the symphysis pubis to anastomose with the superficial network of vessels. The name ‘‘corona mortis’’ or crown of death testifies to the importance of this anatomic feature, as significant hemorrhage may occur if accidentally cut and it is difficult to achieve subsequent homeostasis. Attention needs to be paid to these anastomoses by surgeons performing pelvic and acetabular surgery and also general surgeons performing hernia repair or laparoscopic procedures.

OBJECTIVE-To study incidence and anatomy of the corona mortis variant in the black African population in relation to side and gender.

METHODOLOGY-Forty embalmed hemipelvices obtained from the Department of Human anatomy at Moi University were used for this descriptive cross sectional study. The cadavers were dissected at the preperitoneal area of the abdominal wall from inside to look for corona mortis.The medial and middle windows of the ilioinguinal approach were performed, as described by Letournel . Identification of vessels more than 2mm in diameter traversing the superior pubic ramus was done and dissected to the point of anastomosis. After identifying the aberrant obturator artery or vein, the distance from the pubic symphysis medially to the point where the aberrant vessel crosses the superior pubic ramus was measured using vernier calipers. Further the distance from the point where the corona mortis crosses the superior pubic ramus to the anastomosis with the superficial network of vessels was measured. Chi-Square test was used to compare the incidence of the corona mortis between males and females. The level of significant difference used was $p < 0.05$. The unpaired t-test was used to compare mean of incidences of corona mortis in males and females.

RESULTS-Corona mortis was present in 38% (15 of 40). Of these, 47% were in men and 53% in women. The mean distance from the pubic symphysis to the point where the corona mortis traverses the pubic ramus was 53.2mm (arterial) and 54.3mm (venous).The mean distance from the pubic ramus to the point of anastomosis with the external iliac systems were 16.4mm and 11.5mm for the artery and vein respectively. Regarding the nature of connection, 2(13.4%) were purely arterial, 5(33.3%) were purely venous while 8(53.3%) had both .From the chi-square results it showed that there was no significant relationship between the gender and nature of connections or side of the pelvis; (χ^2=.134, df=2 ; p>0.05). The Independent Samples t-Test showed that there was no significant difference in mean incidence of corona mortis between male and female specimens (t=.135, df= 13; p>0.05)

CONCLUSION AND RECOMMENDATIONS-In pelvic and acetabular surgery, the corona mortis must be ligated or clipped to advance the dissection further along the pelvic brim and quadrilateral surface during the modified stoppa approach which enables access to the anterior wall, anterior column, and associated anterior column and posterior hemitransverse fractures, as well as certain both-column, T-shaped, and transverse fractures. General Surgeons who repair direct, indirect, femoral, or obturator hernias need to be aware of the incidence of the corona mortis.

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DISCLOSURE

The researcher did not receive any outside funding or grants in support for this study. Neither he nor a member of his immediate family received payments or other benefits or commitment or agreement to provide such benefits from a commercial entity.

Sign……

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DEDICATION

To my mother Salinah whose calm and strength I so greatly admire.

ACKNOWLEDGEMENT

I thank my family for their psychological , moral and material support all through my studies.

I thank my supervisors and all those who assisted in making this work possible

DEFINITION OF TERMS

Acetabulum The cup-shaped hollow in the hipbone into which the head of the femur fits to form a ball-and-socket joint

Anastomosis An anastomosis is the reconnection of two streams that previously branched out, such as blood vessels or leaf veins.

Corona mortis Refers to retropubic vascular communication between either the external iliac (or deep epigastric vessels) and the obturator artery

External iliac artery The external iliac arteries are two major arteries, which bifurcate off the common iliac arteries anterior to the sacroiliac joint of the pelvis.

Hernioraphy Surgical correction of a hernia by suturing.

Internal iliac artery It is a short, thick vessel, smaller than the external iliac artery, and about 3 to 4 cm in length formerly known as the hypogastric artery is the main artery of the pelvis

Laparoscopy Is an operation performed in the abdomen or pelvis through small incisions (usually 0.5–1.5 cm) with the aid of a camera? It can either be used to inspect and diagnose a condition or to perform surgery

Obturator artery Is a branch of the internal iliac artery that passes antero-inferiorly (forwards and downwards) on the lateral wall of the pelvis, to the upper part of the obturator foramen, and, escaping from the pelvic

cavity through the obturator canal, it divides into both an anterior and a posterior branch

Symphysis pubis The pubic symphysis or symphysis pubis is the midline cartilaginous joint (secondary cartilaginous) uniting the superior rami of the left and right pubic bones.

Pelvis A basin-shaped structure of the vertebrate skeleton, composed of the innominate bones on the sides, the pubis in front, and the sacrum and coccyx behind, that rests on the lower limbs and supports the spinal column.

Pubic ramus The pubic rami are a group of bones that make up a portion of the pelvic bone. Each of these bones, when referred to individually, is known as a pubic ramus. These bones are generally divided into two separate categories. These categories are known as the superior and inferior pubic rami.

ABBREVIATIONS

CMA	Corona mortis Artery
CMV	Corona mortis Vein
IEA	Inferior Epigastric Artery
IEV	Inferior Epigastric Vein
OA	Obturator Artery
OF	Obturator Foramen
OV	Obturator Vein
PS	Pubic symphysis

CHAPTER ONE

1.0 INTRODUCTION

The purpose of this study was to define the incidence, location, and dimensions of aberrant,retropubic, anastomosing arteries or veins, the corona mortis, that connect the external iliac and obturator vessels and determine whether they interfere with the clinical approaches to the pelvis and acetabulum in the Kenyan population . These surgical approaches are used by orthopaedic surgeons to reduce and fix fractures of the pelvic girdle (particularly at the symphysis pubis and the superior pubic ramus) and of the acetabulum (particularly the anterior column). The corona mortis has been said to cause massive uncontrolled bleeding[1] , significant bleeding [2], profuse bleeding [3] , persistent pelvic bleeding [4] ,or life-threatening haemorrhage [5].

To avoid this catastrophic complication, the surgeon must understand the anatomy and plan to clamp and ligate the Corona Mortis when it is encountered.

CHAPTER TWO

2.0 LITERATURE REVIEW

Corona mortis represents anastomotic connection between the obturator and external iliac vascular systems. The name "corona mortis" or crown of death testifies to the importance of this feature, as significant hemorrhage may occur if accidentally cut and it is difficult to achieve subsequent hemostasis.The surgical relevance of the vascular relations of the superior branch of pubis (in trauma, orthopedic approaches, hernia repair, embolizations and intra-arterial infusions) recommends a detailed knowledge of the morphological and topographical possibilities of the crown of death and the individual evaluation of this risky anatomical structure. [6]. Prevalence of these vascular connections displays ethnic and regional differences. Anastomoses between the obturator and external iliac systems occurred in 83% of English [7], 80% of Romania[8], 77% in Thais [9], 72% of Chinese [10], 61% of Turkish [11] of the studied specimens. Venous connection is more probable than an arterial ones[12].The surgeon must appreciate the importance of the venous connections because of the possibility of massive uncontrolled bleeding. Presence of both arterial and venous connections have been found in 20% of specimens.[13]

Accessory branches of the obturator artery were observed in 8%, 14.81%, 19%, and 34%, [12, 14,11,15,13] of the different ethnic populations. In classical anatomy textbooks, a description of the veins that form corona mortis is found less often than descriptions of the arteries. This vein coursed vertically to the inferior border of the superior pubic ramus and connected to the obturator vein [12].Venous anastomosis on the superior pubic ramus are a finding in 96% [12], 70%[13], 40% [16], 20.37% [14]of cases. The mean distance

from the symphysis to the anastomotic vessels averaged 6.2 cm [13]. The mean distance between the anastomotic arteries and the symphysis pubis was 64 (45-90) mm, and 56 (37-80) mm for the communicating veins [11].

Corona mortis is at risk during surgical treatment of acetabular fractures, which was treated with the modified medial Stoppa approach [7, 15]. These vascular anastomosis are also at risk during ilionguinal approach to the acetabulum [7]. A medial approach for pelvic osteotomies for acetabular dysplasia though technically easier than a lateral approach puts several structures such as the corona mortis at risk [16]. General surgeons who repair direct, indirect, femoral, or obturator hernias need to be aware of these anastomoses and their close proximity to the femoral ring [12]. Attention needs to be paid to these anastomoses between the arterial and the venous system located over the superior pubic ramus during laparoscopic procedures as in totally extra peritoneal laparoscopic hernioplasty [17].

ANATOMY OF THE PELVIS

BONE

INNOMINATE BONE

The innominate or hip bone is large, irregular, constricted centrally and expanded above and below. Its lateral surface has a deep, cup-shaped acetabulum, articulating with the femoral head, anteroinferior to which is the large, oval or triangular obturator foramen. Above the acetabulum the bone widens into a plate with a sinuously curved iliac crest.

The bone articulates in front with its fellow to form the pelvic girdle. Each has three parts, ilium, ischium and pubis, connected by cartilage in youth but united as one bone in adults. The principal union is in the acetabulum. The ilium includes the upper

acetabulum and expanded area above it; the ischium includes the lower acetabulum and bone posteroinferior to it; the pubis forms the anterior acetabulum, separating the ilium from ischium, and the anterior median region where the pubes meet.

Obturator foramen

The obturator foramen lies below and slightly anterior to the acetabulum, between the pubis and ischium. It is bordered above by the grooved obturator surface of the superior pubic ramus, medially by the pubic body and its inferior ramus, below by the ischial ramus, and laterally by the anterior border of the ischial body, including the margin of the acetabular notch. The foramen is almost closed by the obturator membrane , which is attached to its margins, except above, where a communication remains between the pelvis and thigh. This free edge is attached to an anterior obturator tubercle at the anterior end of the inferior border of the superior pubic ramus, and a posterior obturator tubercle on the anterior border of the acetabular notch; these tubercles are sometimes indistinct. Since the tubercles lie in different planes and the obturator groove crosses the upper border of the foramen, the acetabular rim is in fact a spiral. The foramen is large and oval in males, but smaller and nearly triangular in females.

Superior pubic ramus

The superior pubic ramus passes upwards, backwards and laterally from the body, superolateral to the obturator foramen, to reach the acetabulum. It is triangular in section and has three surfaces and borders. Its anterior, pectineal surface, tilted slightly up, is triangular in outline and extends from the pubic tubercle to the iliopubic eminence. It is bounded in front by the rounded obturator crest and behind by the sharp pecten pubis (pectineal line) which, with the crest, is the pubic part of the linea terminalis (i.e. anterior

part of the pelvic brim). The posterosuperior, pelvic surface, medially inclined, is smooth and narrows into the posterior surface of the body, which is bounded above by the pecten pubis and below by a sharp inferior border. The obturator surface, directed down and back, is crossed by the obturator groove sloping down and forwards. Its anterior limit is the obturator crest and its posterior limit is the inferior border.

Pecten pubis

The pecten pubis is the sharp, superior edge of the pectineal surface. The conjoint tendon and lacunar ligament are attached at its medial end. A strong fibrous pectineal ligament is attached along the rest of its surface. The smooth pelvic surface is separated from parietal peritoneum only by areolar tissue, in which the lateral umbilical ligament descends forwards across the ramus and, laterally, the vas deferens passes backwards. The obturator groove, converted to a canal by the upper borders of the obturator membrane and obturator muscles, transmits the obturator vessels and nerve from the pelvis to the thigh. Some fibres of the pubofemoral ligament are attached to the lateral end of the obturator crest.

JOINTS

PUBIC SYMPHYSIS

The pubic bones meet in the midline at the pubic symphysis, a secondary cartilaginous joint .

