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Ph.D. synopsis of the thesis on
"A CADAVERIC STUDY OF MORPHOLOGY OF INTERNAL ILIAC
ARTERY & VARIATION IN ITS BRANCHING PATTERN WITH ITS
CLINICAL SIGNIFICANCE"

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For the degree of
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Submitted by:
DR. RASHMI BHARDWAJ

Under the guidance of
DR. VASANT H. VANIYA
Professor & Head
Department Of Anatomy
Medical College, Baroda

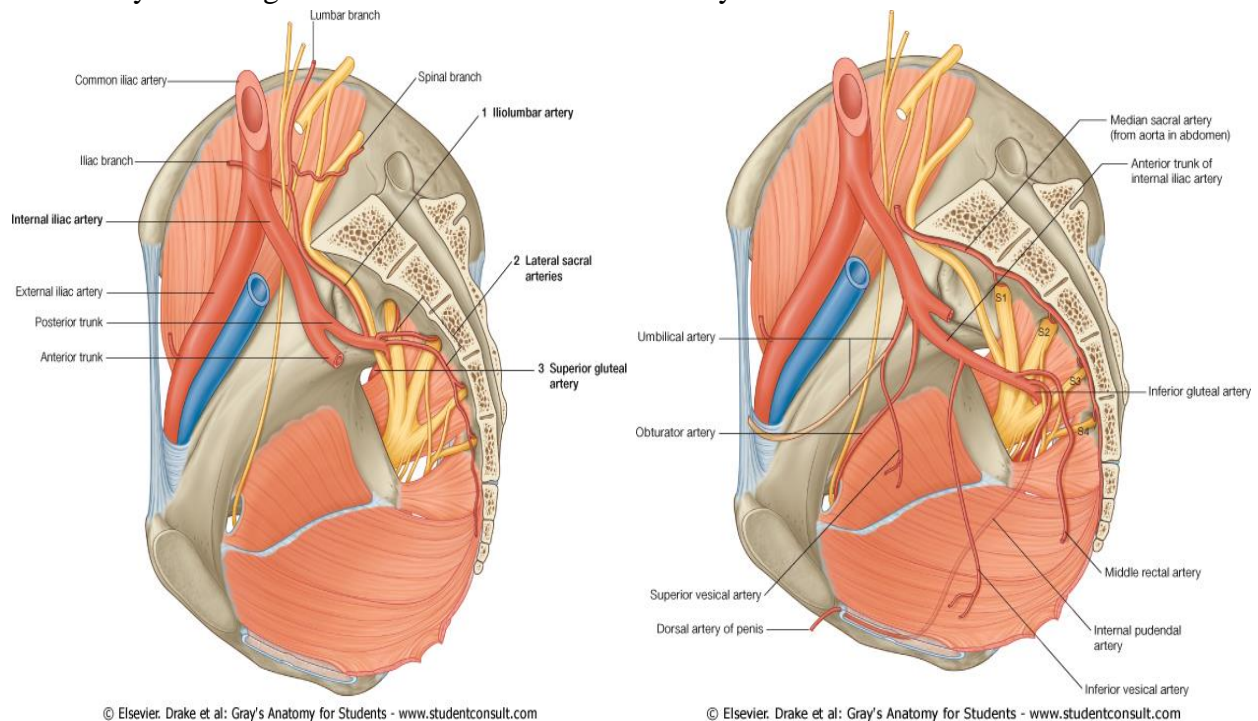


At Department of Anatomy
Medical College, Baroda
Faculty of Medicine
The Maharaja Sayajirao University of Baroda.

TITLE OF THE STUDY: “A CADAVERIC STUDY OF MORPHOLOGY OF INTERNAL ILIAC ARTERY & VARIATION IN ITS BRANCHING PATTERN WITH ITS CLINICAL SIGNIFICANCE”

INTRODUCTION: -

The internal iliac artery (also known as hypogastric artery) is the “artery of the pelvis”. It supplies most of the blood to the pelvic viscera, gluteal region, medial thigh region and perineum. A severe and potentially lethal complication in pelvic surgeries is arterial bleeding commonly involving the branches of internal iliac artery.



At the upper margin of greater sciatic notch it divides into two trunks anterior and posterior trunks

A.) Branches of the anterior trunk are:

- 1) Superior vesical artery for the supply of urinary bladder. Its distal part forms the medial umbilical ligament after birth.
- 2) Obturator artery for the supply of muscles of medial compartment of thigh.
- 3) Inferior vesical is present only in male. It supplies urinary bladder, prostate and seminal vesicles.
- 4) Vaginal artery replaces inferior vesical of male. It supplies vagina and rectum.
- 5) Uterine artery is present only in female. It is large and tortuous and runs along the lateral border of uterus to supply uterus and medial two-thirds of fallopian tube.
- 6) Middle rectal artery only supplies the muscle coat of the rectum.
- 7) Internal pudendal artery supplies the muscles of the perineum.

