

## Study of Branching Pattern of Pelvic Artery

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### Abstract

Vascular variations have always been a subject of controversy as well as curiosity, because of their clinical significance. Pelvic arteries are the arteries supplying the lesser pelvis i.e. walls of pelvis and pelvic organs. The major neurovascular structures of pelvis lie extraperitoneally against the posterolateral walls. The nerves lie most external or superficial (adjacent to the walls), with the vascular structures internal or deep (medial) to them. Generally, the veins are external (lateral) to the arteries. So study of pelvic artery i.e. internal iliac artery was done. Cadavers of both the sexes were dissected. Pelvic artery or internal iliac artery showed variable branching pattern like, obturator artery taking origin from posterior division of internal iliac artery or arising from external iliac artery, inferior vesical artery arising from obturator artery, middle rectal artery originating from other branches of internal iliac artery, common stem was found for internal pudendal and inferior gluteal arteries, even variable pattern of branches of posterior division of internal iliac artery were observed. All the variations were photographed, tabulated and discussed.

**Keywords:** Internal Iliac Artery; Branches of Anterior Division; Branches of Posterior Division; Variations.

### Introduction

The pelvic walls and viscera are supplied by branches of the internal iliac artery. The major neurovascular structures of pelvis lie extraperitoneally against the posterolateral walls. The nerves lie most external or superficial (adjacent to the walls), with the vascular structures internal or deep (medial) to them. Generally, the veins are external (lateral) to the arteries [1].

The abdominal aorta bifurcates into the right and left common iliac arteries 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 peritoneum and the gluteal region.

Each internal iliac artery, approximately 4 cm long, begins at the common iliac bifurcation. It descends posteriorly to the superior margin of 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.

In the adult it is the smaller of the two branches of the common iliac artery, though it is larger in the foetus when it transmits blood to the placenta through the umbilical artery. At birth the umbilical arteries are tied, and rapidly degenerate into fibrous cords to the level of the last persistent branch, the superior vesical artery. The internal iliac artery, formerly known as hypo gastric artery is the main artery of the walls and contents of the pelvis. The arrangement of its visceral branches is very variable [2]

### *Branches of the Anterior Division of Internal Iliac Artery*

1. *Superior Vesical Artery:* it is the first large branch of anterior trunk. It lies just below the pelvic brim and supplies the distal end of ureter, the bladder, the proximal end of vas deference and the seminal

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Received | 18.12.2017, Accepted | 17.01.2018

vesicles. From the proximal patent part of the umbilical artery arises the superior vesical artery, which supplies the upper portion of the bladder.

2. *Inferior vesical artery*: It supplies the bladder, the prostate, the seminal vesicles and the vas deference. In females it is often replaced by vaginal artery.
3. *Obturator artery*: It runs anteroinferiorly from the anterior trunk along the lateral wall of pelvis, leave the pelvis via obturator canal and divides into anterior and posterior branches.
4. *Middle rectal artery*: the middle rectal artery is often multiple and may be small. It runs into the lateral fascial coverings of mesorectum. It occasionally arises as a common stem with inferior vesical artery.
5. *Internal pudendal artery*: It arises just below the obturator artery, descends laterally to the inferior rim of greater sciatic foramen, where it leaves the pelvis between the piriformis and ischiococcygeus to enter the gluteal region. It gives off several muscular branches in the pelvis and gluteal region which supplies adjacent muscles and nerves.
6. *Inferior gluteal artery*: It is the greater terminal branch of anterior division of internal iliac trunk and principally supplies the buttock and thigh.
7. *Uterine artery*: It is the additional branch in females. It is a large artery which arises below obturator artery on the lateral wall of the pelvis and runs inferomedially into the broad ligament of uterus.
8. *Vaginal artery*: In females vaginal artery may replace the inferior vesical artery. It may arise from the uterine artery close to its origin.