Articulating surfaces

The articulating surfaces are the medial (symphyseal) surfaces of the pubic bones, each covered by a thin layer of tightly adherent hyaline cartilage . The junction is not flat but

marked by reciprocal crests and papillae. The surfaces of hyaline cartilage are connected by fibrocartilage, varying in thickness and constituting the interpubic disc.

VASCULAR SUPPLY

The true pelvis contains the internal iliac arteries and veins as well as the lymphatics draining the majority of the pelvic viscera. The common and external iliac vessels as well as the lymphatics draining the lower limb lie along the pelvic brim and in the lower retroperitoneum, but are conveniently discussed together with the vessels of the true pelvis

ILIAC VESSELS

The abdominal aorta bifurcates into the right and left common iliac arteries anterolateral to the left side of the fourth lumbar vertebral body. These arteries diverge as they descend to divide at the level of the sacroiliac joint into external and internal iliac arteries. The external iliac artery is the principal artery of the lower limb and the internal iliac artery provides the principal supply to the pelvic viscera and walls, the perineum and the gluteal region.

Right common iliac artery

The right common iliac artery is approximately 5 cm long and passes obliquely across part of the fourth and the fifth lumbar vertebral bodies. The sympathetic rami to the pelvic plexus and, at its division, the ureter, cross anterior to it. It is covered by the parietal peritoneum, which separates it from the coils of the small intestine. Posteriorly, it is separated from the fourth and fifth lumbar vertebral bodies and their intervening disc by the right sympathetic trunk, the terminal parts of the common iliac veins and the start

of the inferior vena cava, the obturator nerve, lumbosacral trunk and iliolumbar artery. Lateral to its upper part are the inferior vena cava and the right common iliac vein and lower down is the right psoas major. The left common iliac vein is medial to the upper part.

Left common iliac artery

The left common iliac artery is shorter than the right and is approximately 4 cm long. Lying anterior to it are the sympathetic rami to the pelvic plexus, the superior rectal artery and, at its terminal bifurcation, the ureter. The sympathetic trunk, the fourth and fifth lumbar vertebral bodies and intervening disc, the obturator nerve, lumbosacral trunk and iliolumbar artery are all posterior to it. The left common iliac vein is posteromedial to the artery while the left psoas major lies lateral to it.

Branches

In addition to the external iliac and internal iliac terminal branches, each common iliac artery gives small branches to the peritoneum, psoas major, ureter, adjacent nerves and surrounding areolar tissue.

INTERNAL ILIAC ARTERIES

Each internal iliac artery, c.4 cm long, begins at the common iliac bifurcation, level with the lumbosacral intervertebral disc and anterior to the sacroiliac joint. It descends posteriorly to the superior margin of the greater sciatic foramen where it divides into an anterior trunk, which continues in the same line towards the ischial spine, and a posterior trunk, which passes back to the greater sciatic foramen. Tributaries of the internal iliac vein are also medial.

EXTERNAL ILIAC ARTERIES

The external iliac arteries are of larger calibre than the internal iliac artery. Each artery descends laterally along the medial border of psoas major from the common iliac bifurcation to a point midway between the anterior superior iliac spine and the symphysis pubis. It enters the thigh posterior to the inguinal ligament to become the femoral artery.

On the right the artery is separated from the terminal ileum and, usually, the appendix by the parietal peritoneum and extraperitoneal tissue. On the left the artery is separated from the sigmoid colon and coils of the small intestine lie anteromedially.

The external iliac artery is principally the artery of the lower limb and as such has few branches in the pelvis. Apart from very small vessels to psoas major and neighbouring lymph nodes, the artery has no branches until it gives off the inferior epigastric and deep circumflex iliac arteries which arise near to its passage under the inguinal ligament.

Inferior epigastric artery

The inferior epigastric artery originates from the external iliac artery posterior to the inguinal ligament. It curves forwards in the anterior extraperitoneal tissue and ascends obliquely along the medial margin of the deep inguinal ring where it continues as an artery of the anterior abdominal wall.

VEINS OF THE PELVIS

The true pelvis contains a large number of veins which drain the wall and most of the viscera contained within the pelvis and carry venous blood from the gluteal region, thigh the hip. The external iliac veins, lying close to the brim of the pelvis, carry the venous

drainage of most of the lower limb. There is considerable variation in the venous drainage of the pelvis and although the major veins frequently follow their named arterial counterparts, the small tributaries exhibit a great deal of variation between individuals.

COMMON ILIAC VEINS

The common iliac vein is formed by the union of external and internal iliac veins, anterior to the sacroiliac joints. It ascends obliquely to end at the right side of the fifth lumbar vertebra, uniting at an acute angle with the contralateral vessel to form the inferior vena cava. The right common iliac vein is shorter and more nearly vertical, lying posterior then lateral to its artery. The right obturator nerve passes posterior. The left common iliac vein is longer and more oblique and lies first medial, then posterior to its artery.

INTERNAL ILIAC VEIN

The internal iliac vein is formed by the convergence of several veins above the greater sciatic foramen. It does not have the predictable trunks and branches of the internal iliac artery but its branches drain the same territories. It ascends posteromedial to the internal iliac artery to join the external iliac vein, forming the common iliac vein at the pelvic brim, anterior to the lower part of the sacroiliac joint.

Obturator vein

The obturator vein begins in the proximal adductor region and enters the pelvis via the obturator foramen. It runs posteriorly and superiorly on the lateral pelvic wall below the obturator artery and between the ureter and internal iliac artery to end in the internal iliac

vein. It is sometimes replaced by an enlarged pubic vein, which joins the external iliac vein.

EXTERNAL ILIAC VEIN

The external iliac vein is the proximal continuation of the femoral vein. It begins posterior to the inguinal ligament, ascends along the pelvic brim and ends anterior to the sacroiliac joint by joining the internal iliac vein to form the common iliac vein. On the right it lies medial to the external iliac artery, gradually inclining behind it as it ascends. On the left it is wholly medial of the external iliac artery may cause it to adhere closely to the vein at the point where it is. The vein is usually valveless, but may contain a single valve. It tributaries are the inferior epigastric, deep circumflex iliac and pubic veins.

Inferior epigastric vein

One or two inferior epigastric veins accompany the artery and drain into the external iliac vein a little above the inguinal ligament. [24]

Diagram with pelvic anatomy detail:

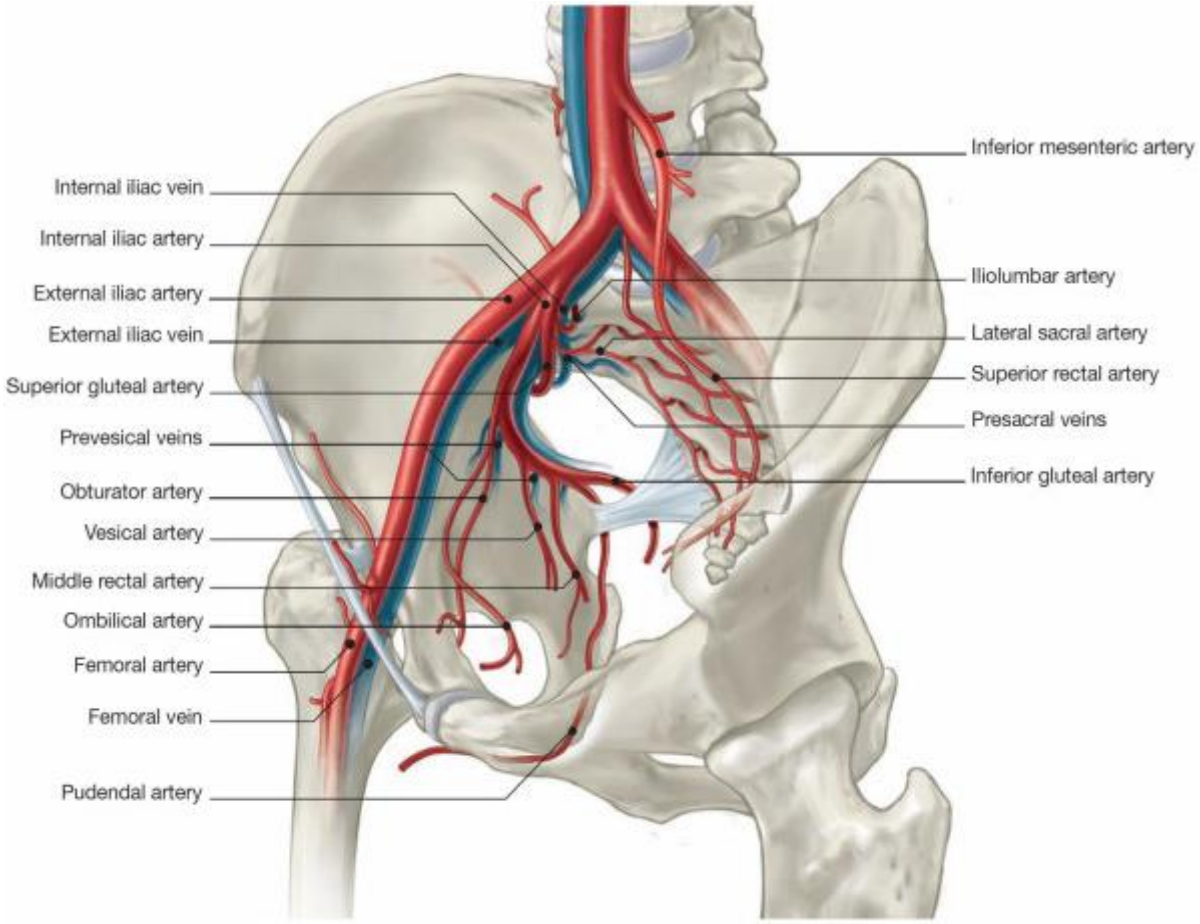
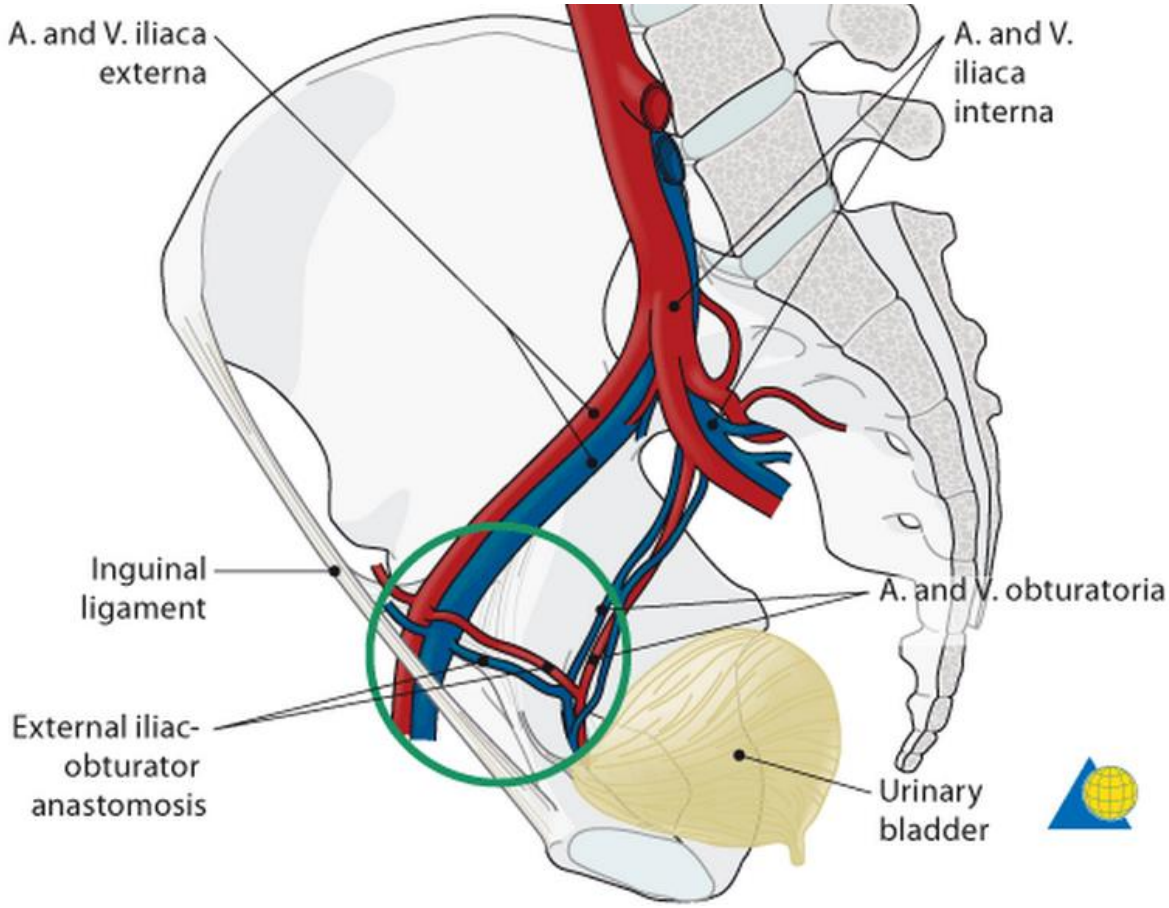


FIG. 1.0

Retropubic Vascular anastomosis:[25]



(Courtesy of AO foundation website , Retropubic vascular anastomoses

https://www2.aofoundation.org)

FIG 2.0

2.1 RESEARCH QUESTIONS

1. What is the incidence of Corona mortis in the black African population?
2. Is there a difference in the incidence of corona mortis between males and females?
3. What is the average distance of corona mortis from the pubic symphysis?

