

Study on Variations in the Origin and Branching Pattern of Internal Iliac Artery in Cadavers

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<http://dx.doi.org/10.13005/bpj/1602>

(Received: 02 November 2018; accepted: 24 November 2018)

The variations in blood vessels are common and have long received the attention of anatomists and surgeons. The true pelvic cavity usually refers to that part of pelvis, which has its bony walls, the sacrum and lower part of hip bone. This small area is well covered by bones and has important structures namely the pelvic viscera, pelvic floor muscles, vessels and nerves supplying it. The aim of the study was to know the branching pattern of internal iliac artery based on the Adachis classification, along with length and thickness of artery. The internal iliac artery was traced from its origin, course, branching pattern, length and thickness of the trunk of internal iliac artery was measured by using digital vernier calliper from its point of origin to bifurcation into anterior and posterior division. The length of right & left internal iliac artery ranged from 2.4 cm to 5.4 cm with average length of 3.943cm \pm 0.859cm, whereas the length of left internal iliac artery ranged from 2.7cm to 4.7cm with average length of 3.610cm \pm 0.626cm. Bilateral ligation of internal iliac artery is helpful in controlling postpartum haemorrhage. Applying ligatures on an anomalous blood vessel may lead to alarming haemorrhage. The most ideal point of ligation of internal iliac artery would be distal to its posterior division, since proximal ligation has been associated with buttock claudication and necrosis. Knowledge regarding the internal iliac artery and its branches is helpful in applying ligatures safely during pelvic surgeries.

Keywords: Internal iliac artery, Postpartum Haemorrhage, Ligation, Anomalous, Necrosis. and Claudication.

The variations in our body are rampant in nature. Developmental variations of blood vessels, nerves, bones, organs and almost all tissues in the body can occur. Even though many variations occur, they may or may not interfere with the functions of the body. The variations in

blood vessels are common and have long received the attention of anatomists and surgeons. The true pelvic cavity usually refers to that part of pelvis, which has its bony walls, the sacrum and lower part of hip bone. This small area is well covered by bones and has important structures namely the

pelvic viscera, pelvic floor muscles, vessels and nerves supplying it.

The principal blood supply to the pelvic viscera is by internal iliac artery and its branches. The internal iliac artery also known as hypogastric artery is found bilaterally in the pelvic cavity. It is one of the branches of common iliac artery given in front of the sacroiliac joint and runs downwards sub-peritoneal. At the upper margin of greater sciatic foramen it divides into anterior and posterior divisions. The anterior division gives nine branches while the posterior division gives three branches. It mainly supplies the pelvic cavity, medial compartment of thigh and gluteal region^[1]. Any compromise in the blood supply will produce ischemia to these organs. The embryological explanations for the variations in the arterial pattern are based on unusual selection of channels from a primary capillary plexus, wherein the most appropriate channels enlarge while others retract and disappear thereby establishing the final arterial pattern^[2,3]. During posterior pelvic fractures, anterior and anterolateral spinal approaches, lumbosacral spinal endoscopic procedures, lateral disc excision, anterior approaches to the sacroiliac joint for arthrodeses or internal fixation, injury to

the iliolumbar artery may occur. During surgical repair of fracture of superior ramus of pubis, the obturator artery may be injured due to anomalous origin from the external iliac artery which might lead to profuse bleeding. The knowledge regarding the course and branches of internal iliac artery is necessary which might greatly help the surgeon during surgical procedures of the pelvic region. The aim of the study was to know the branching pattern of internal iliac artery based on the Adachi classification, along with the length and thickness of artery.