- 8) Inferior gluteal artery leaves the pelvis through greater sciatic notch and supplies the gluteus maximus muscle.

B.) Branches of posterior trunk are:

- 1) Iliolumbar artery supplies muscles, e.g. iliacus, psoas major and quadratus lumborum.
 - 2) Lateral sacral arteries are two in number. Each divides into two branches. These enter the sacral canal through ventral sacral foramina.
 - 3) Superior gluteal artery is the largest branch of internal iliac artery. It leaves the pelvis through greater sciatic foramen to supply the gluteal muscles.
- In 1825, Herbert stated that the internal iliac artery (IIA) is a branch of the common iliac artery (CIA). The internal iliac artery is the main artery of the pelvis but is shorter, thicker and smaller than the external iliac artery. During embryological development the IIA appears as a continuation of CIA before EIA development and is twice large: its length varies from one to two inches.
- It arises at the bifurcation of the common iliac artery anterior to the lumbosacral junction (L5/S1) and descends along the convexity over the anterior (ventral) surface of the sacrum to the superior border of the greater sciatic foramen.
- Generally, the internal iliac artery supplies the pelvis including the walls and viscera, as well as the perineum, hip, gluteal region and medial (adductor) compartment of the thigh.
- Previously, **Herbert (1825)** in an older description of the IIA divisions did not refer to anterior and posterior trunks, rather he described the trunk as having numerous branches classified into the internal surface of the pelvis, pelvic viscera and extra pelvic branches based on their terminal course.
- The first classified branches to the internal surface of pelvis are the iliolumbar artery and lateral sacral artery. The second classified branches to pelvic viscera are hypogastric artery or umbilical, vesical and middle rectal arteries. The third classified branches are the gluteal artery, sciatic artery, internal pudendal and obturator arteries.
- Then, **Power (1862)** gave a different classification, which were internal and external arteries based on whether they remain inside or were distributed outside the pelvis, respectively. The first class has a different classification in males to females. In males, the internal arteries are iliolumbar, lateral sacral, middle rectal, vesical and umbilical arteries. In females, this class has same division except it has additional branches which are vaginal and uterine arteries. The second class is external arteries are gluteal, pudendal (pudic), sciatic and obturator artery.
- A different approach was adopted by **Jastschinski (1891)** into three groups based on size of artery. The first group of large calibre arteries are the superior gluteal, inferior gluteal and internal pudendal arteries; the second group of medium caliber arteries is the obturator artery; the third group of small calibre arteries are iliolumbar and lateral sacral arteries.

- More recent authors have classified the internal iliac artery branches into visceral branches supplying the urinary bladder, prostate, seminal vesicles, ejaculatory ducts and rectum in males, and the urinary bladder, ovaries, uterus, vagina, urethra and rectum in females (Testut 1948; Williams 1995). In addition, previous studies have also classified the internal iliac artery branches supplying the gluteal region, posterior and medial compartment of thigh and hip joint (Fredet 1899; Rouviere 1967) into the extra pelvic branches of the internal iliac artery.
- Limitations of previous classifications: These classifications have not been used to any great extent because of deficiencies in their descriptions; for example, some of arteries supply both intra and extra pelvic structures. The size of the artery varies from one cadaver to another.
- A relatively simple classification of the Internal iliac artery has been described as dividing into two trunks, anterior and posterior trunks (Carter 1867; Sharpey et al 1867; Wilson 1868)
- **Adachi (1928)** was the first to classify the variation of internal iliac artery into 5 types :

Type I: The superior gluteal artery arose independently from the internal iliac artery whereas the inferior gluteal and internal pudendal vessels arose from a common trunk into two forms above and below the pelvic floor which are Type Ia and Type Ib. respectively.