#### *Branches of the Posterior Division of the Internal Iliac Artery*

1. *Iliolumbar artery*: It is the first branch of the posterior trunk and ascends laterally to the sacroiliac joints. It divides into iliac and lumbar branches. The lumbar branch supplies the psoas major and quadratus lumborum. The iliac branch supplies the iliocostalis muscle and gives nutrient artery to the ilium.
2. *Lateral sacral arteries*: It is usually double, the large superior branch passes into first and second anterior sacral foramina, supplies the sacral vertebra and contents of sacral canal and comes out through dorsal sacral foramina. Inferior artery passes anterior to piriformis and form anastomosis with its fellow and median sacral artery.
3. *Superior gluteal artery*: It is the largest branch of internal iliac artery and forms continuation of its posterior division. It runs posteriorly between the lumbosacral trunk and the first sacral ramus, leaves the pelvis through greater sciatic foramen

above piriformis, dividing into superficial and deep branches [3].

Pelvic vessels play an important role in pelvic support. There is significant anatomic variation between individuals in branching pattern of Internal iliac vessels [4].

Nine major types of branching and 49 subtypes have been described. The structure and regions supplied by the branches of the artery, however, are quite constant [5].

#### **Materials and Methods**

Thirty five pelvises (70 arteries) from 35 cadavers were procured from the department of Anatomy of Dr. D. Y. Patil Medical College, Pimpri, Pune, which comprised the material for the present study. These cadavers were embalmed with 10 per cent formalin and fixed.

They were labelled from 1-35, left and right side. After separating the pelvis from the cadaver, sagittal section of the pelvis was taken, by cutting the sacrum in the midline. Branches of internal iliac artery were dissected following dissection procedure as per Cunningham's manual [6].

The Steps of Dissection were as Follows:

- Dissected cadavers were cut at the level of twelfth thoracic vertebra.
- Sagittal section of this cut pelvis was taken in the midline.
- The specimen was labelled with number & side.
- External & internal iliac arteries were exposed by removing the fascia over it.
- Branches of internal iliac artery supplying the pelvic organs like urinary bladder, uterus, rectum, were traced and identified with all these organs in situ.
- Thus superior vesical artery, inferior vesical artery, middle rectal artery, uterine and vaginal arteries in females, was identified.
- The origin of all the branches was noted.
- The pelvic organs were removed and internal pudendal artery, inferior gluteal artery, and branches of posterior division were identified.
- Variations in origin of all the branches of internal iliac artery were noted according to the side of the specimen and the sex.
- Photographs of the variations were taken.

## Results

Different types of variations were observed in the branching pattern of internal iliac artery. They were as follows-

A-Variations in the branches of anterior division of internal iliac artery:

1. *Superior Vesical Artery*: No variation was found in the origin of superior vesical artery.

2. *Inferior Vesical Artery*: right sided inferior vesical artery showed variant origin from obturator artery in one case (Figure 1).

3. *Obturator Artery*-

- Arising from the posterior division of internal iliac artery in 6 cases. One bilateral and five unilateral (Figure 2).

- Was seen arising from the external iliac in 3 cases. Two bilateral and one unilateral (Figure 3).

- From internal pudendal artery in 3 cases. One bilateral and two unilateral.

- From inferior gluteal artery in 2 cases. Both unilateral.

4. *Midde Rectal Artery*-

- It was arising from the internal pudendal artery in 9 cases. Four bilateral and five unilateral.

- Two cases unilaterally showed common stem for middle rectal, internal pudendal and inferior gluteal artery. Both unilateral.

- Was arising from the inferior vesical artery in 1 case on the right side (Figure 4).

- As a branch of obturator artery in 2 cases. Both on the left side.

5. *Internal Pudendal Artery* showed only variation that it arose as a common stem with inferior gluteal artery in 12 cases. Four cases showed bilateral variation while eight were unilateral (Figure 5).

6. *Inferior Gluteal Artery* Arose from the posterior division in 3 cases and from inferior gluteal artery in 3 cases. In all cases finding was unilateral.