MATERIALS AND METHODS

The present study was carried in the Department of Anatomy, Chettinad Hospital and Research Institute. A Total of 80 formalin fixed specimen, inclusive of both male and female were utilized for the present study. The internal iliac artery was traced from its origin and the course of the artery was studied. The length and thickness of the trunk of internal iliac artery was measured by using digital vernier calliper from its point of origin to bifurcation into anterior and posterior division. Variations in the origin and branching

Table 1. Comparison of minimum, maximum and average length of right and left internal iliac arteries

Side	Minimum (cm)	Maximum (cm)	Average (cm)	Standard deviation	T – Value	P – Value
Right	2.4	5.4	3.943	0.859	1.72	0.0914*
Left	2.7	4.7	3.610	0.626		

P value ≥ 0.05 not significant

*Statistically not significant

Table 2. Different modes of origin of obturator artery

S. no	Mode of Origin	Percentage
1	Anterior division of Internal iliac artery	45
2	posterior division of Internal iliac artery	20
3	With ilio-lumbar artery	3
4	Superior gluteal artery	5
5	External Iliac artery(Direct)	5
6	Inferior epigastric artery	22

Branching pattern of obturator artery in present study with percentage

pattern of internal iliac artery was recorded and photographed.

RESULTS

The variations in the branching pattern of internal iliac artery were observed in the specimens. The variations in the origin of branches of both anterior and posterior divisions of internal iliac artery were also observed. Among the branches of anterior division, variations were observed in origin of obturator artery, other branches of

anterior division showed a normal course. Among the branches of posterior division, variations were observed in the origin of iliolumbar artery, lateral sacral artery and superior gluteal artery. In all 80 specimens, the length of internal iliac artery was measured. In Table:I the length of right internal iliac artery ranged from 2.4 cm to 5.4 cm with average length of $3.943\text{cm} \pm 0.859\text{cm}$, whereas the length of left internal iliac artery ranged from 2.7cm to 4.7cm with average length of $3.610\text{cm} \pm 0.626\text{cm}$. The calculated P value (0.0914) shows that the differences between the lengths of internal iliac artery of both sides were statistically not significant.

The calibre thickness of main trunk of internal iliac artery ($4.85 \pm 0.60\text{cm}$), obturator artery ($3.27 \pm 0.52\text{cm}$), ilio-lumbar artery ($3.25 \pm 0.49\text{cm}$) were also studied in this study shown in Table:III

The obturator artery took origin from several sources as shown in Table: II it originated from anterior division of internal iliac artery (45%), posterior division of internal iliac artery (20%), with ilio-lumbar artery (3%) or superior gluteal artery (5%), directly from external iliac artery (5%) or from inferior epigastric artery (22%).

The origin of ilio lumbar artery from main trunk of internal iliac artery was observed in 75%

of the specimen. In rest of the cases, ilio lumbar artery originated from posterior division of internal iliac artery as showed in Table: IV

DISCUSSION

The first known person to do a study on variations of internal iliac artery was Jaschinski in 1891. Later this study was modified by Adachi 1928^[4] and he added the 5th type. The variations in branching pattern of internal iliac artery are mainly due to embryological reasons. Abnormal vasculature could be abnormal angiogenesis, as a result of hypoxia, as low oxygen saturation leads to the stabilization of hypoxia inducible factor 1-A, which upregulates vascular endothelial growth factor (VEGF) and nitric oxide synthase expression. The production of nitric oxide causes dilation of the existing vessels and extravasation of plasma proteins, leading to protease and matrix metalloproteinase expression. The plasma proteins then play a major role in the proliferation and angiogenesis of endothelial cells which leads to formation of abnormal vasculature. The variations in vasculature are essential while performing surgery for safe and successful outcomes. In our study the variations are more commonly seen in the following arteries namely, obturator artery,

Table 3. Various origins of ilio lumbar artery

S. no	Modes of Origin	Present Study	Previous Study Chandrika et al., 2013	Kiray et al., 2010
1	Posterior division	25%	80%	19%
2	Trunk of internal iliac artery	75%	20	71.4%
3	External iliac artery	-	-	-
4	Common iliac artery	-	-	4.8%
5	Abdominal aorta	-	-	-

Branching pattern of iliolumbar artery

Table 4. Thickness of important branches of internal iliac artery

S. no	Thickness of Arteries	Mean	Standard Deviation
1	Thickness of trunk	4.85	0.60
2	Thickness of obturator artery	3.27	0.52
3	Thickness of ilio lumbar artery	3.25	0.49

Calibre thickness of branches of internal iliac artery

iliolumbar artery, lateral sacral artery and superior gluteal artery.