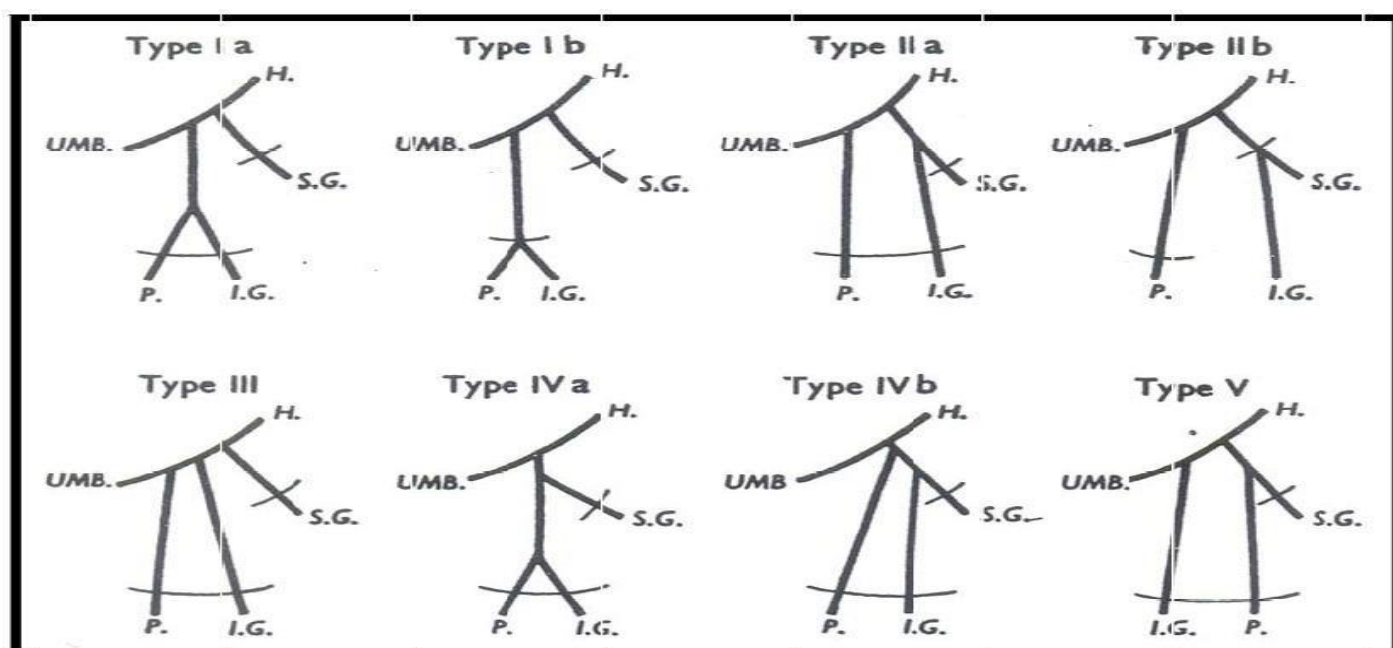
Type II: The superior and inferior gluteal arteries arose from a common trunk whereas the internal pudendal artery arose independently. The gluteal common trunk divide into two forms above and below pelvic floor which are Type IIa and Type IIb respectively.

Type III: The superior and inferior gluteal arteries and the internal pudendal artery arose from the internal iliac artery independently

Type IV: The superior and inferior gluteal arteries and the internal pudendal artery arose from a common trunk of the internal iliac artery.

Type V: The internal iliac artery trunk gives the internal pudendal and superior gluteal arteries from a common trunk whereas the inferior gluteal has a separate origin.

Fig. 1: Adachi's types H- internal iliac artery; I.G- Inferior gluteal artery; P- Internal pudendal artery; S.G- Superior gluteal artery; UMB - Umbilical artery



- **Ashley and Anson (1941)** have updated this classification by adding the umbilical artery to the three previous arteries used in the Adachi's classification, which in turn was a modification of Lipshutz (1916) classification excluding the obturator artery.
- **Yamaki et al (1998)** classification is a modification of the Adachi's classification, he reported that the artery divided into a common trunk with the superior gluteal artery instead of the genitourinary branches (80%).
- However, based on a radiological review of 197 cases **Pelage et al (1999)** established a classification of the internal iliac artery reporting that it terminated as two main trunks (anterior and posterior) in 77% of cases and into three main trunks in 14% of cases including posterior branches a common trunk of the internal pudendal and inferior gluteal artery and genitourinary branches. In addition, Pelage also stated that in 3% of cases the internal iliac artery has four or more terminal divisions, in 4% of cases the internal iliac artery remains as a single main trunk, while in 2% of cases the internal iliac artery had no systematic termination.
- **Bilhim et al (2011)** using angio Magnetic Resonance and digital angiography, angiocomputed topography in 42 specimens.

2. AIMS & OBJECTIVES:-

Primary objectives of the present work are:

- To locate the site of origin of Internal Iliac Artery.
- To describe morphological features like length, diameter, course, termination of Internal Iliac Artery.
- To find Branching pattern of Internal Iliac Artery.
- To find out anatomical variations in origin of individual branches of Internal Iliac Artery like Obturator artery, Superior Vesical Artery, Iliolumbar Artery.
- To compare data with other studies.