4. What is the nature of the corona mortis ?

5. What is the average distance of the corona mortis anastomosis with the external iliac vessels from its crossing over the pubic ramus?

6. Is there difference in the gender?

2.2 RESEARCH OBJECTIVES

To study incidence and the anatomy of the corona mortis vessels in the black African population in relation to side and gender.

2.3 SIGNIFICANCE OF THE STUDY

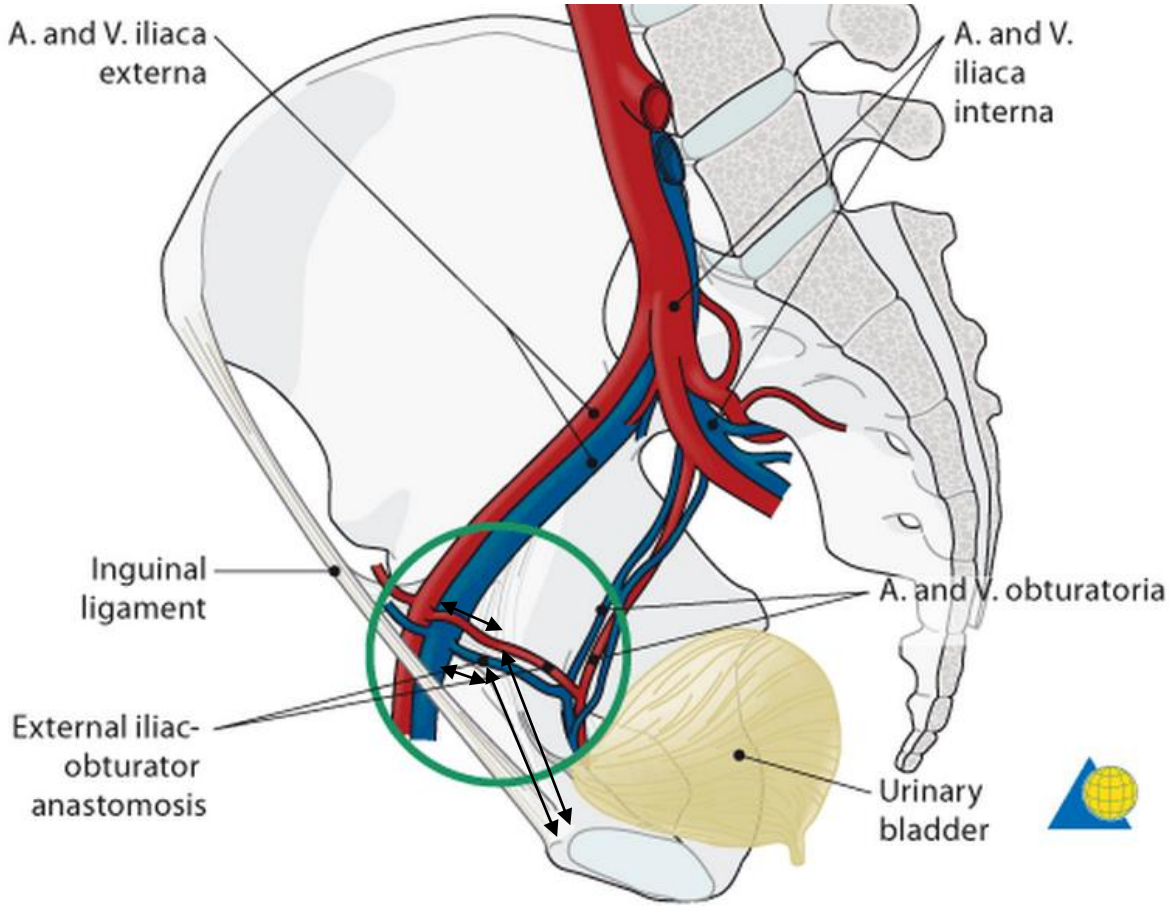
The corona mortis is prone to laceration during anterior approaches to the pelvis and acetabulum. If the corona mortis is not sought out, orthopaedic surgeons encounter it during the ilioinguinal and stoppa approaches as massive bleeding occurs during dissection laterally along the superior pubic ramus. Thus, the corona mortis deserves great attention during the ilioinguinal and stoppa approaches. In case of pelvic fracture, massive extra peritoneal hemorrhage may arise due to tear or incarceration of the corona mortis in the fracture .Surgeons and endovascular specialists dealing with direct, indirect, femoral, or obturator hernias, superior pubic ramus fractures, and acetabulum fractures need to be aware of these anastomoses (arterial, venous, or both) and avoid undue hemorrhage.

CHAPTER THREE

3.0 METHODOLOGY

3.1 MATERIALS AND METHODS

Forty formalin embalmed hemipelvices obtained from the Department of Human anatomy at Moi University were used for this study. The cadavers were dissected at the preperitoneal area of the abdominal wall from inside to look for corona mortis. After identifying any aberrant obturator artery or vein, the distance from the pubic symphysis medially to the point where the aberrant vessel crosses the superior pubic ramus was measured using vernier calipers SOMET^{TM} CN–25 1234 (accurate to 1mm). Further the distance from the point where the corona mortis crosses the superior pubic ramus to the anastomosis with the inferior epigastric vessels or external iliac vessels was measured. Pictures of the dissections were then taken.



(POINTED ARROW SHOWS THE DISTANCES MEASURED)

(AO foundation website , Retropubic vascular anastomoses https://www2.aofoundation.org)

FIG. 3.0

3.2 DATA MANAGEMENT

The measurements taken were analyzed using the SPSS version 20. Bar graphs and pie charts were drawn to represent the data. Means, frequencies and ranges were applied to the various measured parameters. The student t-test was used to compare variables on the various measured distances in relation to side and sex at 95% confidence interval.

3.3 STUDY DESIGN

A descriptive cross sectional study.

3.4 STUDY SETTING:

Department of Human Anatomy laboratory, Moi University School of medicine.

3.5 STUDY POPULATION AND SAMPLE SIZE

The study included adult male and female cadaveric specimen in the Moi university school of medicine human anatomy labs. All the available 40 cadavers whose anatomy on the pelvic region was intact were used.

3.6 SAMPLING PROCEDURE

All adult black cadaveric non-mutilated, non-decomposed cadavers whose anatomy on the pelvic region was intact from the human anatomy labs.

3.7 INCLUSION CRITERIA

- Cadavers of either sex from the Human Anatomy Lab

3.8 EXCLUSION CRITERIA

- Mutilated or decomposed cadevers whose anatomy on the pelvic region has been distorted
- Skeletally immature cadavers.

3.9 DATA COLLECTION AND MANAGEMENT

The measurements preformed following dissection were analyzed using the SPSS Version 20. Bar graphs and pie charts were drawn to represent the data. Means, frequencies and ranges were applied to the various measured parameters. The student t test was used to compare variables on the various measured distances in relation to side and sex at 95% confidence interval.

3.10 LIMITATIONS OF THE STUDY

- Dissection could have changed the location of the corona mortis
- The number of specimens could have been larger

3.11 ETHICAL CONSIDERATIONS

In order to protect and respect the specimen the following steps were taken,

1. Permission and clearance to conduct the study was sought and obtained from IREC
2. Study was conducted in accordance to **The Anatomy Act** Chapter 249-3 of the Laws of Kenya which entitles a person registered as a student of any approved school of anatomy to examine cadavers anatomically .
3. Approval from the Department of Human Anatomy ,Moi University School of medicine

CHAPTER FOUR

4.0 RESULTS

Incidence of Corona mortis

The findings of the study showed that of the 40 dissected hemipelvices, the corona mortis was present in 15 (37.5%) while 25(62.5%) did not have either venous or arterial anastomosis between the obturator and the external iliac systems.

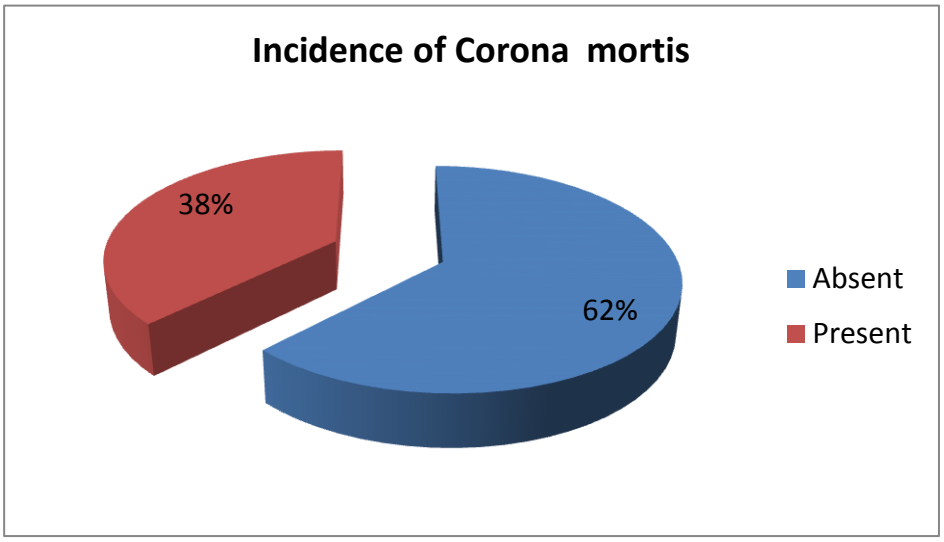


FIG. 4.0

Gender of specimen with Corona Mortis

Corona mortise was present in 8(53%) female specimen compared to 7(47%) in the male hemipelvices.

