

Variations in Origin and Branching Pattern of Anterior Division of Internal Iliac Artery: a Cadaveric Study

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ABSTRACT

Introduction

Detailed knowledge of the branching pattern of internal iliac artery will be a guidance for ligating the artery and its branches during various pelvic surgeries. Hence, the main objective of this study was to know the branching pattern of internal iliac artery, based on the Adachis Classification along with the length and diameter of the arteries.

Methods

The descriptive observational cross-sectional study was conducted at the Department of Human Anatomy of the Nepal medical college, examined over a period of 9 months from June 2021-February 2022 which included 30 internal iliac arteries and its branches of right and left sides from 15 embalmed male human cadavers.

Results

In the study, branching pattern of internal iliac artery (IIA) was Type Ia in 19 (63.33%) and Type III in 11 (36.66%) of the cases while type I b, Type II a, Type II b, IV and V pattern were not observed. The total minimum and maximum lengths of both right and left trunk of internal iliac arteries were 1.33 cm and 3.42 cm respectively and average lengths with standard deviation were 2.61cm ± 0.66. The calculated P value (0.002) showed that the differences between the lengths of IIA of both sides were statistically significant. The diameter and standard deviation of IIA and obturator artery were 6.35±1.31 and 2.47cm±0.67 respectively. The obturator artery was found to be originated from both anterior and posterior division of IIA accounting as 96.66% and 3.33% respectively.

Conclusions

Pelvic surgeries may lead to hemorrhage if branching patterns of the IIA are incorrectly interpreted and thus endanger the patient's life while ligating the artery during prostatectomy, hernioplasty. The current study explain the important aspects of the vascular anatomy of the IIA not only for anatomists and morphologists, but also for the radiologists, general and vascular surgeons.

Keywords: internal iliac artery; inferior gluteal artery; internal pudendal artery; obturator artery and variations.

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INTRODUCTION

The variations in arteries are very common and has been a subject of curiosity.^{1,2}

While reviewing the origin of the internal iliac artery (IIA), the abdominal aorta is unavoidable. It gets branched into right and left common iliac arteries and further divided into external and internal iliac arteries.³ Each IIA, descends posteriorly to the superior margin of the greater sciatic foramen where it divides into an anterior and posterior trunks.⁴ In general, the IIA supplies the pelvic viscera, perineum and gluteal region.^{5,6} Hence, surgeon should be careful during operative procedure of these area having variations in IIA.⁴

The obturator artery (OBA) ,mainly affected during surgical procedure.¹ Hence, this study has been aimed to know the branching pattern of IIA, based on the Adachi's classification along with the lengths and diameters of the arteries and to find out the origin of the OBA and their diameters.

METHODS

The descriptive observational cross-sectional study was conducted at the Department of Human Anatomy of the Nepal medical college, examined over a period of 9 months from June 2021- February 2022 which included 30 internal iliac arteries and its branches of right and left sides from 15 embalmed male human cadavers.⁷

The origins of branches of anterior division of the internal iliac arteries were recorded and along with that the lengths and diameters of the trunk of internal iliac arteries and obturator arteries were also measured, each dissected specimen was photographed. Once the anterior abdominal wall, foregut and hindgut had been dissected by undergraduates as part of their studies, the peritoneum was then carefully removed.

The vas deferens was reflected superoanteriorly. Waldeyer's fascia was incised and the rectum was released from the pelvic wall at the recto sigmoidal

junction, the sigmoid colon was separated from the rectum at the level of the sacral promontory. The pelvic fascia was separated and removed from the pelvic wall once the pelvic viscera had been reflected.