3. RESEARCH METHODOLOGY:-

3.1. DATA COLLECTION PROCEDURE:

This was an observational study carried out after obtaining approval from ethics committee Medical College Baroda, Gujarat. Twenty Five properly embalmed and formalin fixed adult cadavers (11 males and 14 females) were selected for the study. All the available specimens, did not have any visible external abnormalities in their pelvic region were included. Any cadavers with previously operated in pelvic region which may prevent the morphometric analysis were excluded from the study. Dissection was done under the guidance and supervision and observations were made after dissecting the cadavers.

3.2.DATA COLLECTION METHODOLOGY:-

- A horizontal incision through the abdomen at the fourth lumbar vertebral level is taken. The whole pelvic is dissected to expose the common iliac arteries. After evisceration the Common Iliac artery (CIA) is traced to find the external iliac artery (EIA) extending in line with CIA towards the inguinal ligament and internal iliac artery directed towards the pelvic cavity.
- Then, the peritoneum is removed from the bladder, uterus (in female), rectum and the lateral pelvic wall from each side of the pelvis.
- The vertebral level of bifurcation of CIA into EIA and IIA is noted, as the level of origin of the IIA & its distance from the mid -sagittal plane of the pelvis was recorded.
- Careful dissection was done to trace the IIA to its point of terminal branching into its anterior and posterior divisions.
- The length of the artery was measured from the point of origin at the bifurcation of the common iliac artery to its terminal branching point & external diameter of the artery was measured at the middle point between the origin and termination.
- The level of its termination into anterior and posterior division was identified and noted. The occasional branches that are arising from the common trunk were dissected.
- The individual branches (parietal, visceral) arising from the anterior and posterior divisions were dissected upto their terminations inside the pelvis. A pattern of variation that have occurred at the level of origin and division of the main trunk, anomalous branches that have arisen from both anterior and posterior divisions, any absence of definitive branches from the anterior and posterior division was noted.

3.3 DATA ANALYSIS: -

- The data was measured by using digital vernier caliper in millimeters (mm) & relevant photographs of the dissected specimen were taken using a 16-megapixel digital camera.
- Data entry will be done and analysed in Microsoft Excel.

3.4 EXPECTED OUTCOME:-

- Morphological variation of the internal iliac artery

4. RESULTS:

Total Fifty adult human pelvic halves were dissected (Right 25, Left 25) with known gender. All measurements, Branching Pattern, Origin of Various branches were taken & observed respectively in the Department of Anatomy, medical college, Baroda. Data was measured by using digital vernier caliper. Recorded observation & Data were enlisted below in detail in tables.

4.1 Results on Vertebral Level of origin of internal iliac artery.

The artery take origin from different vertebral levels varying from between L4& L5 to S1 (Table 1). Notably, the most common vertebral level of origin was at the L5/S1 intervertebral disk level (23/50).

<u>Vertebral level</u>	Male				Female				Total	
	Right		Left		Right		Left			
	No.	%	No.	%	No.	%	No.	%	No.	%
B/W L4 & L5	04	8%	02	4%	-	-	-	-	06	12%
L5	02	4%	01	2%	02	4%	02	4%	07	14%
B/W L5 & S1	04	8%	06	12%	07	14%	06	12%	23	46%
S1	01	2%	02	4%	05	10%	06	12%	14	28%
Total	11	22%	11	22%	14	28%	14	28%	50	100%