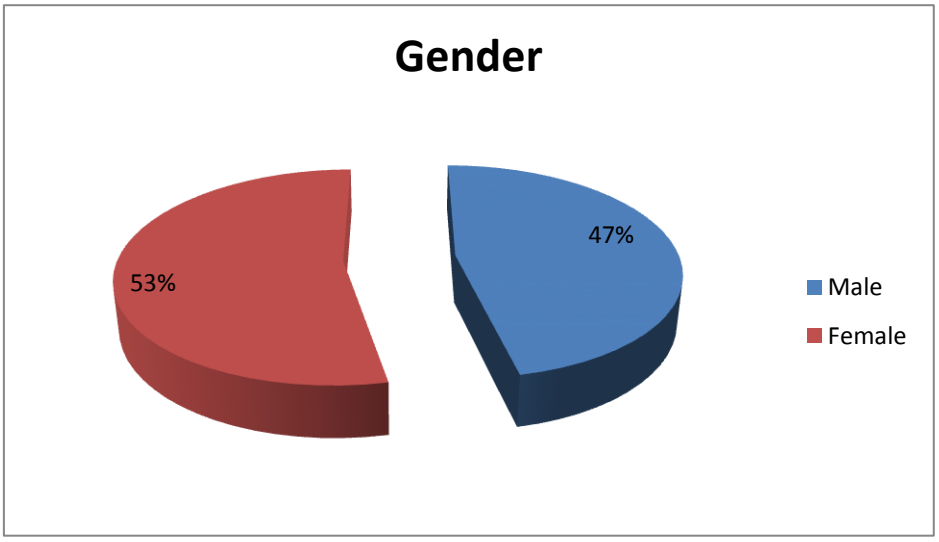


FIG 5.0

Side of connection

Of the 15 hemipelvices with Corona mortise, 8(53%) were on the left while 7(47%) were on the right side.

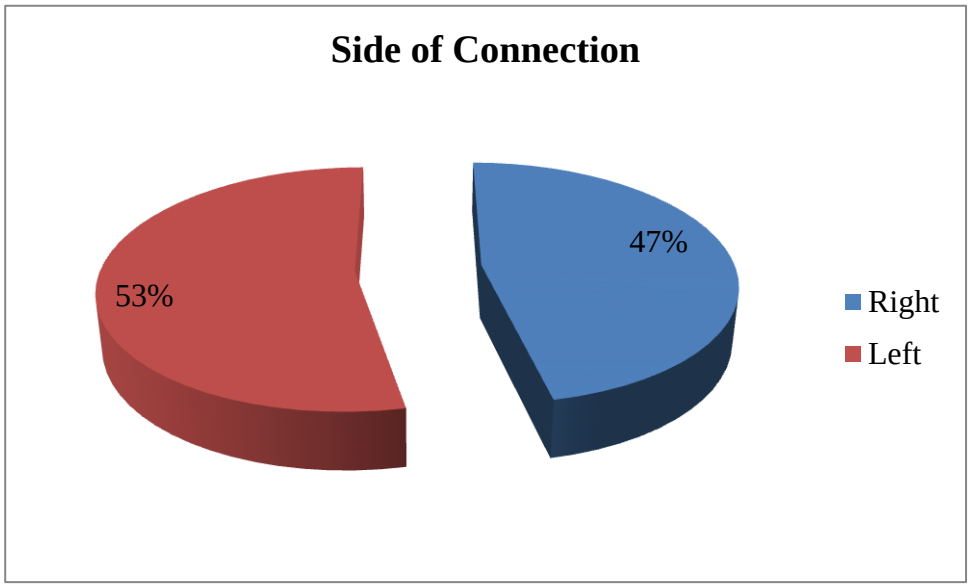


FIG 6.0

The Nature of connection based on Gender

Regarding the nature of connection, 2(13.4%) were purely arterial, 5(33.3%) were purely venous while 8(53.3%) had both venous and arterial communication/corona mortis. A majority of the hemipelvices had both mixed and venous communication.

Gender		Nature of connection			Total
		Arterial	Venous	Both	
Male	**Count**	**1**	**2**	**4**	**7**
	% of Total	6.7%	13.3%	26.7%	46.7%
Female	**Count**	**1**	**3**	**4**	**8**
	% of Total	6.7%	20.0%	26.7%	53.3%
Total	**Count**	**2**	**5**	**8**	**15**
	% of Total	**13.4%**	**33.3%**	**53.3%**	**100.0%**

TABLE 1.O

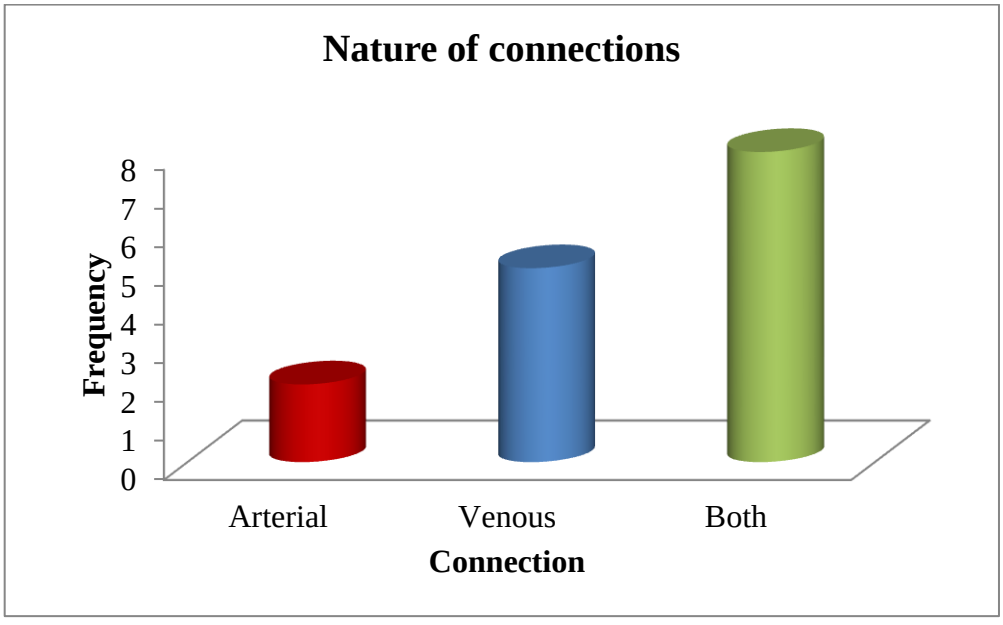


FIG 7.0

Chi-Square Tests on Nature of connections

Cross tabulation was used to compare the relationship between gender and nature of connections as summarized in table below. From the chi-square results it showed that there was no significant relationship between the gender and nature of connections; (χ^2=.134, df=2 ; p>0.05).

Chi-Square Tests on Nature of connections

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	.134[a]	2	.935
Likelihood Ratio	.135	2	.935
Linear-by-Linear Association	.020	1	.888
N of Valid Cases	15		

TABLE 2.0

Independent Samples t-test

The t-test was used to compare mean of incidences of corona mortis in males and females. From the findings it showed that the mean was slightly higher in males (2.43) as compared to female (2.38) hemipelvices. The Independent Samples t-Test showed that there was no significant difference in mean between male and female specimens (t=.135, df= 13; p>0.05) as shown in the table below where p=0.894.

Independent Samples t-test

	Gender	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**t-test**	**sig(2-tailed)**
Nature of	Male	7	2.4286	.78680	.29738	t=.135	
connection	Female	8	2.3750	.74402	.26305	df=13	.894

TABLE 3.0

The mean distance from pubic symphysis to corona mortis

The mean distance from pubic symphysis to corona mortis was computed during the study as shown in table below. The mean venous distance (54.27mm) to corona mortis was slightly longer compared to arterial (53.17mm).

The mean distance from pubic symphysis to corona mortis

Distance from pubic symphysis to corona mortis	**N**	**Min**	**Max**	**Mean**	**Std. Error**	**Std. Deviation**
Arterial	12	40.00	62.00	53.1667	2.04062	7.06892
Venous	11	40.00	62.00	54.2727	2.24455	7.44434

TABLE 4.0

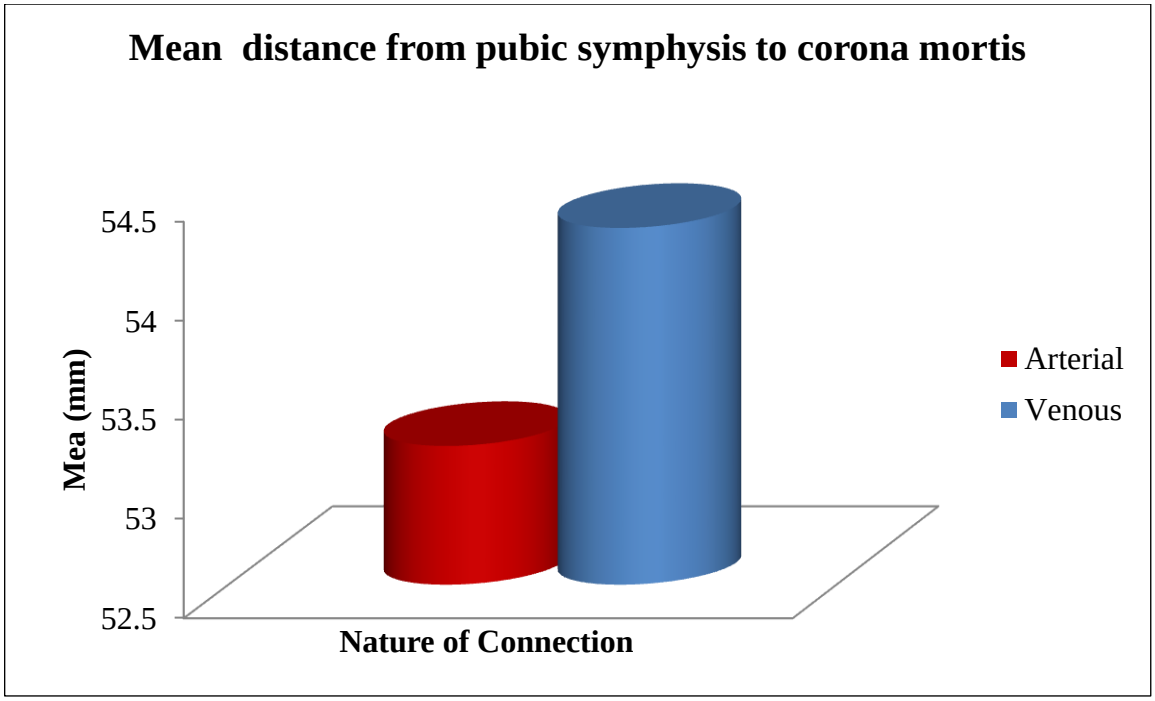


FIG. 8.0

The mean distance from pubic ramus to corona mortis anastomosis with the external iliac vessels

The mean distance from pubic ramus to corona mortis anastomosis varied during the study as shown in table below. The mean of Arterial anastomosis distance was 16.42mm, while that of the venous anastomosis was 11.45mm.