Absent inferior gluteal artery was found in one case (Figure 6).

7. *Uterine Artery*- common stem for uterine artery and internal pudendal artery was seen on left side in one case out of five (Figure 7).

B- Variations in the Branches of Posterior Division of Internal Iliac Artery :

1. *Iliolumbar Artery*-

- Was arising from the main trunk of internal iliac artery in 9 cases. All were unilateral.

- Common iliac artery gave origin to iliolumbar artery in 1 case on left side (Figure 8).

- Iliac branch from the posterior division and lumbar from the internal iliac was seen in 4 cases. All unilateral.

- Iliac branch from the obturator artery and lumbar from the posterior division in 3 cases. All unilateral.

2. *Lateral Sacral Artery* -

- One from the posterior division other from the inferior gluteal artery in 2 cases. Both unilateral.

- One from the posterior division other from the internal iliac in 5 cases. All unilateral.

- One from the anterior division other from posterior division in 2 cases. Both unilateral (Figure 8).

- From the common iliac in 1 case. It was found on left side.

*Superior Gluteal Artery* didn't show any variations in its origin, it was always the continuation of posterior division.

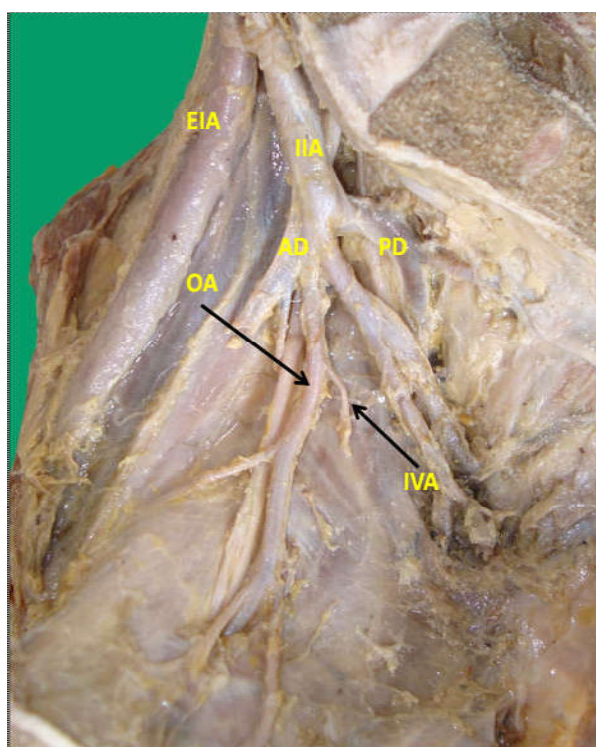


Fig. 1: *Inferior vesical artery* from obturator artery

IIA- Internal Iliac artery

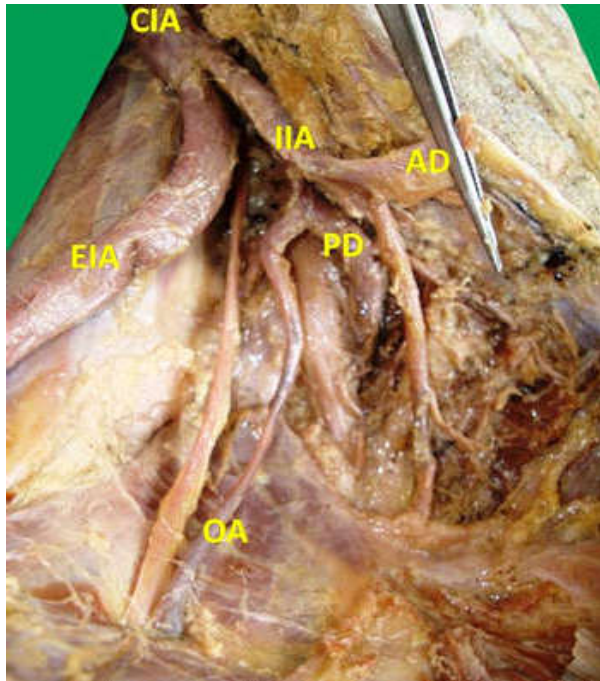
EIA- External Iliac artery

OA- Obturator artery

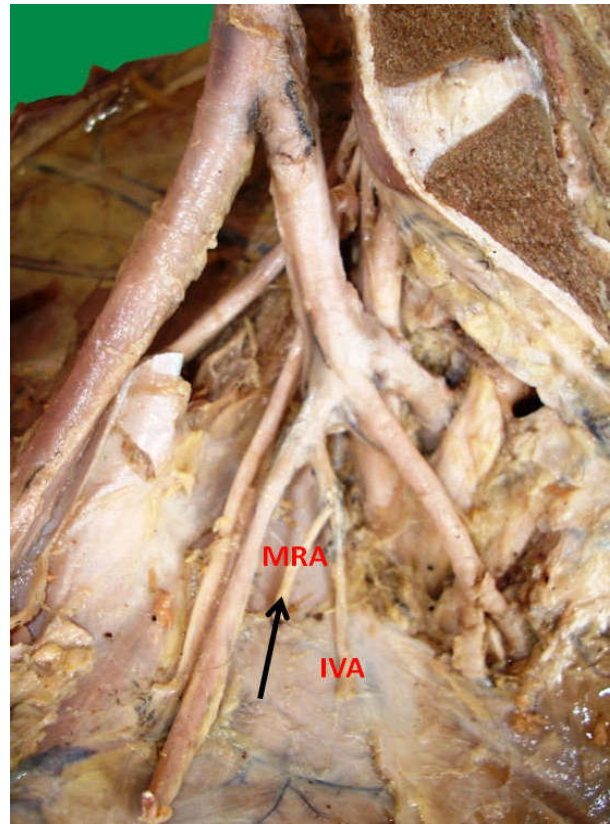
AD- Anterior division

PD- Posterior division.