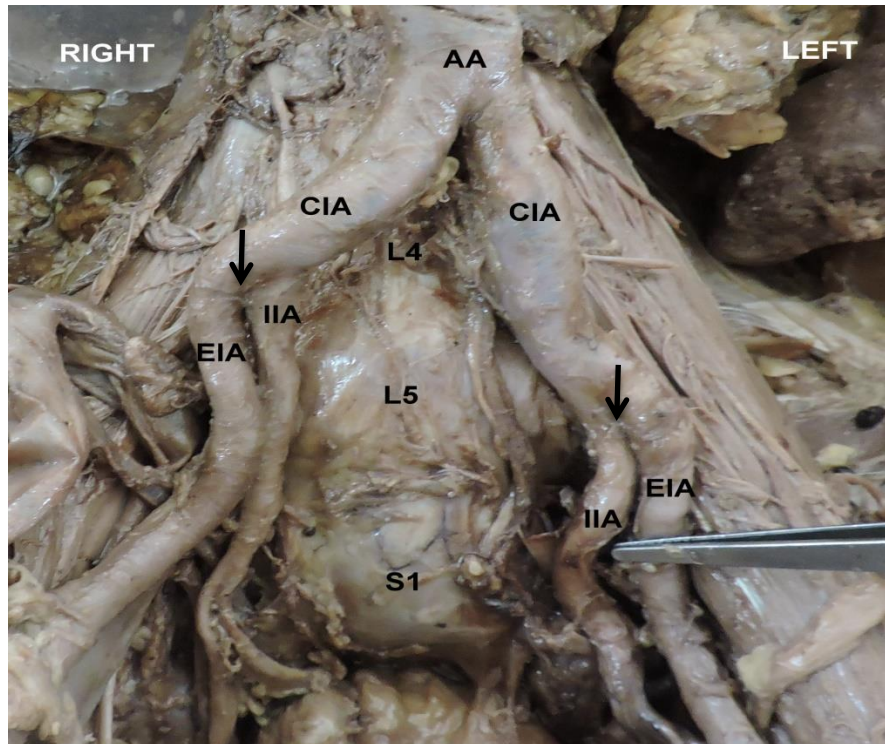


Figure 2: Male cadaver showing different vertebral level of origin of internal iliac artery. AA: Abdominal Aorta; CIA: Common iliac artery; EIA: External iliac artery; IIA: internal iliac artery.

4.2 Results on Distance of origin of the internal iliac artery to the midsagittal plane

The average distance of the IIA from the mid-sagittal plane of the pelvis was 33.39.

	Mean (mm)	Minimum (mm)	Maximum (mm)
Right	32.27	23.65	41.86
Left	34.57	28.12	43.26
Male	32.84	23.65	43.26
Female	33.88	28.37	42.67



Figure 3: Distance of the right internal iliac artery to the midsagittal plane; CIA: Common iliac artery; EIA: External iliac artery; IIA: internal iliac artery.

4.3 Results on Length of internal iliac artery

The length of the internal iliac artery varies considerably. The length of IIA ranged from the minimum measure of 20.24 mm (Figure 4) to the maximum of 66.37 mm. However, in majority of specimens (44%) the length of IIA ranged from 30 to 40 mm. The mean length was found to be 38.16 mm.

<u>Length of IIA (mm)</u>	<u>No. of Specimen</u>	<u>Percentage</u>
20 -30	13	26%
30-40	22	44%
40-50	09	18%
50-60	04	8%
60-70	02	4%
Total	50	100%

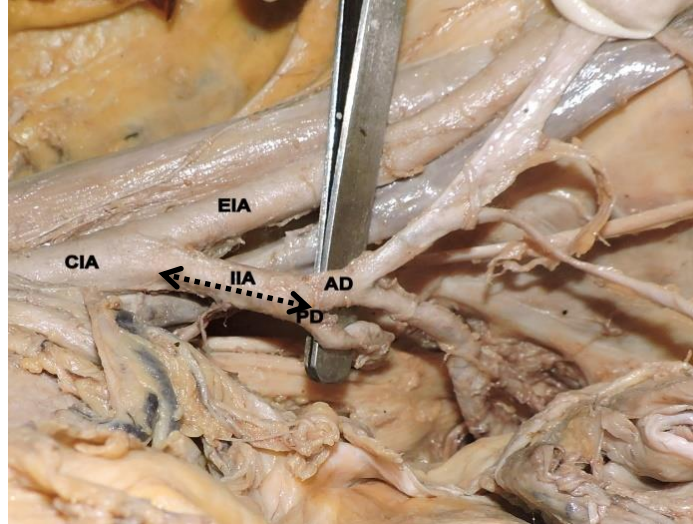


Figure 4: Length of the left internal iliac artery; CIA: Common iliac artery; EIA: External iliac artery; IIA: internal iliac artery; AD: Anterior Division; PD: Posterior Division.

4.4 Results on Diameter of internal iliac artery

The external diameter of internal iliac artery in males range from 3.63mm to 8.45mm & in females it varies from 4.15mm to 8.27mm

The mean diameter of 6.83 mm is observed in this study.



Figure 5: External Diameter of the left internal iliac artery.

4.5 Results on Distance from upper border of Greater Sciatic Foramen (GSF)

<u>Distance from Greater Sciatic Foramen (GSF)</u>	<u>No. of Specimen</u>	<u>Percentage</u>
2.5cm above GSF	04	8%
2 cm above GSF	06	12%
1.5cm above GSF	07	14%
1cm above GSF	11	22%
0.5cm above GSF	08	16%
At upper border of GSF	12	24%
0.5cm below GSF	01	2%
1 cm below GSF	01	2%
Total	50	100%

4.6 Results on Type of branching pattern of internal iliac artery According to Adachi Classification

Our study revealed the predominance of type Ia pattern of internal iliac artery followed by type III and then Type IIa