The iliac system (venous and arterial) were exposed once the endopelvic fascia was removed, the veins were carefully removed up to the level of formation of the common iliac vein.⁸ The dissection was performed without any particular method, however attention were taken to expose the IIA branches. Separation of the IIA from the surrounding structures allowed it to be clearly defined, including its anterior and posterior divisions and further subdivisions.⁹

The internal iliac arteries were traced from its origin and the course were studied in the form of the length and diameter of the trunk of internal iliac artery by using digital vernier caliper from its point of origin to bifurcation into anterior and posterior division. Variations in the branching patterns of internal iliac arteries were recorded and photographed.⁹ The branching patterns of IIA were studied and demonstrated as per the guidelines of Adachi.¹⁰ The Adachi's pattern used in the present study, distinguishes the IIA into five different types as follows (Figure 1).

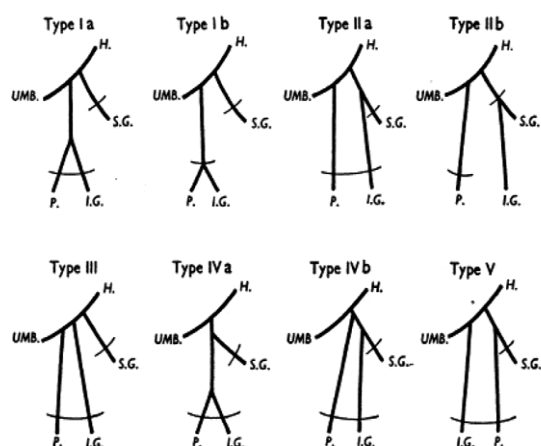


Figure 1. Adachi's types. H. internal iliac artery; I.G. inferior gluteal artery; P. internal pudendal artery; S.G. superior gluteal artery; UMB. umbilical artery.

Type I - The superior gluteal artery arises separately from the IIA, the inferior gluteal and internal pudendal vessels are given off by a common trunk. If the latter divides within the pelvis it is considered to be Type Ia, whereas if the bifurcation occurs below the pelvic floor it is classified as Type Ib. Type II - The superior and inferior gluteal arteries arise by a common trunk and the internal pudendal vessel separately. In this category, as in the previous one, two subtypes are described. Type IIa includes those specimens in which the trunk common to the two gluteal arteries divides within the pelvis and Type IIb those in which the division occurs outside the pelvis. Type III - The three branches arise separately from the internal iliac artery. Type IV - The three arteries arise by a common trunk. The sub typing in this group is based on the sites of origin of the superior gluteal and the internal pudendal arteries from the parent stem. In Type IVa the trunk first gives rise to the superior gluteal artery before bifurcating into the other two branches; in Type IVb the internal pudendal is the first vessel to spring from the common trunk, which then divides into superior and inferior gluteal arteries. Type V - The internal pudendal and the superior gluteal arteries arise from a common trunk and the inferior gluteal has a separate origin.⁹

The origin of the obturator arteries were traced and their thickness were measured. To avoid biasness, the measurements were taken by two different investigators.¹ Data were entered and analyzed using Statistical Package for Social Sciences Statistics, version 16 (SPSS).

RESULTS

The variations in the branching pattern of internal iliac artery as per Adachi's guidelines were observed in the specimens. The branching pattern of IIA was Type I a (Figure 2) in 19

(63.33%) of the cases and Type III (Figure 3) in 11 (36.66%) of the cases. The type I b, Type II a, Type II b, IV and V pattern of Adachi¹⁰ were not observed in the present study. In present study Table 1 shows, the percentage of branching patterns of internal iliac artery as per Adachi's classification.

In all 30 specimens, the lengths of the trunk of Internal iliac arteries were measured. In Table 2 the lengths of right internal iliac arteries ranged from 1.57cm to 3.42cm with average length of 2.80cm and standard deviation 0.68, whereas the lengths of left internal iliac arteries ranged from 1.33cm to 3.27cm with average length of 2.43cm and standard deviation 0.62.