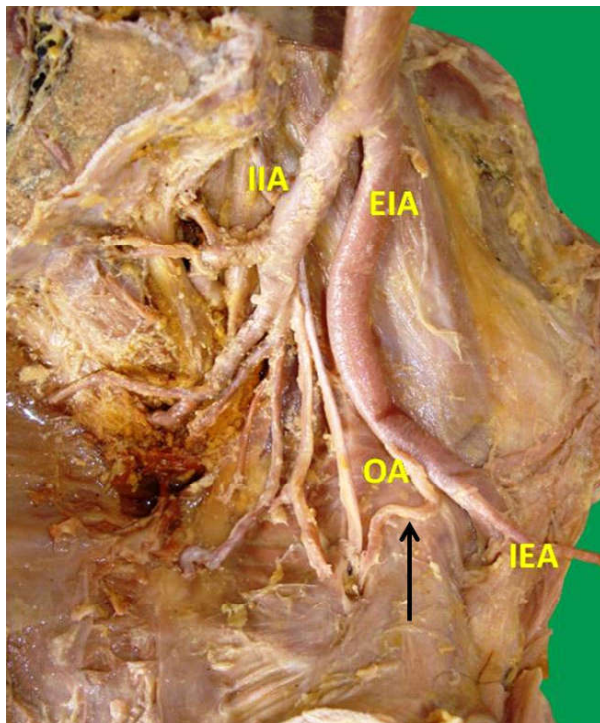
IVA - Inferior vesical artery



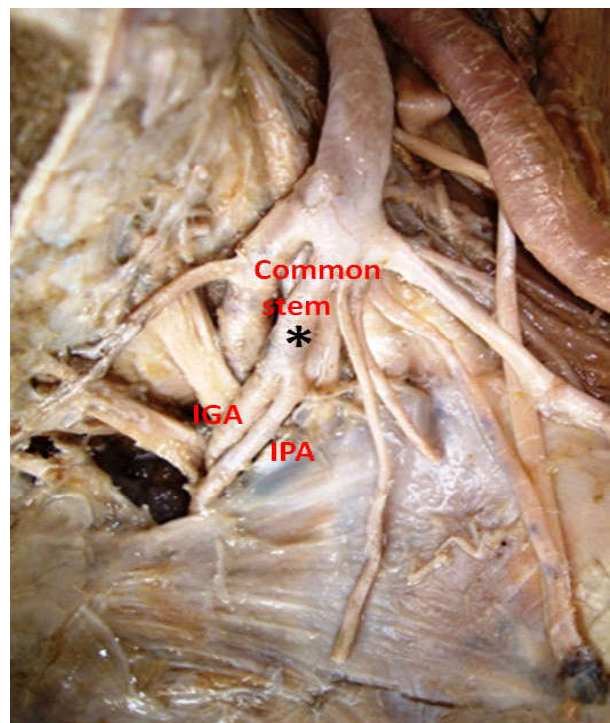
**Fig. 2:** Obturator artery arising from the posterior division of internal iliac artery  
 CIA- Common Iliac artery  
 IIA- Internal Iliac artery  
 EIA- External Iliac artery  
 OA- Obturator artery  
 AD- Anterior division  
 PD- Posterior division.