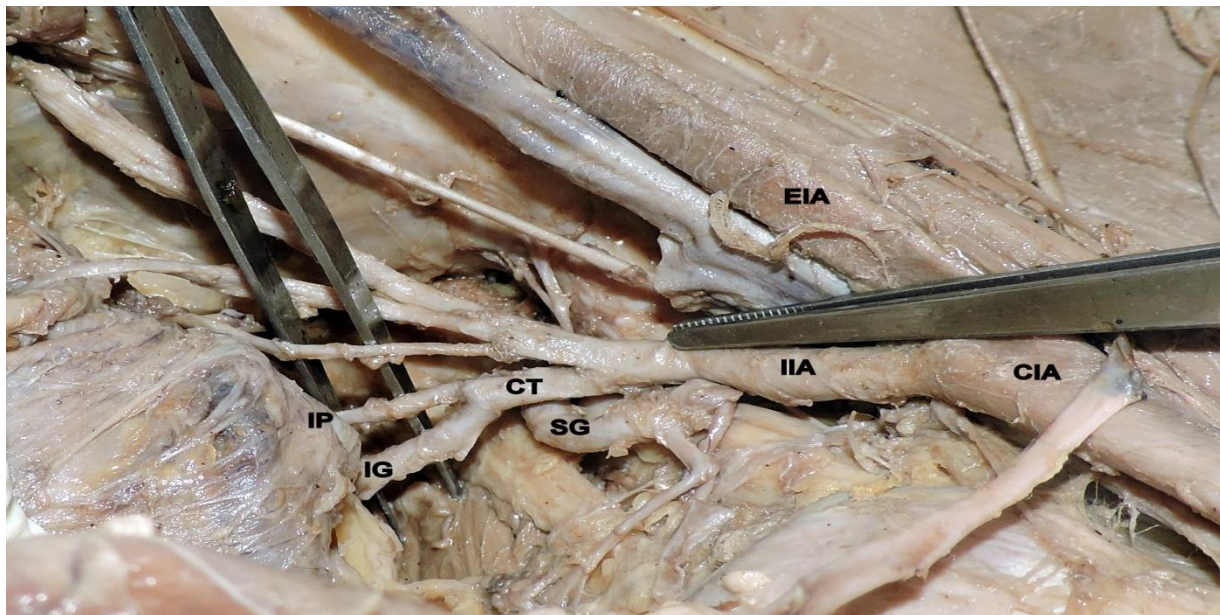


Figure 6: Right pelvic half shows type Ia Adachi's classification—superior gluteal artery arises separately from internal iliac artery and a common trunk (CT) for inferior gluteal artery and internal pudendal artery divides proximal to the pelvic floor. IIA: internal iliac artery; IG: inferior gluteal artery; SG: superior gluteal artery; IP: internal pudendal artery.

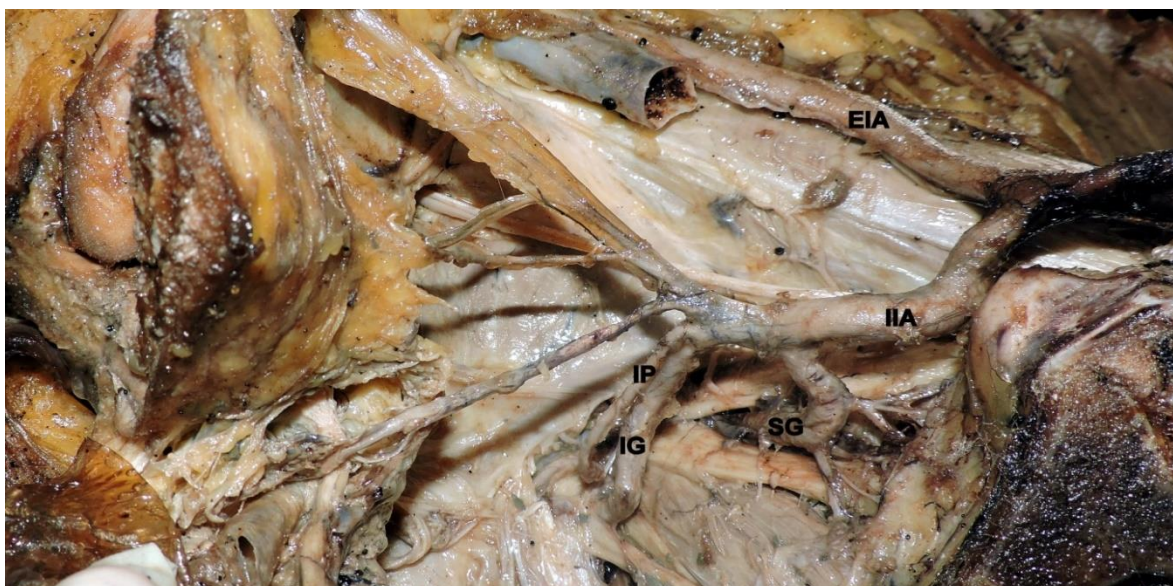


Figure 7: Right pelvic half shows type III Adachi's classification - the three branches, namely, inferior gluteal, superior gluteal, and internal pudendal artery, arise separately from the internal iliac artery. CIA: common iliac artery; IIA: internal iliac artery; EIA: external Iliac artery; IG: inferior gluteal artery; SG: superior gluteal artery; IP: internal pudendal artery