The total minimum lengths of both right and left of the trunk of internal iliac arteries were 1.33 cm and maximum lengths of both right and left of the trunk of internal iliac arteries were 3.42 cm and average lengths were 2.61cm and standard deviation 0.66. The calculated P-value (0.002) shows that the differences between the lengths of internal iliac artery of both sides were found statistically significant

In all 30 specimens, the diameters of the trunk of internal iliac arteries were measured. The diameters of the trunk of right internal iliac arteries ranged from 3.92cm to 8.42cm with mean diameter of 6.26cm and standard deviation 1.25, whereas the diameter of left the trunk of internal iliac arteries ranged from 4.2cm to 8.57 cm with mean diameter of 6.45cm and standard deviation 1.40 (Table 3).

The total minimum diameters of both right and left internal iliac arteries were 3.92cm and maximum diameters of both right and left internal iliac arteries were 8.57 cm and mean diameters of both right and left internal iliac arteries was 6.35cm and standard deviation 1.31. The calculated P-value (0.696) shows that the differences between diameters of internal

iliac artery of both sides were statistically highly insignificant.

In all 30 specimens, the obturator arteries were measured. The diameter of right obturator arteries ranged from 1.5cm to 3.43cm with mean diameter of 2.46cm and standard deviation 0.71, whereas the diameter of left obturator arteries ranged from 1.02cm to 3.38 cm with mean diameter of 2.49cm and standard deviation 0.67 (Table 4).

The total minimum diameters of both right and left obturator arteries were 1.02cm and maximum diameters of both right and left obturator arteries were 3.43 cm and mean diameters was 2.47 and standard deviation

0.67. The calculated P-value (0.920) shows that the differences between diameters of obturator arteries of both sides were statistically highly insignificant.

Among the branches of anterior division, variations were observed in origin of obturator artery, other branches of anterior division showed a normal course.

The obturator artery took origin from several sources as shown in Table 5. It was originated from both anterior division of internal iliac artery and posterior division of internal iliac artery accounting as 96.66% and 3.33% respectively and shown in Figure 2 and Figure 4 respectively.