Obturator artery

The variations observed in obturator artery and its accessory artery are difference in origin and in its relation to pubic ramus. The internal iliac artery usually provides the obturator artery, which may communicate with the external iliac artery through either the accessory obturator or inferior epigastric artery. A collateral circulation between

the external and internal iliac system is known as Corona mortis^[5]. The most commonly occurring variation in internal iliac artery is associated with obturator artery. Normally the obturator artery takes origin from the anterior division of internal iliac artery. In our study only about 45% were from anterior division, while the rest of them had different origins. About 20% originated from the posterior division as shown in Fig: 1. This is mainly due to persistence of vascular channels in relation to the posterior division and the vascular channels in relation to the anterior division might be disappeared^[6]. The origin of obturator artery from the posterior division had increased the

length of obturator artery, thus providing an added advantage for vascular grafting^[3]. The posterior division variation is most commonly seen by Kumar and Sharmishta *et al*^[6, 7]. The origin of obturator artery from inferior epigastric artery is previously reported by Sanudo JR *et al*^[8]. In the present study Fig: 2 shows, origin from inferior epigastric is 22%. The origin of obturator artery from external iliac artery is only 5% and it is also previously reported by Pung papong SU *et al*^[9]. The origin of obturator artery from superior gluteal artery is very minimally reported and in our study it is only 5% as shown in Fig: 3. In 3% of specimens, it originated commonly with ilio-lumbar artery Fig: 4. The knowledge regarding the calibre of the vessel is also important for ligation of obturator artery during various pelvic surgeries. The average size of calibre is 3.27 ± 0.5 cm. A complete knowledge

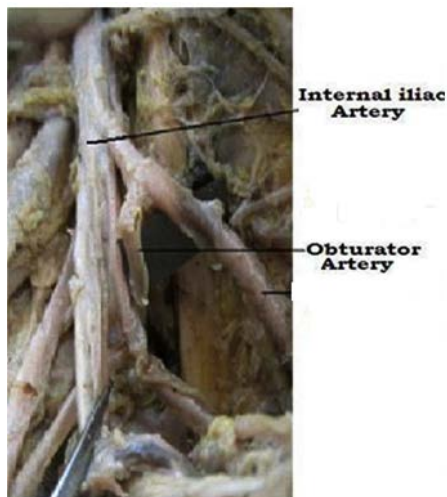


Fig. 1. Origin of obturator artery from posterior division of internal iliac artery