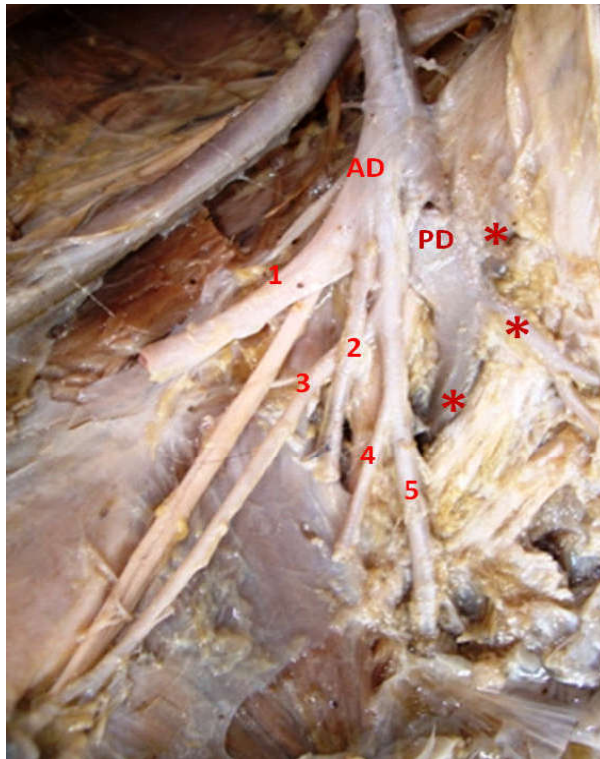
**Fig. 4:** Middle Rectal artery from the inferior vesical artery  
 MRA-middle rectal artery  
 IVA-inferior vesical artery



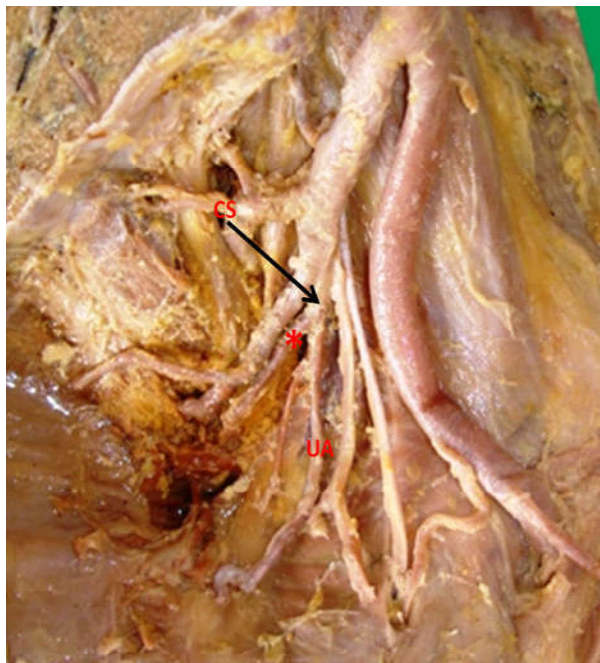
**Fig. 3:** Obturator artery arising from external iliac artery  
 IIA- Internal Iliac artery,  
 EIA- External Iliac artery  
 OA- Obturator artery,  
 IEA- Inferior Epigastric artery