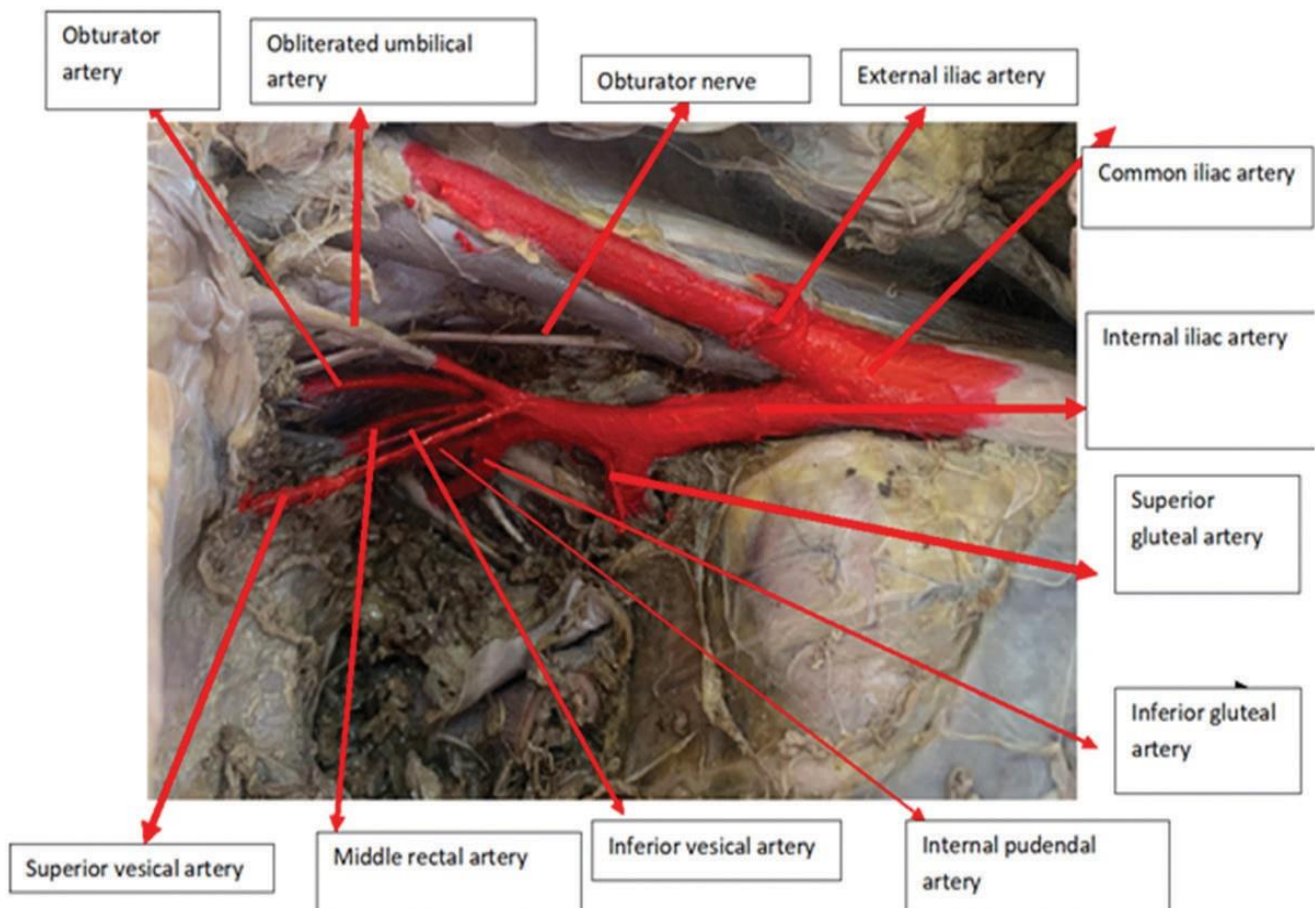


Figure 2. Photograph of the branches of the internal iliac artery obtained after dissection in a cadaver. Type Ia as per Adachi Classification.