The mean distance from pubic ramus to corona mortis anastomosis with superficial network of vessels

Distance from pubic ramus to anastomosis	N	Min	Max	Mean	Std. Error	Std. Deviation
Arterial anastomosis	12	10.00	30.00	16.4167	1.38967	4.81396
Venous anastomosis	11	10.00	16.00	11.4545	.75515	2.50454

TABLE 5.0

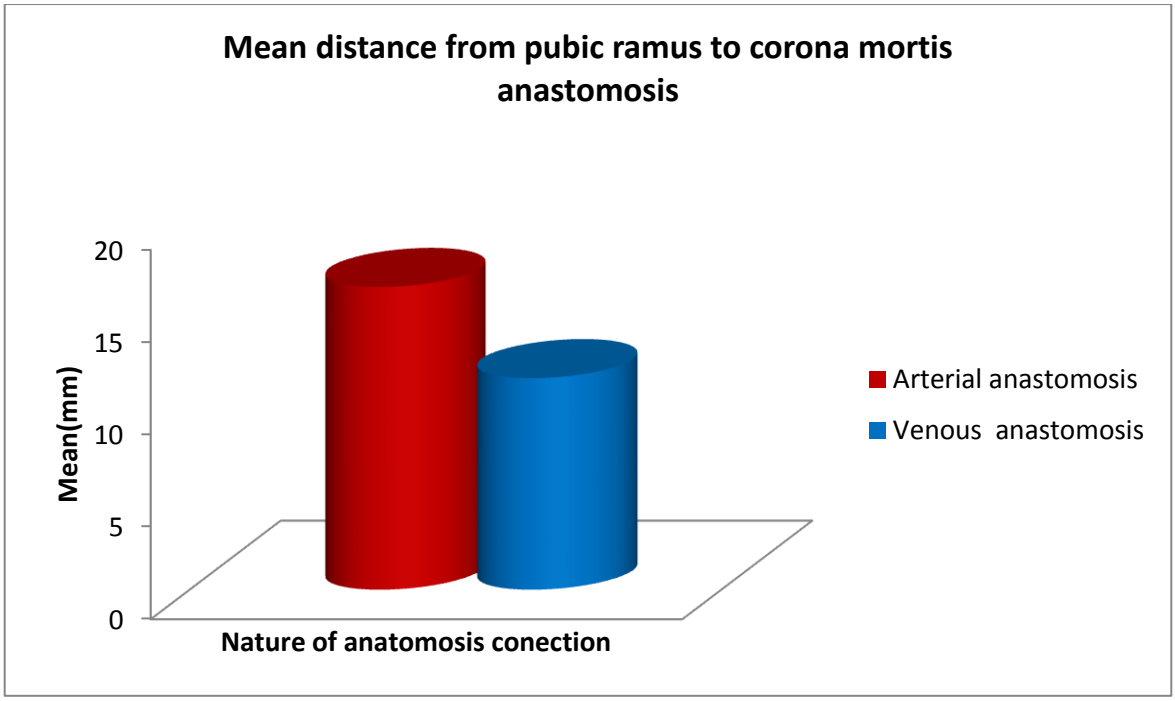


FIG. 9.0

Independent Samples t-test

The Independent Samples t-test showed that there was no significant difference in gender and mean distances from pubic symphysis to corona mortis. The findings also showed that there was no significant difference between the male and female distance from corona mortis (artery and vein) to pubic symphysis ($p>0.05$).

Independent Samples t-test of the mean distance from pubic symphysis to corona mortis ($p>0.05$)

Distance from pubic symphysis to	Gender	N	Mean	Std. Dev	Std. Error Mean	t	Df	Sig. (2-tailed)
Artery	Male	7	56.14	7.034	2.658	1.93	10	.083
	Female	5	49.00	5.099	2.280	2.04	9.98	.069
Vein	Male	4	56.00	10.708	5.354	.561	9	.588
	Female	7	53.29	5.648	2.135	.471	3.98	.662

TABLE6.0

Distance from pubic ramus to corona mortis anastomosis

The Independent Samples t-test showed that there was no significant difference between the gender and mean distances from pubic ramus to corona mortis. The findings showed that there was no significant difference in gender from the Point of anastomosis of the corona mortis (artery and vein) to pubic ramus ($p>0.05$).

Independent Samples t-test of the mean distance from pubic ramus to corona mortis anastomosis ($p>0.05$)

Distance from pubic Ramus to	Gender	N	Mean	Std. Dev	Std. Error Mean	t	Df	Sig. (2-tailed)
Arterial anastomosis	Male	7	17.43	6.294	2.379	.851	10	.415
	Female	5	15.00	.000	.0000	1.02	6.000	.347
Venous anastomosis	Male	4	12.50	2.887	1.443	1.05	9	.320
	Female	7	10.86	2.268	.8571	.979	5.168	.371

TABLE 7.0

Distance from Arterial corona mortis to pubic symphysis

Of the arterial corona mortis 3(25%) had a distance of 51mm and 62mm to pubic symphysis while 2(16.7%) measured 50mm and the rest 40mm, 45mm, 51 and 60mm had 1(8.3%) incidences.

		Distance from corona mortis to ramus pubic symphysis artery							Total
		40.0	**45.0**	**50.0**	**51.0**	**52.0**	**60.0**	**62.0**	
Male	**Count**	**0**	**1**	**1**	**0**	**1**	**1**	**3**	**7**
	% of Total	0.0	8.3	8.3	0.0	8.3	8.3	25.0	**58.3**
Female	**Count**	**1**	**0**	**1**	**1**	**2**	**0**	**0**	**5**
	% of Total	8.3	0.0	8.3	8.3	16.7	0.0	0.0	**41.7**
Total	**Count**	**1**	**1**	**2**	**1**	**3**	**1**	**3**	**12**
	% of Total	8.3	8.3	16.7	8.3	25.0	8.3	25.0	**100.0**

TABLE 8.0

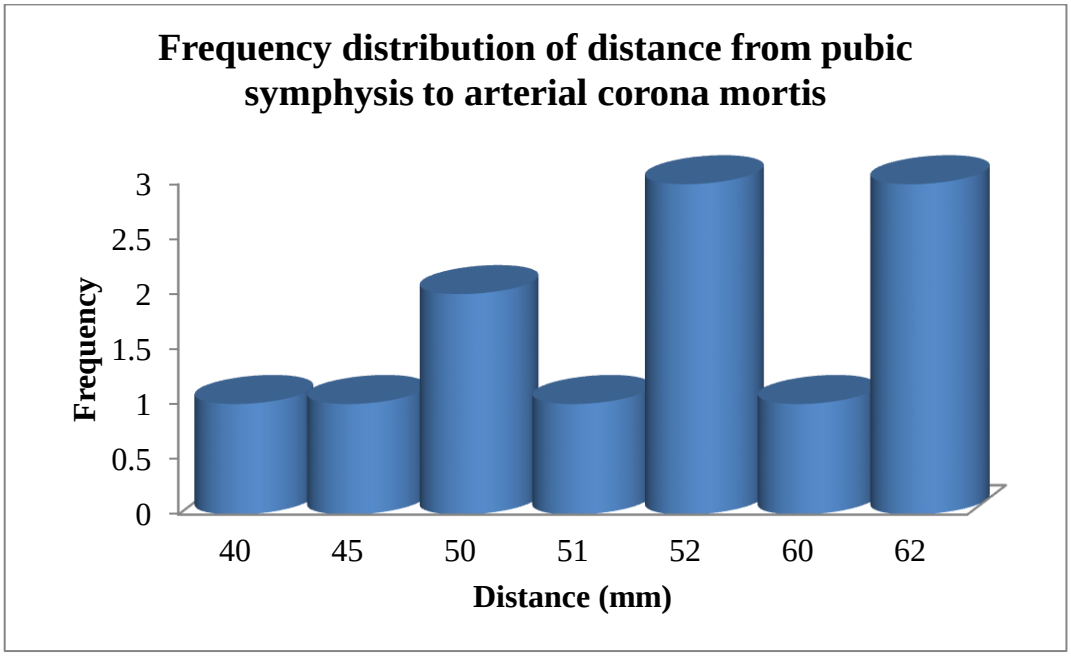


FIG 10.0

Distance from the venous corona mortis to the pubic symphysis

The distance from corona mortis to pubic symphysis vein was varied during the study as shown in table below. Three (27.3%) had a distance of 60mm distance from corona mortis to the pubic symphysis. However those with one incidence (9.1%) comprise of 40mm, 45mm, 49mm, 50mm, 54mm, 55mm and 60mm distance from corona mortis to pubic symphysis vein. Only 2(18.2%) of the veins had a distance of 62mm from corona mortis to pubic symphysis.

Distance from pubic symphysis to corona mortis vein

		Distance from pubic symphysis to corona mortis vein								**Total**
		40.0	45.0	49.00	50.0	54.0	55.0	60.0	62.00	
Male	**Count**	1	0	0	0	0	0	1	2	4
	% of Total	9.1	0.0	0.0	0.0	0.0	0.0	9.1	18.2	36.4
Female	**Count**	0	1	1	1	1	1	2	0	7
	% of Total	0.0	9.1	9.1	9.1	9.1	9.1	18.2	0.0	63.6
Total	**Count**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**2**	**11**
	% of Total	**9.1**	**9.1**	**9.1**	**9.1**	**9.1**	**9.1**	**27.3**	**18.2**	**100.0**

TABLE 9.0

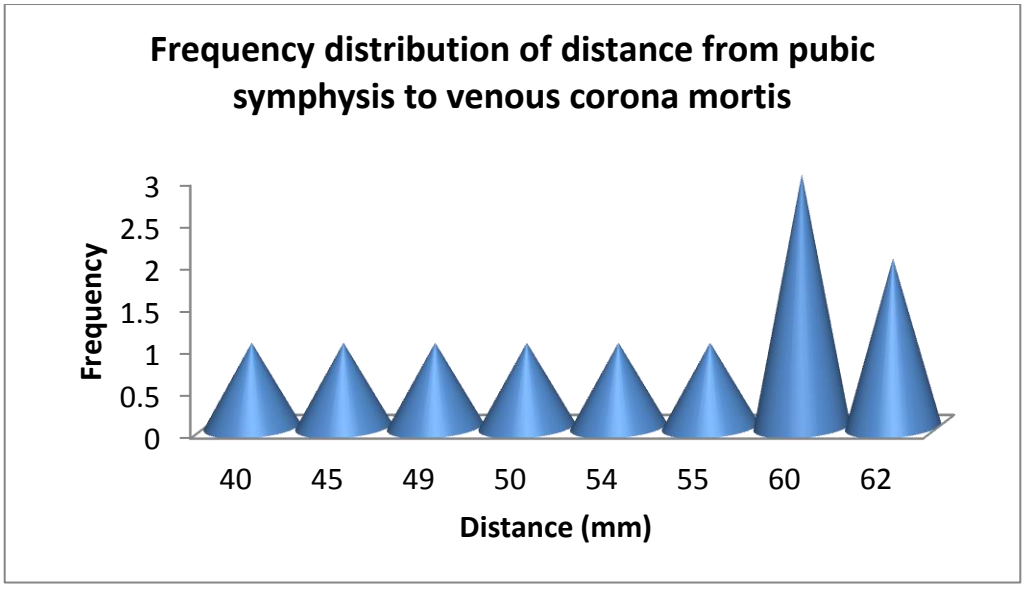


FIG. 11.0

Distance from pubic ramus to corona mortis anastomosis artery

The distance from corona mortis to point of anastomosis of the artery was varied during the study as shown in table below. 8(66.7%) had a distance of 15mm from corona mortis to point of anastomosis artery. However those with one incidence (8.3%) comprise of 10mm, 15mm, 17mm, 20mm and 30mm distance from corona mortis to point of anastomosis artery.

Distance from pubic ramus to the Arterial corona mortis anastomosis

The distance from the pubic symphysis to the arterial corona mortis was taken during the study.