4.7 Results on Origin of Obturator artery

<u>SNo.</u>	<u>Origin Of Obturator Artery</u>	<u>No. of Specimen</u>	<u>Percentage</u>
1.	Direct from Anterior division of the internal iliac artery	19	38%
2.	Direct from Posterior division of the internal iliac artery	08	16%
3.	Superior Gluteal Artery	03	6%
4.	Iliolumbar Artery	02	4%
5.	Inferior Epigastric Artery	13	26%
6.	Direct from External iliac artery	05	10%
	Total	50	100%

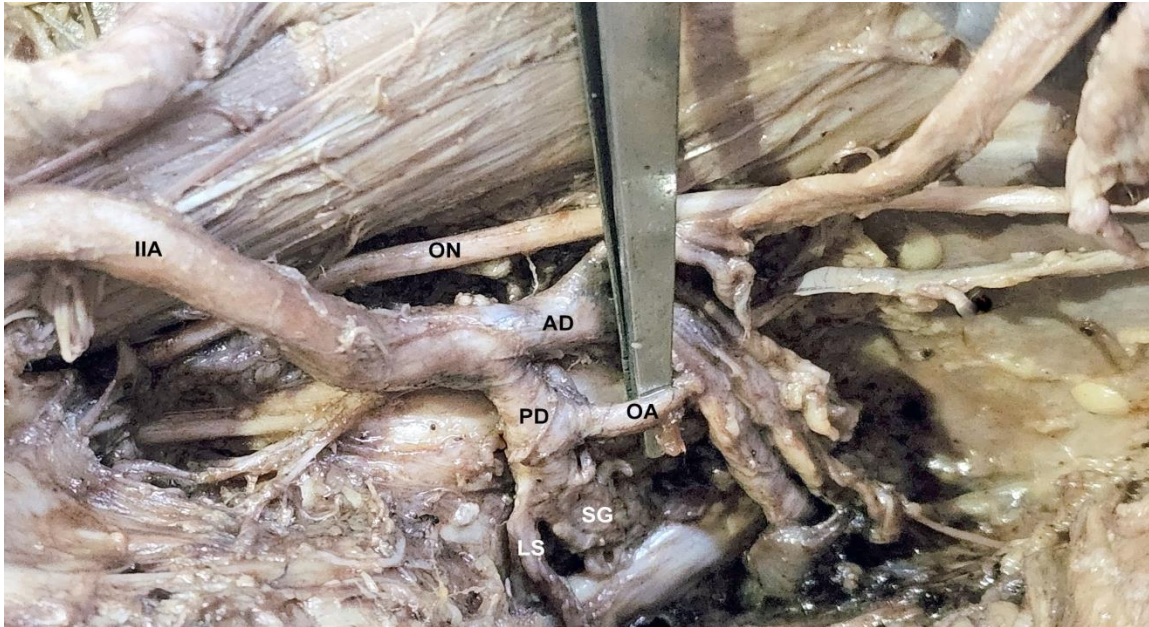


Figure 8: Left pelvic half shows origin of Obturator artery direct from Posterior division of the internal iliac artery IIA: internal iliac artery; AD: Anterior Division; PD: Posterior Division; OA: Obturator artery; SG: Superior gluteal artery; LS: Lateral sacral artery; ON: Obturator nerve

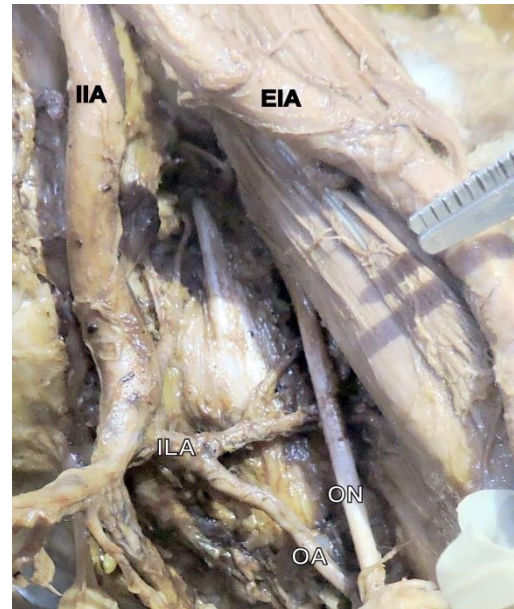
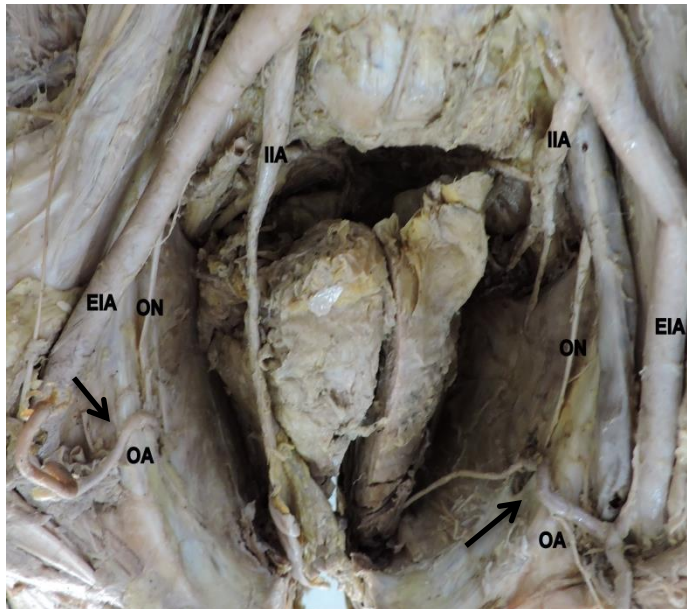