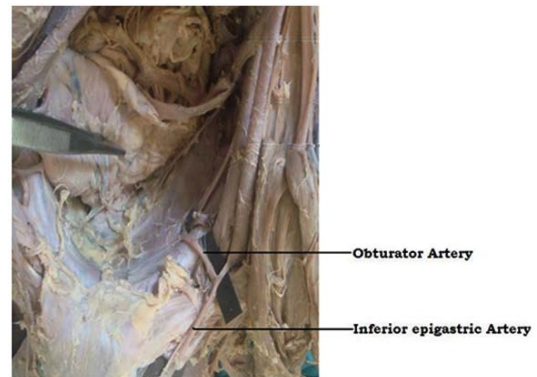


Fig. 2. Origin of obturator artery from inferior epigastric artery

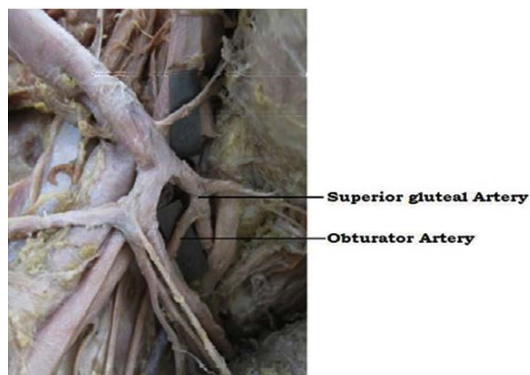


Fig. 3. Origin of obturator artery from superior gluteal artery

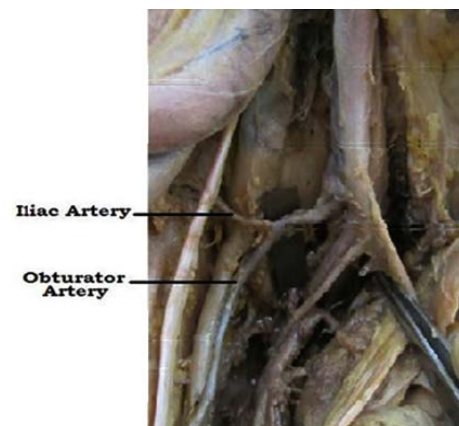


Fig. 4. Origin of obturator artery with ilio lumbar artery

of abnormal origin of arteries in the retropubic pelvic vascular anatomy plays an important role in reducing the complications while performing endoscopic, inguinal herinoplasty and laparoscopic surgical procedure^[10].

Iliolumbar artery

Iliolumbar artery arises from posterior division of internal iliac artery and is important, as it may be injured during lumbo sacral spinal surgeries. It further divides into iliac and lumbar branch at the medial side of psoas major and supplies cauda equina. Later it anastomosis with 4th lumbar artery^[11]. In our study we mainly studied the modes of origin and also calculated the calibre of the artery. The artery took origin from the trunk of internal iliac artery in 75% as shown in Fig: 5, as against the previous studies done by Kiray (71.4%) and Chandrika (20%)^[12,13]. In 25%, it took origin

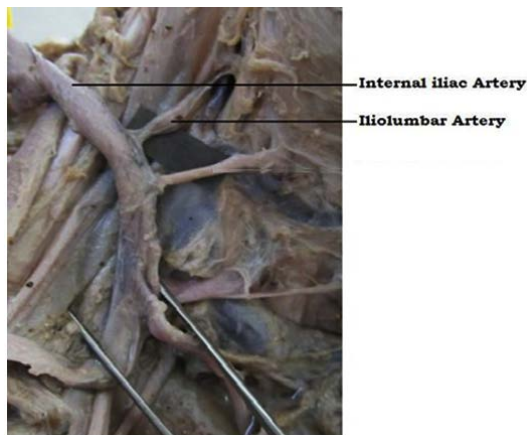


Fig. 5. Origin of Iliolumbar Artery from trunk of internal iliac artery

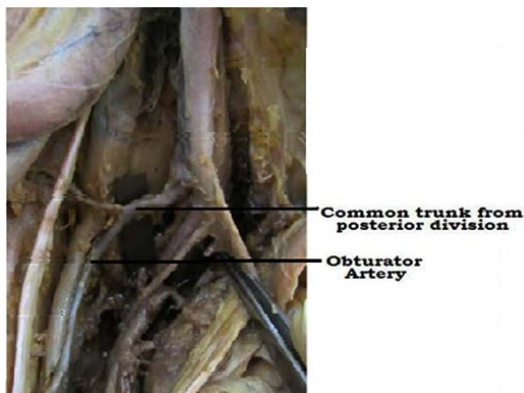


Fig. 6. Origin of iliolumbar artery from posterior division

from the posterior division of internal iliac artery as shown in Fig: 6 and the artery did not take origin from the external iliac artery, common iliac artery and abdominal aorta. The average size of the calibre was 3.2 ± 0.5 cm whereas, in Chandrika *et al.*^[13], it was 3.4 ± 0.5 cm. Ilio lumbar arteries are used as vascular pedicles in iliac crest flaps. The relationship of artery with sacropelvic joint is importantly considered because during the shear fracture or open book fracture, it is possible to injury the artery^[14, 15]. The arterial anatomy of the pelvis, lumbar vertebrae and the sacrum is very important in neurosurgeries and orthopedicans for spinal fixations.