		Distance from pubic ramus to the Arterial anastomosis					**Total**
		10.00	15.00	17.00	20.00	30.00	
Male	**Count**	1	3	1	1	1	**7**
	% of Total	8.3	25.0	8.3	8.3	8.3	**58.3**
Female	**Count**	0	5	0	0	0	**5**
	% of Total	0.0	41.7	0.0	0.0	0.0	**41.7**
Total	**Count**	**1**	**8**	**1**	**1**	**1**	**12**
	% of Total	**8.3**	**66.7**	**8.3**	**8.3**	**8.3**	**100.0**

TABLE 10.0

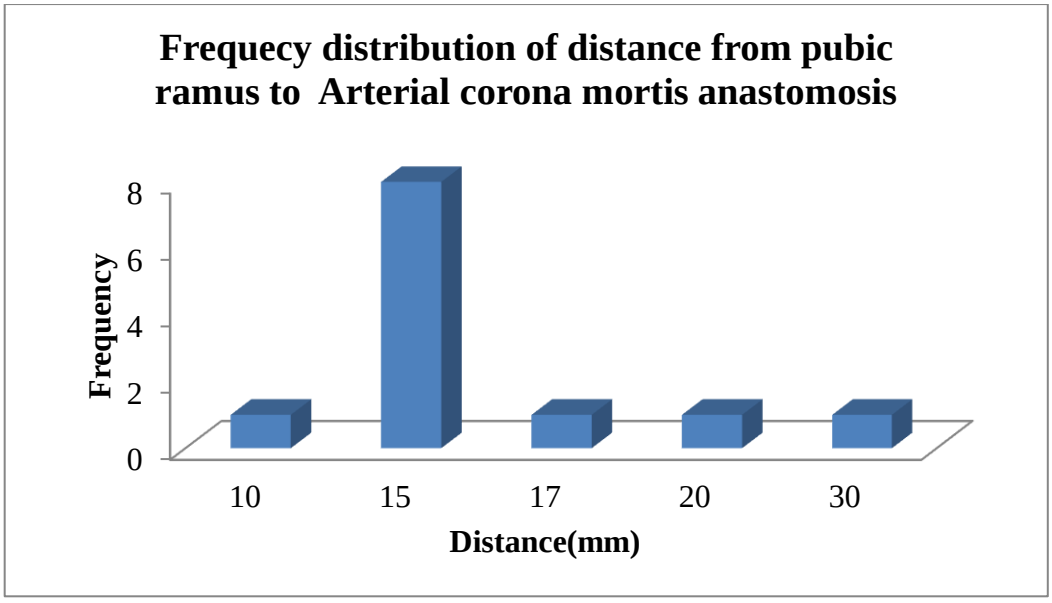


FIG 12.0

Distance from pubic ramus to the venous corona mortis anastomosis

The distance from venous corona mortis to point of anastomosis was varied during the study as shown in table below. Of those veins with anastomosis 8(72.7%) had a distance of 10 mm from corona mortis to point of anastomosis to the pubic ramus. However those with 2(18.2%) had 15mm distance from corona mortis to point of anastomosis vein and 1(9.1%) had 16mm.

Distance from pubic ramus to venous corona mortis anastomosis

		Distance from pubic ramus to venous corona mortis anastomosis			**Total**
		10.00	15.00	16.00	
Male	Count	2	2	0	**4**
	% of Total	18.2	18.2	0.0	**36.4**
Female	Count	6	0	1	**7**
	% of Total	54.5	0.0	9.1	**63.6**
Total	**Count**	**8**	**2**	**1**	**11**
	% of Total	**72.7**	**18.2**	**9.1**	**100.0**

TABLE 11.0

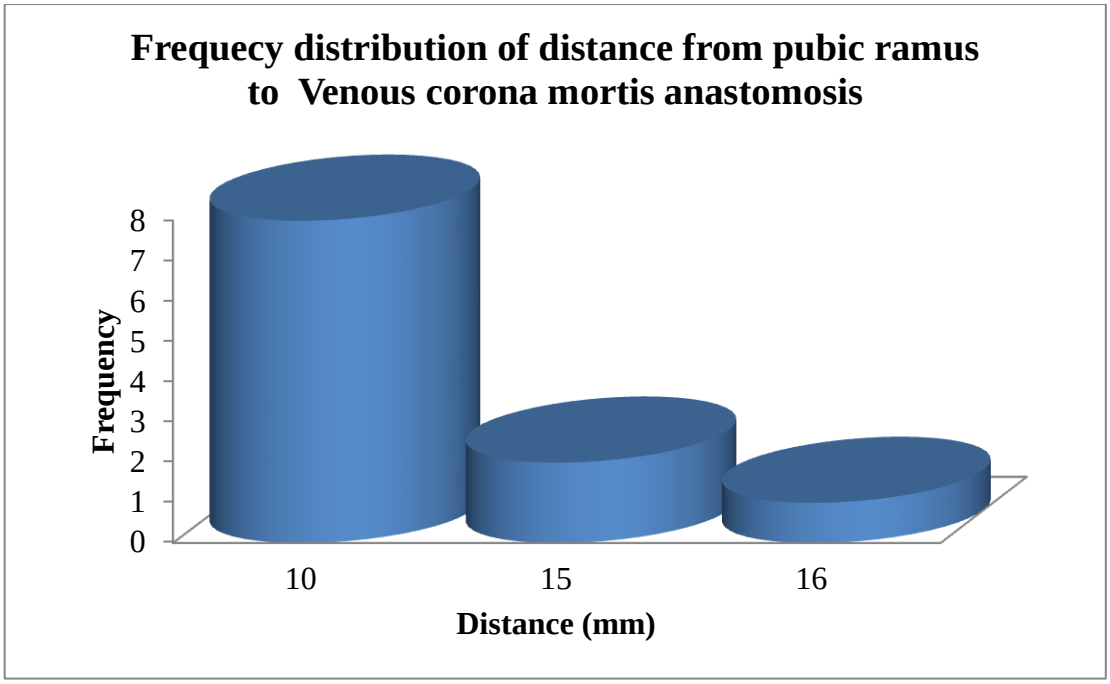

Frequecy distribution of distance from pubic ramus to Venous corona mortis anastomosis
Frequency
8
7
6
5
4
3
2
1
0
10
15
16
Distance (mm)

FIG 13.0

CHAPTER FIVE

5.0 DISCUSSION

Vascular connections between the external iliac network of vessels and obturator systems are called the corona mortis. These connections may be arterial, venous or both. With the increase in surgery of the anterior pelvic ring, many investigators have started to study the detailed anatomy of the retro-pubic vascular system [22, 23, 19]. Various other authors have noted the variations in the corona mortis, and estimated the incidence and location.

This study evaluated the incidence and location of communicating vascular channels running over the superior pubic ramus and the determination of the gender and occurrence in either the left or the right hemipelvises among black African cadavers.

The corona mortis originates from the obturator vessels and then crosses over the superior pubic ramus to anastomose with external iliac vessels. The distance from the superior pubic ramus to the communication of the corona mortis with the external iliac vessels was also measured.

The findings of the study showed that of the 40 dissected hemipelvices, the corona mortis was present in 15 (37.5%) while 25(62.5%) did not have either venous or arterial anastomosis between the obturator and the external iliac vascular systems.

Studies have reported the incidence of communicating vascular channels to be as high as 96% in a study by Berberoglu et al. [18,22,23] , 73% by Teague et al., and 84% by Tornetta et al.

Berberoglu et al. [18] reported an incidence of arterial corona mortis of 8% in 50 retroinguinal dissections, while Teague et al.[22] found one of 43% in79 cadaveric hemipelvices. To our knowledge, only one study has reported the incidence of the arterial corona mortis in males as compared to females[19].Karakurt et al. [19], in their

angiographic study, noted an arterial incidence of 29%. According to Letournel [20], the incidence was 10%–15%, but clinically, he encountered only one very large vessel out of more than 150 ilioinguinal exposures. He also noted that the type of fracture in that single clinical case probably affected the anastomoses, by lacerating the vascular connections at the time of injury[21]. Teague et al.[22], in their Clinical report, were of the same opinion.

In this study, the nature of connections was characterized which showed that 2(13.4%) were purely arterial, 5(33.3%) were purely venous while 8(53.3%) had both venous and arterial communication. A majority of the hemipelvices had both mixed and venous communication.

Berberoglu et al. [18] the incidence of venous corona mortis was 96%, of Tornetta Et al.

70%[23], of Teague et al.59%[22]. According to Berberoglu et al. the great variation of reported

Incidences may have been be due to regional differences in the development and difficulties in dissecting the collapsed vessels in cadavers

In this study, we chose to exclude vessels smaller than 2 mm in diameter in order to analyze clinically relevant size vessels.

Based on our literature search, only Karakurt et al. [19] estimated the incidence of the arterial corona mortis in males 31%and females 26%. In our study we foundthat of the cadavers with a Corona mortise, it was present in 8(53%) female specimen compared to 7(47%) in the male hemipelvices. Unlike in the current study however , Karakurt et al. [19], in their angiographic study, found a significant difference between men and women in the average distance of anastomotic arteries from the symphysis—i.e., 32 mm in men

and 36 mm in women—but it was not clear how they measured the distance on angiographic images or the way they calculated magnification on the radiographs. Tornetta et al. [23] found that the average distance of anastomotic vessels from the symphysis pubis was 62 (SD 12) mm, but they did not discuss whether they were venous or arterial... In this study, the mean distance from pubic symphysis to the mortis was 54.27mm (venous) and 53.17mm (arterial). The Independent Samples t-Test showed that there was no significant difference in mean between male and female specimens in all measurements performed.

5.1 CONCLUSION

With the increase in surgery of the anterior pelvic ring, more research has to be done to study the detailed anatomy of the retro-pubic region. Bleeding is a major complication in pelvic surgery both from an orthopaedic and a general surgery point of view. It is a complication that can however be prevented by having a detailed understanding of the pelvic anatomy in the population. The corona mortis must be ligated or clipped to advance the dissection further along the pelvic brim and quadrilateral surface during the modified stoppa approach which enables access to the anterior wall, anterior column, and associated anterior column and posterior hemitransverse fractures, as well as certain both-column, T-shaped, and transverse fractures. Understanding this anatomy should aid the surgeon in avoiding vascular complications and catastrophic haemorrhage.

Surgeons who repair with direct, indirect, femoral, or obturator hernias need to be aware of these anastomoses and their close proximity to the femoral ring.

Its high incidence suggests that when obturator arterial injury is initially suspected due to acetabular or pubic rami fractures .

The relevance of the vascular relations of the abarant anastomosis from the obturator vessels to the external iliac vessels in trauma, orthopedic, general surgical, and invasive radiology approaches is paramount to minimize patient morbidity.

5.2 RECOMMENDATIONS

1. In pelvic and acetabular Orthopaedic surgery, the corona mortis must be sought, ligated /clipped to advance the dissection further along the pelvic brim .

2. Unstable patients with pelvic brim fractures ought to be suspected as having possible corona mortis injury by virtue of its incidence and location.

3. General Surgeons who repair direct, indirect, femoral, or obturator hernias need to be aware of the local incidence and location of the corona mortis.
4. Attention needs to be paid to the corona mortis during laparoscopic procedures specifically extraperitoneal laparoscopic hernioplasty.
5. Surgeons to document their encounters with the corona mortis as it will boost our understanding of this variance in vascular anatomy and thus avoiding complications and catastrophic haemorrhage.
6. Further studies including advanced radiological imaging .

REFERENCES

1. Sarikcioglu L, Sindel M, Akyildiz F, Gur S.. Anastomotic vesselsin the retropubic region: Corona mortis. Folia Morphol (Warsz) 200362:179–182.

2. Teague DC, Graney DO, Routt ML Jr. Retropubic vascular hazards of the ilioinguinal exposure: A cadaveric and clinical study.J Orthop Trauma 199610:156–159.

3. Hong HX, Pan ZJ, Chen X, Huang ZJ.. An anatomical study of corona mortis and its clinical significance. Chin J Traumatol2004 7:165–169.

4. Marsman JW, Schilstra SH, van Leeuwen H.. Angiography and embolization of the corona mortis (aberrant obturator artery). A source of persistent pelvic bleeding. Rofo 1984141:708–710.

5. Berberoglu M, Uz A, Ozmen MM, Bozkurt MC, Erkuran C, Taner S,Tekin A, Tekdemir I.. Corona mortis: An anatomic study inseven cadavers and an endoscopic study in 28 patients. SurgEndosc2001 15:72–75.

6. Rusu MC, Cergan R, Motoc AG, Folescu R, Pop E Department of Anatomy and Embryology, Faculty of Dental Medicine, University of Medicine and Pharmacy Carol Davila, 8 Bd. Eroilor Sanitari, Bucharest, Romania. anatomon@gmail.com Surgical and Radiologic Anatomy : SRA [2010, 32(1):17-24]

7. Darmanis S, Lewis A, Mansoor A, Bircher M. Corona mortis: an anatomical study with clinical implications in approaches to the pelvis and acetabulum. Clin Anat. 2007 May; 20(4):433-9.