Figure 9 &10: Both sides show origin of Obturator artery from Inferior Epigastric Artery from EIA. Left pelvic half shows origin of Obturator artery from Iliolumbar artery respectively; IIA: internal iliac artery; EIA: external Iliac artery OA: Obturator artery; ILA: Iliolumbar artery ; ON: Obturator nerve

CONCLUSION

- Knowledge of internal iliac artery and its branching pattern is not only important for the anatomists but also for surgeons, obstetricians and gynaecologists, urologists, vascular surgeons, orthopedics and radiologists.
- Bilateral internal iliac artery ligation is an effective lifesaving method to control obstetrical and gynaecological haemorrhage and avoids a hysterectomy. While operating on pelvic organs, eg: in haemorrhoidectomy, rectal malignancies, the knowledge of internal iliac artery, its branching pattern and its variations is important for surgeons.
- Intractable haemorrhage during transurethral resection of prostate surgeries can be controlled by ligation of internal iliac artery, where no definitive bleeding point is detectable.
- Angiographically directed arterial embolization is very effective in controlling the haemorrhage and now widely practiced because it is a minimally invasive technique.
- The intentional ligation of internal iliac artery is also done in the treatment of endovascular repair of aortoiliac aneurysms.
- The iliac crest flap pedicled on the ilio-lumbar artery, a branch of posterior division of internal iliac artery, is being used as a reliable bone flap.
- Surgeons dealing with laparoscopic herniorrhaphy must also be conscious of unexpected sources of haemorrhage, such as from an aberrant obturator artery that crosses the superior pubic ramus while dealing with direct, indirect inguinal, femoral or obturator hernias and take appropriate precautions to avoid injury during dissection of the Bogros space and mesh stapling onto Cooper's ligament.
- Vascular variations have always been a subject of controversy as well as curiosity, because of their clinical significance
- Prior knowledge of the anatomical variations is beneficial for the vascular surgeons ligating the internal iliac artery or its branches and the radiologists interpreting angiograms of the pelvic region

UNIQUENESS OF PRESENT STUDY:-

- The internal iliac artery of the pelvic region is known to show frequent variations starting from its origin upto the termination and any addition or absence in the pattern of branches which has attracted attention of Anatomists, Radiologists & Pelvic surgeons.
- In this study not only the variation in Origin, Length, Diameter, Branching pattern of Internal Iliac Artery are recorded but also levels of origin of important individual branches of Internal Iliac Artery like Obturator artery, Iliolumbar, Uterine Artery are taken.
- Isolation of internal iliac artery and tracing of the major branches will be done to know more about it than already documented and thereby hoping to add more information to guide the radiologists and operating surgeons.

- The findings that will be discovered in the present study regarding the internal iliac artery will contribute to a better understanding and will prove definitely useful to clinicians in their respective fields

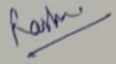
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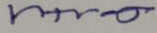
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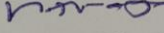
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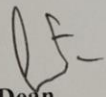

SIGNATURE OF CANDIDATE


Ph.D. Guide
Department of Anatomy
Medical College Baroda

PROFESSOR & HEAD
DEPARTMENT OF ANATOMY
MEDICAL COLLEGE BARODA


Professor & Head
Department of Anatomy
Medical College Baroda

PROFESSOR & HEAD
DEPARTMENT OF ANATOMY
MEDICAL COLLEGE BARODA


Dean
Faculty of Medicine
Medical College Baroda

DEAN
FACULTY OF MEDICINE
THE M.S. UNIVERSITY OF BARODA