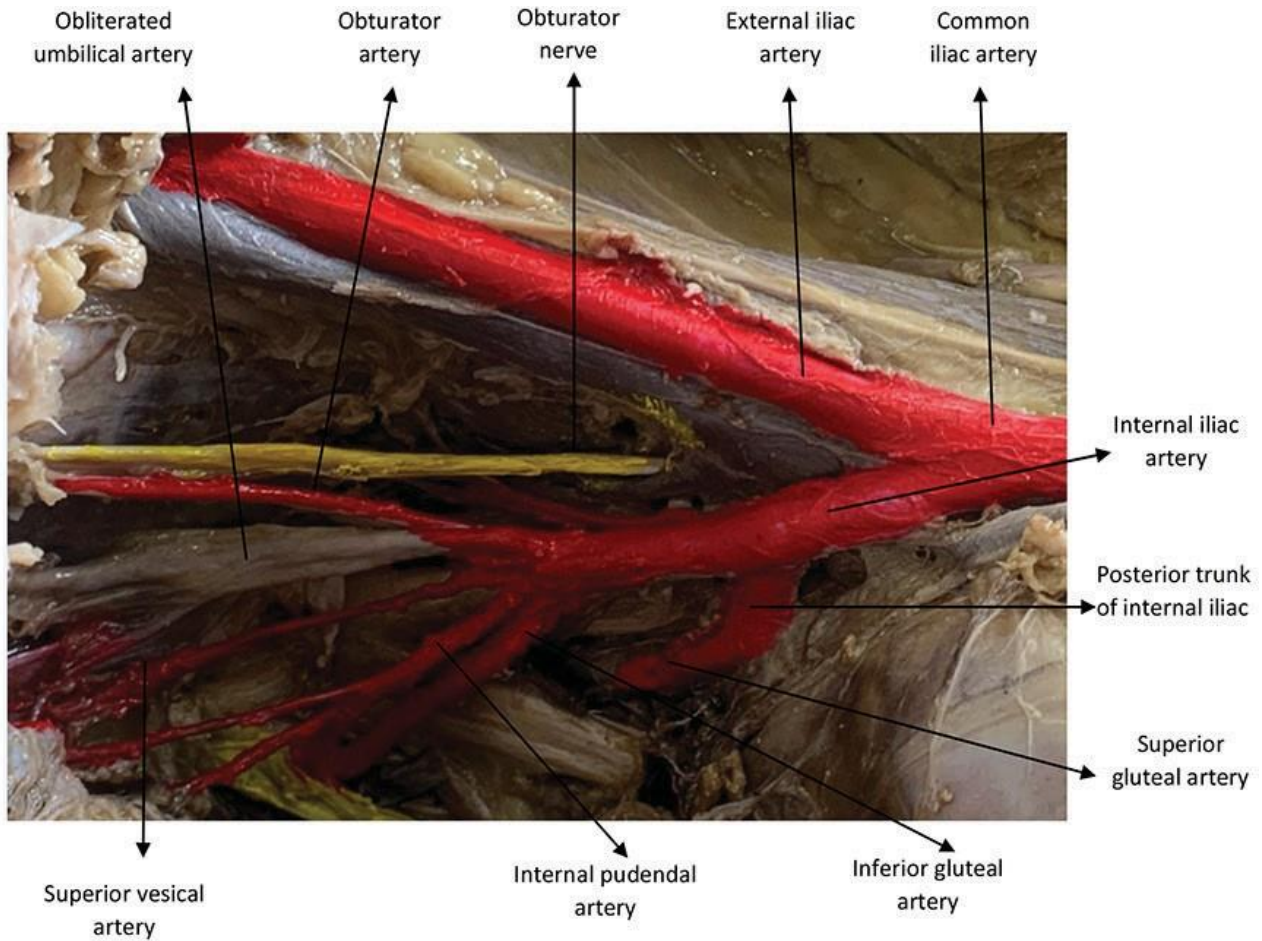


Figure 3. Photograph of the branches of the internal iliac artery obtained after dissection in a cadaver. Type III as per Adachis classification.