8. Rusu MC, Cergan R, Motoc AG, Folescu R, Pop E. Anatomical considerations on the corona mortis. *SurgRadiol Anat.* 2010 Jan;32(1):17-24.

9. Pungpapong SU, Thum-umnauysuk S. Incidence of corona mortis; preperitoneal anatomy for laparoscopic hernia repair. *Med Assoc Thai.* 2005 Sep; 88 (4): S51-3.

10. Hong HX, Pan ZJ, Chen X, Huang ZJ. An anatomical study of corona mortis and its clinical significance. *Chin J Traumatol.* 2004 Jun;7(3):165-9.

11. Okcu G, Erkan S, Yercan HS, Ozic U. The incidence and location of corona mortis: a study on 75 cadavers. *ActaOrthop Scand.* 2004 Feb;75(1):53-5.

12. Berberoglu M, Uz A, Ozmen MM, Bozkurt MC, Erkuran C, Taner S, Tekin A, Tekdemir I. Corona mortis: an anatomic study in seven cadavers and an endoscopic study in 28 patients. *SurgEndosc.* 2001 Jan; 15(1): 72- 75.

13. Tornetta P , Hochwald N, Levine R. Corona mortis. Incidence and location. *ClinOrthopRelat Res* 1996 Aug;(329):97-101.

14. Sarikcioglu L, Sindel M, Akyildiz F, Gur S. Anastomotic vessels in the retropubic region: corona mortis. . *Folia Morphol (Warsz).* 2003;62(3):179-82.

15. Kacra BK, Arazi M, Cicekcibasi AE, Buyukmumcu M, Demirci S. Modified medial stoppa approach for acetabular fractures: an anatomic study. *J Trauma* 2011 Nov;71(5): 1340-1344.

16. De Kleuver M, Kooijman MA, Kauer JM, Veth RP. Pelvic osteotomies: anatomic pitfalls at the pubic bone. A cadaver study. *Arch Orthop Trauma Surg.* 1998; 117(4-5): 270-272.

17. Moreno-Egea A, Paredes PG, Perello JM, Campillo-Soto A, Baena EG, Muñoz JR, Aguayo-Albasini JL. Vascular injury by tacks during totally extraperitoneal endoscopic inguinal hernioplasty. *Surg LaparoscEndoscPercutan Tech* 2010 Jun; 20(3): e129- 131.

18. Berberoglu M, Uz A, Ozmen M M, et al. Corona mortis:An anatomic study in seven cadavers and an endoscopic study in 28 patients. *Surg Endosc* 2001; 15 (1): 72-5.

19. Karakurt L, Karaca I, Yılmaz E, Burma O, Serin E. CoronaMortis: incidence and location. Arch Orthop Trauma Surg 2002; 122 (3): 163-4.

20. Letournel E. The treatment of acetabular fractures throughthe ilioinguinal approach. *Clin Orthop* 1993; 292: 62-76.

21. Letournel E, Judet R. Fractures of the acetabulum. 2nd ed.*Berlin-Heidelberg, Springer* 1993.

22. Teague D C, Graney D O, Routt M L C Jr. Retropubic vascular hazards of the ilioinguinal exposure: a cadaveric and clinical study. *J Orthop Trauma* 1996; 10 (3): 156-9.

23. Tornetta P III, Hochwald N, Levine R. Corona mortis: Incidenceand location. *Clin Orthop* 1996; 329: 97-101.

24. Gray's Anatomy ,39TH Edition , SECTION 7 ABDOMEN AND PELVIS, 111 Pelvic girdle, gluteal region and hip joint Page 1419-1452

25. AO foundation website, Retropubic vascular anastomoses https://www2.aofoundation.org.

APPENDICES

Appendix 1: Equipment and Instruments

1. Dissecting instruments -Forceps, blade holders and scalpels.
2. Vernier calipers
3. Digital camera.-Cannon 13mm
4. Printer.
5. Stationery.
6. Calibrated ruler.
7. Retractors

Appendix 2: Data Collection Sheet

CODE……..

1. Gender M …… F ……
2. Side R……. L……
3. Aberrant anastomosis between external iliac vessels with obturator vessels
    a. Absent …….. Present …….. (Proceed to Q3b)
    b. Nature of connection:

        Arterial ……. Venous …… Both……..
4. Distance from where corona mortis crosses the superior pubic ramus to the pubic symphysis (mm)
    a. Artery ……..mm
    b. Vein ……...mm
5. Distance from junction of corona mortis to the point of anastomosis with the External iliacnetwork vessels systems(Femoral , Inferior Epigastric ,Exrernal iliac)
    a. Artery ……mm
    b. Vein ……..mm

Appendix 3: Budget

Item	Quantity	Unit Cost(Kshs)	Amount(Kshs)
Dissection kit	1	2800	2,800
Printer	1	10000	10,000
Calibrated grid	1	1000	1,000
Digital camera	1	40000	40,000
Plain paper rim	5	410	410
Cartridge 49A	1	6000	6,000
Retractors	5	4000	20000
Total			80, 210

TABLE 12.0

Appendix 4: Pictures

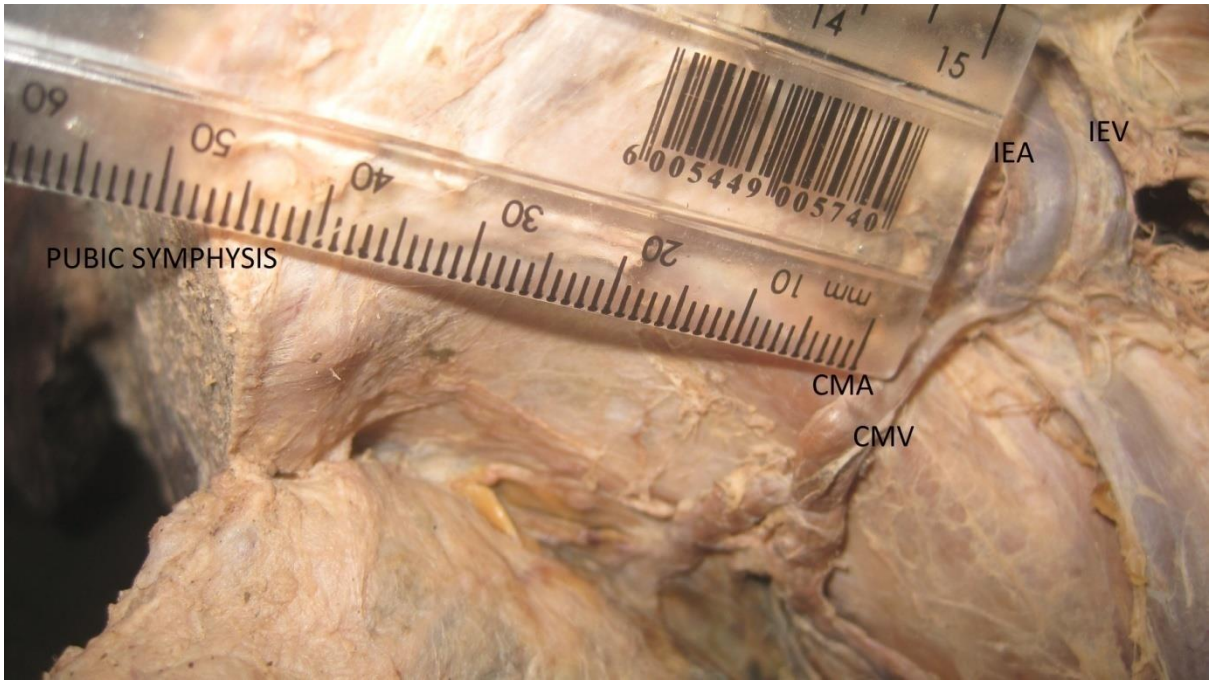


FIG. 14.0

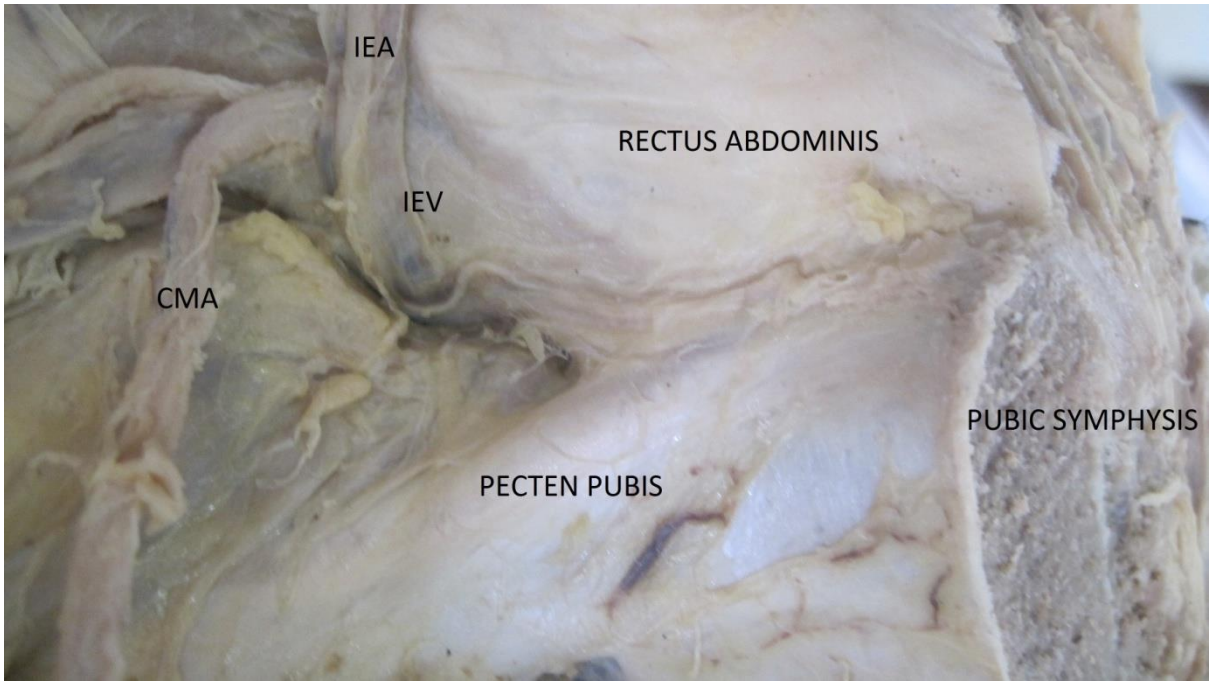
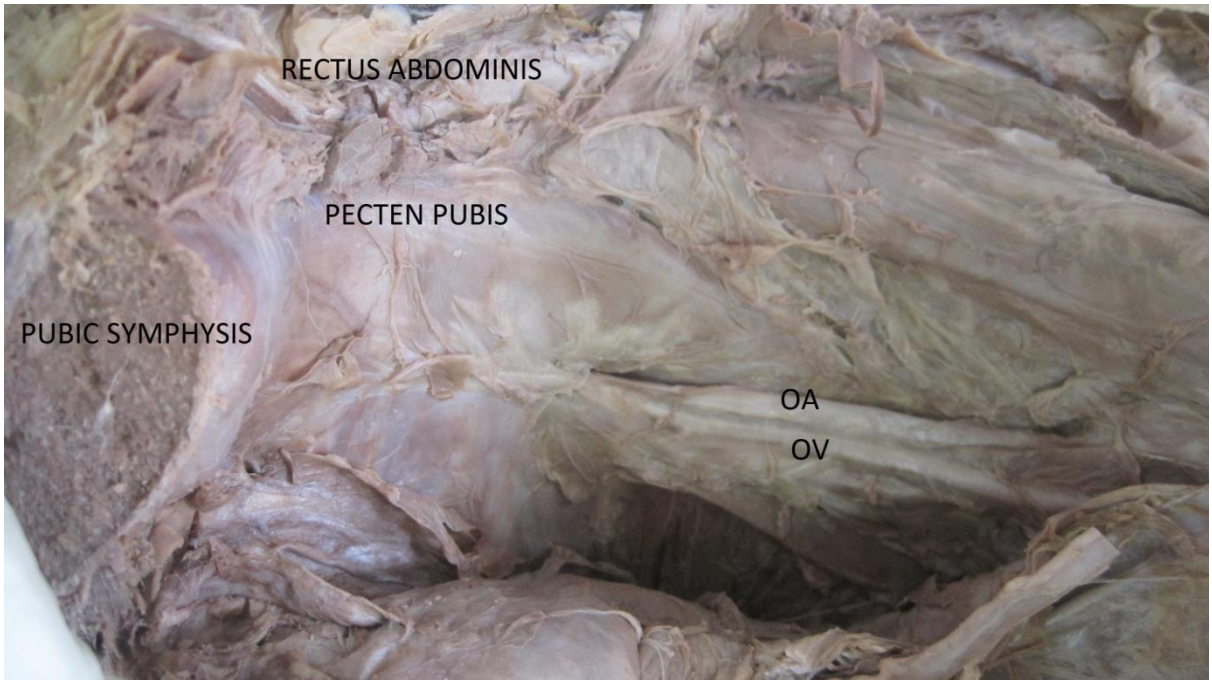