Lateral sacral artery

Lateral sacral artery is a branch from posterior division of internal iliac artery. It commonly divides into superior and inferior branches and mainly supplies the lumbar and sacral roots^[16]. The variations in the origin of lateral sacral artery are concerned with sciatic artery. The lateral sacral artery plexus does not arise from the dorsal aspect of primitive axial artery due to delay in posterior trunk development and early anterior trunk development. The lateral sacral artery arises directly or indirectly from internal iliac artery due to regression from sciatic artery^[17, 18]. In previous studies the artery took origin from anterior trunk in 1%, posterior trunk in 79%, dorsally in 3.7%, superior gluteal artery in 16.8% inferior gluteal artery in 5.4%, internal pudendal artery in 0.3%, and persistent sciatic artery in 8.8%^[19]. In the

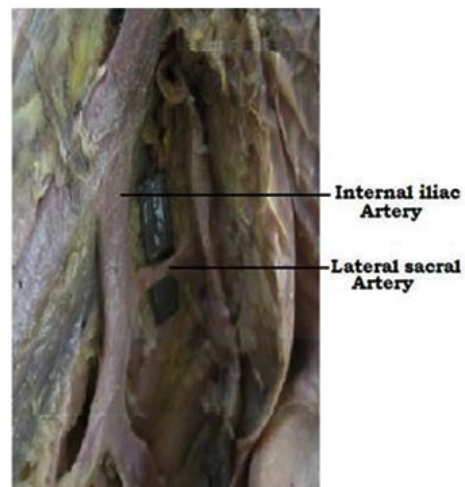


Fig. 7. Origin of lateral sacral artery from trunk of internal iliac artery

present study the artery originated from the trunk of internal iliac artery as shown in Fig: 7. Lateral sacral artery aneurysm associated with thrombosis can create pressure or impairment of the collateral circulation. If the blood supply is minimal to sciatic sacral roots it may lead to sciatic neuropathy with symptoms of sciatica [20, 21]. The origin may be helpful for orthopaedic and neurosurgeons while doing graft and lumbar surgeries.

Superior gluteal artery

The origin of superior gluteal artery from the trunk of internal iliac artery which was observed in the present study is seldom reported (3%). It is either mentioned by Adachi (1928) [4], Villimen (1952) [22], Kosinski (1929) [23], or Terek (2004) [24]. Sound knowledge of superior gluteal vessels is required during surgical repair of acetabular fractures. Knowledge of superior gluteal artery is essential for constructing myocutaneous flaps since the branches of this artery anastomosis with inferior gluteal, lateral circumflex and deep circumflex arteries [25].

Length of internal iliac artery

Knowledge regarding the length of internal iliac artery is absolutely necessary while applying ligature to the internal iliac artery during various pelvic surgeries. The morphometry of the artery at its origin and length were previously studied [26, 27, 28].

The length of the internal iliac artery varies in different races. The length for English is 36.8 ± 0.6 mm [26], Japanese is 44.3 ± 1.32 mm [4], Romanian is 49 ± 3.34 mm [29] and in south Indian population is 37 ± 4.62 mm [30]. According to present study, the length of the artery ranged between 2.4 and 5.4 cm. The mean value was 37.7 ± 0.76 mm without major differences between two sides. These value matches with previous study by Naveen *et al.*, [30] in south Indian population (37 ± 4.6 mm).

A severe and potentially lethal complication in pelvic injuries is arterial bleeding commonly involving the branches of the internal iliac artery, namely, the lateral sacral, iliolumbar, obturator, vesical, and inferior gluteal arteries. The most ideal point of ligation of internal iliac artery would be distal to its posterior division, since proximal ligation has been associated with buttock claudication and necrosis.

CONCLUSION

In the present study variations in the origin of obturator artery, iliolumbar artery, lateral sacral artery and superior gluteal artery were observed. Among the branches mentioned above obturator artery showed a higher incidence of variations. The average length of internal iliac artery was found to be 37.7 ± 0.76 mm and there was no significant difference in the length between the right and left side. Bilateral ligation of internal iliac artery is helpful in controlling postpartum haemorrhage. Applying ligatures on an anomalous blood vessel may lead to alarming haemorrhage. Knowledge regarding the internal iliac artery and its branches is helpful in applying ligatures safely during pelvic surgeries.

ACKNOWLEDGEMENTS

I thank the Department of Anatomy, Chettinad hospital and research institute and my staffs

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