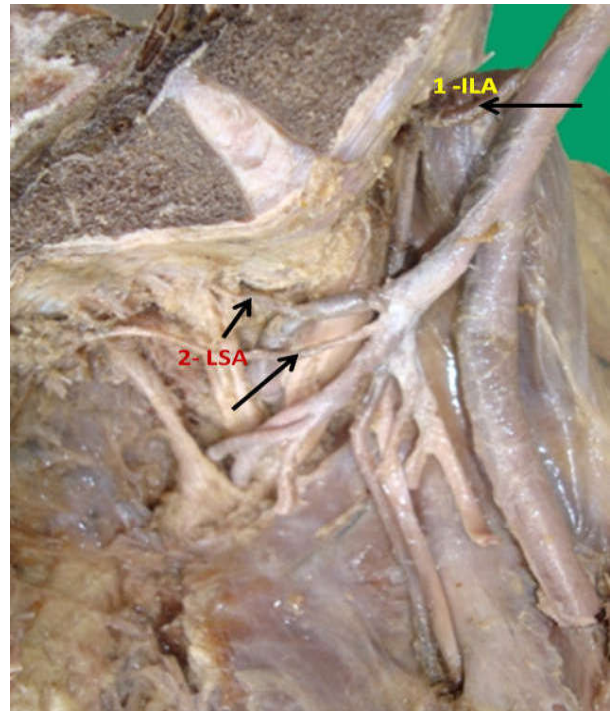
**Fig. 5:** Internal Pudendal artery had common stem with Inferior gluteal artery.  
 IGA- Inferior gluteal artery  
 IPA-Internal pudendal artery



**Fig. 6: Absent Inferior Gluteal artery.**  
 AD-anterior division  
 1- superior vesical artery  
 2- inferior vesical artery  
 3- obturator artery  
 4- middle rectal artery  
 5- internal pudendal artery  
 PD-posterior division



**Fig. 7: Uterine artery has common stem with Internal Pudendal artery**  
 UA-uterine artery  
 \*- internal pudendal artery



**Fig. 8: Iliolumbar artery from Common iliac artery and Lateral sacral artery from anterior division of internal iliac artery.**  
 ILA-Iliolumbar artery  
 LSA -Lateral sacral artery

## Discussion

Thirty five pelvises (70 internal iliac arteries) were dissected for the study of branches of internal iliac artery. All the branches of the anterior and posterior divisions of internal iliac artery were studied. Pelvic arteries showed numerous variations in their origin.

The inferior vesicle artery arose in common with the middle rectal artery in 3% cases this finding correlates with the finding of Ronald Bergman [7].

Sometimes the inferior vesicle artery arise in common with superior vesicle artery which correlates with study of Parsons and Keith [8]. Benjamin Lipschutz [9] found the origin of Inferior vesicle artery from the vaginal artery in 2.5% of cases, and from the internal pudendal artery in 2% of cases,

In the present study obturator artery was arising from the posterior division of internal iliac artery in 10% of cases, this finding was correlating with the finding of Pushpa M.S. [10].

Levi [11] reported two roots for the obturator artery, one from the anterior division and the other from the posterior division.

Mangala M. Pai. Observed the origin of Obturator artery from the external iliac artery. Sometimes it was

arising separately from the external iliac and sometimes as a common stem with the inferior epigastric artery.