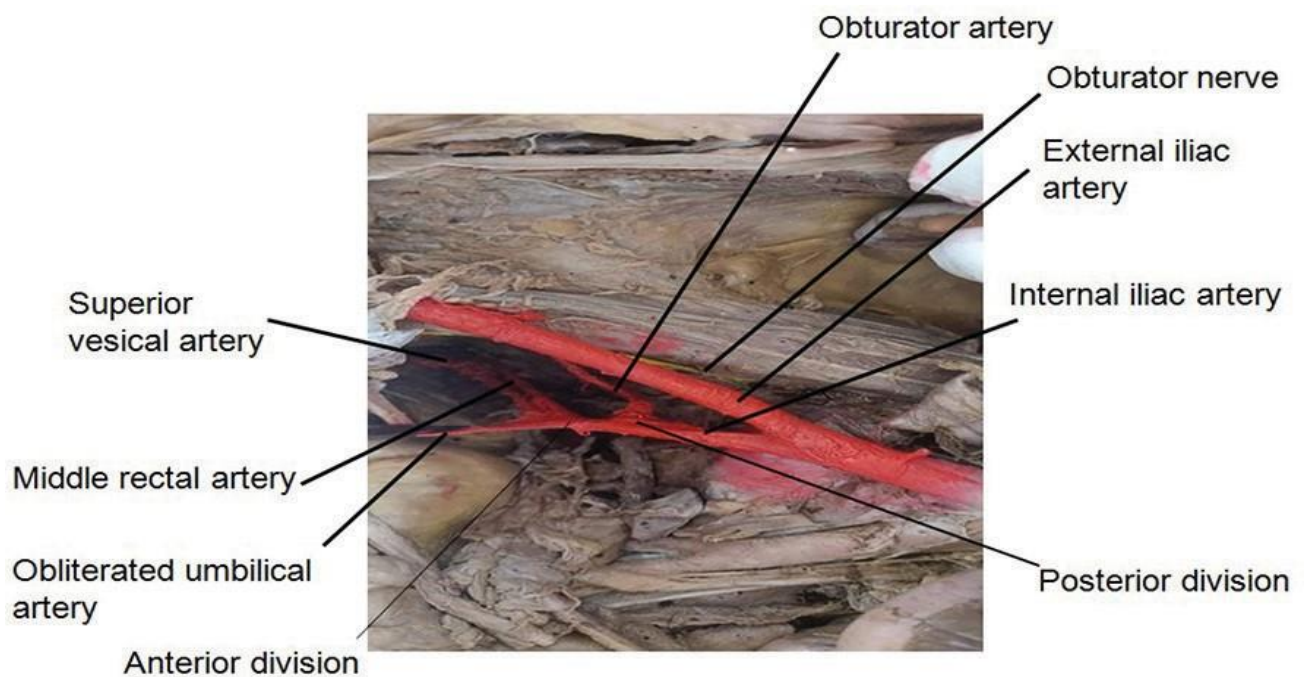


Figure 4. Photograph of Obturator artery arising from posterior division of internal iliac artery.

Table 1. Percentage of branching patterns of internal iliac artery as per Adachi classification.

SN	Branching patterns of IIA	Percentage
1	Type I a	63.33%
2.	Type I b	-
3.	Type II a	-
4.	Type II b	-
5.	Type III	36.66%
6.	Type IV	-
7.	Type V	-
8.	Others	-

Table 2. Mean and standard deviation of total length of the trunk of internal iliac in both right and left sides.

Length of internal iliac	side		
	Right	left	Total
Length in cm			
Minimum	1.57	1.33	1.33
Maximum	3.42	3.27	3.42
Mean±SD	2.80±0.68	2.43± 0.62	2.61±0.66

significant (P value= 0.002)

Table 3. Mean and standard deviation of diameter of the trunk of internal iliac arteries in both right and left sides.

Internal iliac artery	side		
	Right	left	Total
Diameter in cm			
Minimum	3.92	4.2	3.92
Maximum	8.42	8.57	8.57
Mean±SD	6.26±1.25	6.45±1.40	6.35±1.31

insignificant (P value 0.696)

Table 4. Mean and standard deviation of diameter of obturator arteries in both right and left sides.

Obturator artery	side		
	Right	left	Total
Diameter in cm			
Minimum	1.5	1.02	1.02
Maximum	3.43	3.38	3.43
Mean±SD	2.46±0.71	2.49±0.67	2.47±0.67

insignificant (P value 0.920)

Table 5. Different Mode of Origin of Obturator artery.

S.N.	Mode of Origin	Percentage
1.	Anterior division of Internal iliac artery	96.66%
2.	Posterior division of Internal iliac artery	3.33%
3.	External iliac artery (Direct)	Absent
4.	Internal pudendal artery	Absent
5.	Inferior gluteal artery	Absent
6.	Inferior epigastric artery	Absent
7.	Superior gluteal artery	Absent

DISCUSSION

The present study showed higher percentage of the branching pattern of IIA type 1a (63.33%) of the cases than other branching pattern of IIA as per Adachi classification. Previous authors also reported that the type I was more common than other branching pattern. Frequency for each type in the Adachi classification from previous authors were mentioned shown in Table 6.

In present study branching pattern of IIA type IA was found to be 63.33% which was similar to the studies conducted by Sakthiverian,¹⁶ Krishnan,¹⁷ and Fatu,¹⁸ whereas Naveen⁹ found type I in 83.5% which was higher than our study.

In the present study type III branching pattern of IIA was 36.66% which was similar to the studies done by Jastchinski¹⁵ and Waseem⁸ which were 32.55% and 34.8% respectively.