FIG. 15.0



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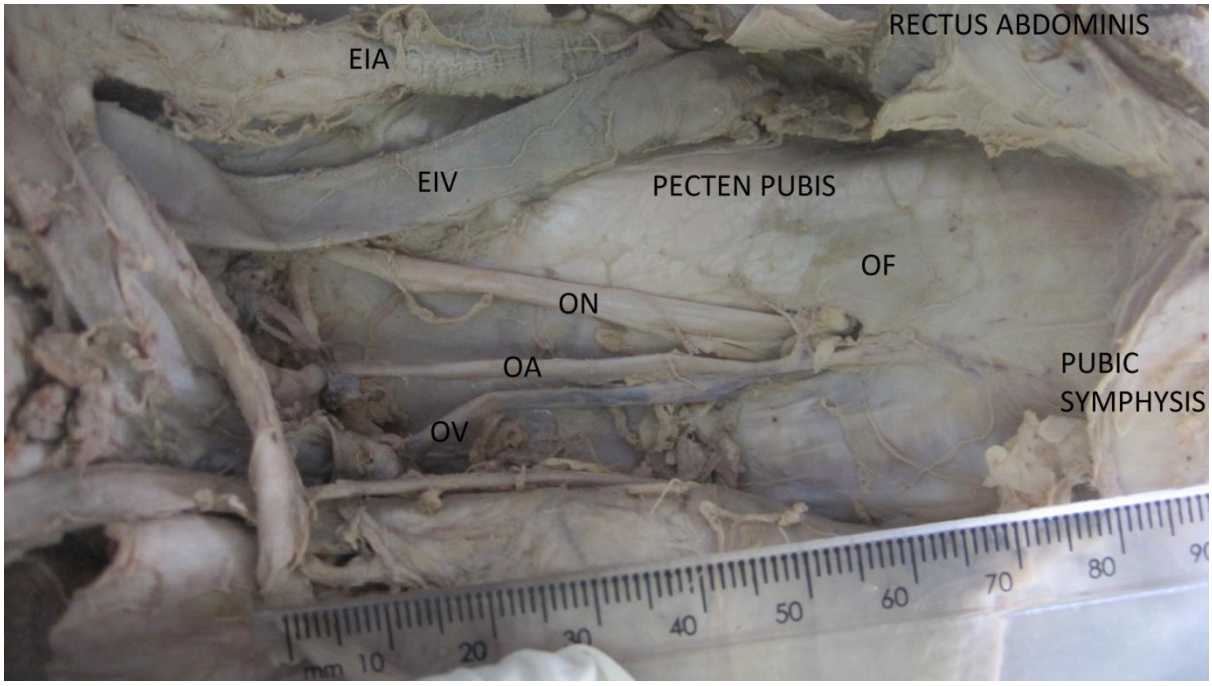

FIG 17.0

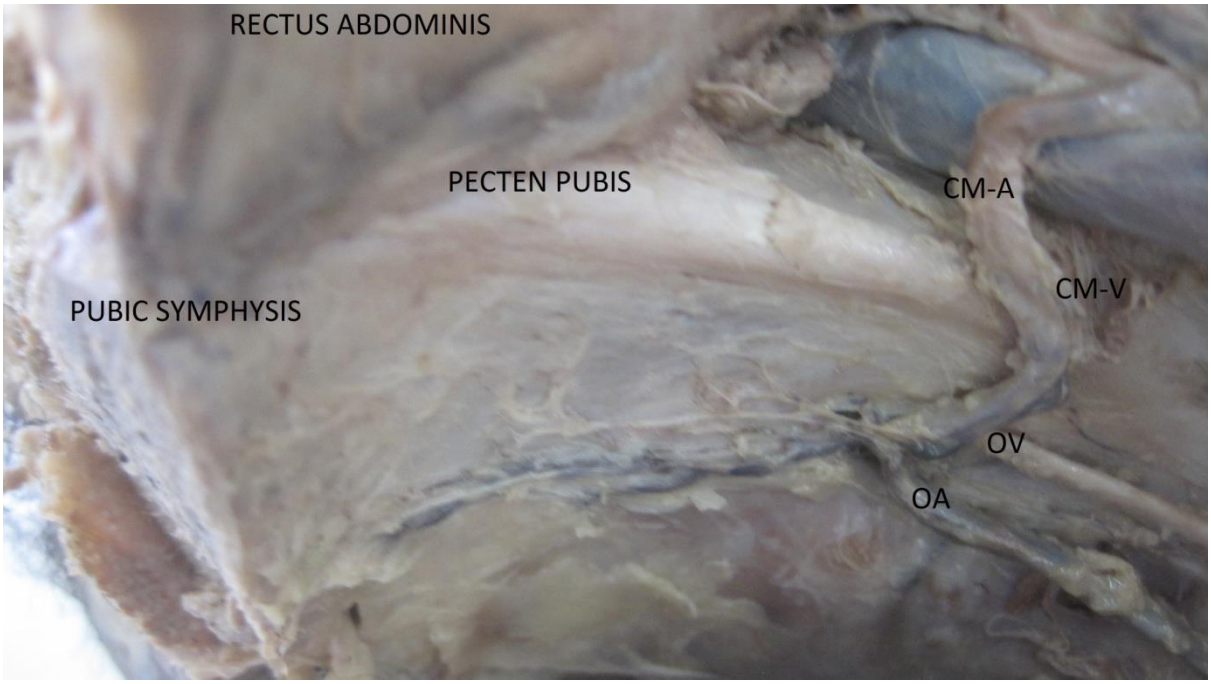

FIG. 18.0

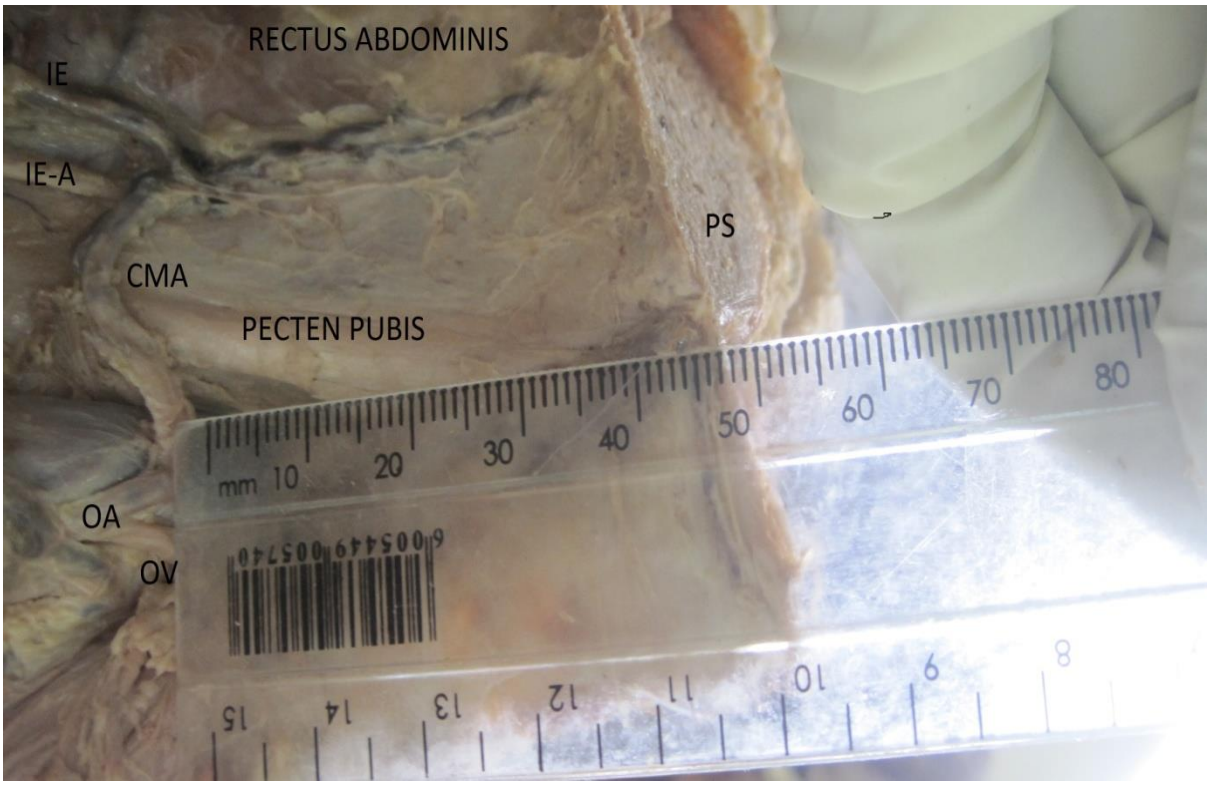

FIG 19.0

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

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

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET
Tel: 33471/2/3

Reference: IREC/2012/40
Approval Number: 000904

28th September, 2012

Dr. Victor K. Bargoria & Team,
Moi University,
School of Medicine,
P.O. Box 4606-30100,
ELDORET-KENYA.

Dear Dr. Bargoria,

RE: FORMAL APPROVAL

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

"Variant anatomy of Corona Mortis in Black Africans: A Cadaveric Study at Moi Teaching and Referral Hospital and Moi University Anatomy Lab."

Your proposal has been granted a Formal Approval Number: **FAN: IREC 000904** on 10th October, 2012. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 9th October, 2013. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

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

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
APPROVED
28 SEP 2012
P.O. Box 4606 ELDORET

Yours Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

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MOI UNIVERSITY
COLLEGE OF HEALTH SCIENCES
SCHOOL OF MEDICINE
Department of Human Anatomy

MU/SOM/HA/37

Dr. Victor K. Bargoria
Moi University
School of Medicine
P.O. Box 4606-30100
ELDORET, Kenya

Dear Dr. Bargoria,

RE: CONSENT TO CARRY OUT RESEARCH IN HUMAN ANATOMY DEPARTMENT

Following the IREC approval dated 28th September, 2012, the Department authorises you to conduct your research using the hemipelvises.

You will use intact available hemipelvices in the anatomy Department. While conducting your research you will be expected to adhere to the requirement of the anatomy act.

DR. M. K. NDIEMA
HEAD, DEPT. OF HUMAN ANATOMY