Anomalous origin of obturator artery from the posterior division may be beneficial to vascular surgeons ligating the internal iliac artery. The obturator artery is known to supply the head of the femur and in the event of the obturator artery arising from the posterior division of the internal iliac artery; it may be spared during any injury to the anterior division.

Obturator artery arising from the external iliac artery is called as aberrant obturator artery. General surgeons dealing with laparoscopic herniorrhaphy should be aware of the aberrant obturator artery that crosses the superior pubic ramus and is susceptible to injuries during surgery. It may cause serious complications during femoral ring procedures or laparoscopic interventions. It may compress the external iliac vein and can result in venous stagnation in the lower limb. Besides, it may be an additional source of bleeding in cases of hemorrhage secondary to pelvic fracture. The "corona mortis" is an anatomical variant, an anastomosis between the obturator and the external iliac or inferior epigastric arteries, located on superior pubic ramus. It is significant because hemorrhage may occur if the corona mortis is accidentally cut and achievement of subsequent hemostasis is difficult. Orthopedic surgeons planning an anterior approach to the acetabulum, such as the ilioinguinal or the intrapelvic approach, must be cautious when dissecting near the superior pubic ramus [12].

Jastschinski found the origin of middle rectal artery from the internal pudendal in 40% cases, from the inferior gluteal in 26.7% and from the internal iliac in 16.8% cases. It can also occur as a common stem with the inferior gluteal, the uterine or from the posterior division [13]. In the present study middle rectal artery was arising from the common stem for internal pudendal and inferior gluteal in two cases. It was arising from the inferior gluteal in 2.1% of cases and from the obturator in 4.8% of cases. Middle rectal artery was arising as a the common stem with internal pudendal which was similar with the finding of Ronald A. Bergman [7]. It was also arising in common with inferior vesical in 4.3% of cases.

In the present study there was a common stem for the internal pudendal, inferior gluteal and obturator arteries which was similar to the finding of Benjamin Lipschutz [9]. Internal pudendal was arising in common with inferior gluteal which was similar with finding of Ronald A. Bergman [7]. Such type of variation of internal pudendal artery leads to erectile dysfunction.

Benjamin Lipschutz found the origin of the inferior gluteal in common with the superior gluteal in 24 % cases. Inferior gluteal can arise from the internal iliac, it can be the continuation of the lateral sacral or it can be doubled [9]. In the present study a rare variation of absence of inferior gluteal artery was found which was similar to that of Sreenivasulu Reddy [14]. Inferior gluteal artery was absent in 7.5% of cases and superior gluteal artery was supplying its region. In such cases if the superior gluteal artery is compressed, the blood supply to the gluteus maximus muscle will be diminished since the inferior gluteal artery is absent.

Also present study showed inferior gluteal as a separate branch of the anterior division which was similar to the finding of Cruveilhier and Sappey [15].

Inferior gluteal was from the posterior division of the internal iliac artery which was similar to finding of Ronald A. Bergman [7]. Inferior gluteal was arising in common with internal pudendal which was coinciding with finding of Benjamin Lipschutz [9].

M. Bajka [16] reported that the uterine artery was a branch of the inferior gluteal artery. It was also found to arise as a common stem with inferior vesicle in 16.9% cases and there was a common stem for the uterine and middle rectal arteries in 1% cases.

In the present study uterine artery arose as a common stem with internal pudendal artery which was similar with finding of Ronald A. Bergman [7].

Pelage reported 1, 3 or 4 stems to the uterine artery. Variations of the uterine artery should be known to gynecologists dealing with different surgical procedures. Bleeding from a uterine or cervical perforation during instrumentation of the uterus in the area of the uterine artery and vein can lead to severe blood loss. Direct rupture of an arterial branch can manifest as rapid catastrophic bleeding during the trauma or operation, necessitating immediate embolization.

Uterine curettage or surgical trauma can cause uterine vascular abnormalities, including pseudo aneurysms, acquired arteriovenous malformations, arteriovenous fistulas, and rupture of vessels. Recognition of these abnormalities as the cause of hemorrhage is important [17].