In our study type IV and V pattern of IIA were not found which was resembling to the studies conducted by Naveen⁹ and Sakthiverian.¹⁶ In contrast to this various other studies observed type IV and V pattern in^{10,15,18-21} While various other authors didn't find type IV.^{17,22,23}

It was also reported that the length of IIA, depends on the length of the common iliac artery.²⁴

In the present study the average length of the trunk of IIA was 26.17mm ranged between 13.3 mm to 34.2 mm and similar lengths of the trunk of IIA was observed by Bleich²⁴ (27.0mm).

When compared to our study, the length of the trunk of IIA was found to be longer as reported by Naveen,⁹ 37mm (range, 13-54) Fatu et al,¹⁸ 49mm (ranged 20 -90 mm).

In our study mean diameter of the trunk of IIA was 6.35±1.31 which was thicker than the study reported by Yuvaraj¹ which was (4.88±0.60).

The knowledge regarding the diameter of the vessel is also important for ligation of obturator artery during various pelvic surgeries. In the present study the mean diameter of obturator artery was 2.47±0.67 which is thinner than the study conducted by Yuvraj¹ which was (3.07±0.52)

In the present study 96.66% obturator artery originated from anterior division of IIA where

as 45% obturator arteries were originated from anterior division of IIA in another study conducted by Yuvraj.¹

In the present study 3.33% obturator artery arose from posterior division which was similar as per of Pick et al.²⁵(3.28% of the cases), whereas Sonje et al.⁷ found in 10% of the cases which is higher the value of present study.

In contrast to our study origin of obturator artery from posterior division were most frequently observed by Kumar² and Sharmistha.²⁶

The origin of obturator artery from the posterior division was found to be longer than from anterior division, thus providing an added advantage for vascular grafting.²⁷

Hence a complete knowledge of abnormal origin of arteries related to pelvic vascular anatomy plays an important role in reducing the complications while performing endoscopic, inguinal hernioplasty and laparoscopic surgical procedures.²⁸

Authors	Type I %	Type II %	Type III %	Type IV %	Type V %	Others %	No. of cases
Adachi ¹⁰ (1928)	51.2	23.1	18.2	4.1	0.8	2.5	121
Jastschinski ¹⁵ (1891)	38	22.8	32.5	7.3	1.2		
Ashley and anson ¹⁹ (1941)	56.2	13.5	23.2	4.4	0.4		78
Braithwaite ²² (1952)	58.5	15.3	22.5	3.86			169
Fisher ²³ (1959)	50	26	16	8			50
Yamani ²⁰ (1998)	58	13.6	22.8	54	0.2		645
Fatu ¹⁸ (2006)	60	20	10	1	8		100
Naveen NS ⁹ (2011)	83.5	6.6	9.9				60
Pk ramkrishan ¹⁷ (2012)	60	30	8	2			50
Sakthivelivan ¹⁶ (2014)	63.2	15.8	21				116
Talalwal ⁸ (2014)	36.1	5.3	34.8	2.3			342
Mohamambayi ²¹ (2019)	54.2	17.7	20.7	5.6	0.4	3.41	4998
Present study(2022)	63.33*		36.66				30

* Type Ia pattern, Type Ib is not found in our study.

CONCLUSIONS

The present study highlights the variations seen in the branching pattern of IIA, length and diameter of the trunk of IIA, and we also observed variation in the origin of the obturator artery and its diameter. In the present study we found the branching pattern of IIA was Type I a in 19 (63.33%) of the cases and Type III in 11 (36.66%) of the cases. The type I b, Type II a, Type II b, IV and V pattern of Adachi were not observed. Obturator artery was found to be originating from both anterior division and posterior division of internal iliac arteries accounting as 96.66% and 3.33% respectively. Pelvic surgeries may lead to hemorrhage if branching patterns of the IIA are incorrectly

interpreted and thus endanger the patient's life, while ligating the artery during prostatectomy and hernioplasty. We believe that this study aims to explain the important aspects of the vascular anatomy of the IIA, not only for anatomists and morphologists, but also for the radiologists, general and vascular surgeons.

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