Study of Ronald A. Bergman Iliolumbar artery showed the origin of superior gluteal artery in 3.8% cases and branch of anterior division in 3% cases. Also it was reported that one stem of iliolumbar was arising from lateral sacral and other from the posterior division and one stem from posterior division and other from the inferior gluteal [7]. Parsons and Keith reported it as the as a branch of middle rectal artery [8].

In the present study origin of Iliolumbar from the Common Iliac artery was seen in 7% cases and also from the internal iliac which was coinciding with the finding of Rusu Mc et al [18]. Iliolumbar artery arising from the Internal Iliac artery was also seen which was similar to that of Ronald A. Bergman [7]. In some cases it was showing one twig from posterior division and the other from the Internal Iliac artery. Common stem for the iliolumbar and obturator artery was reported which was coinciding with that of Parsons and Keith [8]. A common trunk for two lateral sacral arteries was seen in 51% cases and presence of three lateral sacral arteries [9]. Also only one lateral sacral artery was reported in 1% cases [7].

The present study showed one lateral sacral artery arising from the anterior division and other from the posterior division in 1.6% cases. In 1.7% cases it was arising from the Common Iliac. The lateral sacral artery arising as a single branch from the superior gluteal artery and the other from the inferior gluteal which was similar to the finding of Parsons and Keith [8]. Lateral sacral from the internal iliac was reported in 8.8% of cases. The present study also showed double origin from the posterior division in 40% cases.

Cruveilhier and Theile found the superior gluteal artery arising as a common trunk with inferior gluteal in 24% and sometimes obturator is the branch of superior gluteal. In the present study it was the continuation of the posterior division in all the cases.

Regarding branching pattern of Internal Iliac artery the present study shows origin of inferior vesicle in common with middle rectal in 4.3%. Surgeons operating the rectum in rectal carcinoma must know this variation to avoid damage to the middle rectal artery.

In 2.5% of cases inferior vesicle artery was arising from the obturator artery. During ligation of the branches of internal artery this variation is important.

In the present study superior gluteal artery was the continuation of the posterior division in all the cases. No variation in its origin was found.

The ramification of superficial branch of superior gluteal artery is used to construct skin flaps hence construction of any graft or flap requires very accurate knowledge about the vascular supply.

Accidental haemorrhage is common during erroneous interpretation of anomalous blood vessels. Alarming, haemorrhage has been considered the leading cause of obstetrical mortality in all the developing countries of the world. Thus, a thorough knowledge of the normal and the abnormal anatomy of the branches of the internal iliac artery is essential for obstetric surgeons.

### ***Developmental Aspect of Branches of Internal Iliac Arteries***

*Superior Gluteal Artery:* The umbilical arteries initially paired ventral branches of the dorsal aorta, course to the placenta in close association with the allantois. During the fourth week, each artery acquires a secondary connection with the dorsal branch of the aorta, the common iliac artery, and loses its earliest origin. After birth the proximal portions of the umbilical arteries persist as the internal iliac and superior vesical arteries, and the distal parts are obliterated to form the medial umbilical ligaments.

*Inferior Gluteal Artery:* The axial artery (sciatic artery) is the major arterial supply to the lower limb bud at an early embryological stage. It primarily originates from the dorsal root of the umbilical artery. In the adult, remnants of the sciatic artery persist as the proximal portion of the inferior gluteal artery, the popliteal and fibular arteries.

*Obturator Artery:* Embryologically, Obturator artery has been reported to arise late in the development. abnormal regression of primitive vascular channels and abnormal selection of vascular channels leads into numerous variations in the final arterial pattern [19].

### **Conclusion**

After studying the branching pattern of internal iliac artery it was observed that there are numerous variations in the branching pattern of internal iliac artery, mainly branches of anterior as well as posterior division showed different types of variations in their origin. All these variations are important for orthopaedic surgeons during repair of pelvic fractures, gynaecologists during hysterectomy and general surgeons during repair of femoral hernia.

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