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ORIGINAL RESEARCH

Anatomical Study of the Branching Pattern of the Internal Iliac Artery in Human Cadavers

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Abstract

Background: The internal iliac artery supplies pelvic organs, the perineum, and the gluteal region. It generally exhibits notable anatomical variations in its branching pattern, which can be significant in pelvic surgeries, interventional radiology, or trauma care. A thorough understanding of these variations can prevent intraoperative complications such as inadvertent vascular injuries. The current study aimed to understand the branching patterns and variations of the internal iliac artery in human cadavers to enhance anatomical knowledge and surgical safety in pelvic procedures.

Methods: This anatomical study was conducted on 30 embalmed human cadavers with a total of 60 hemipelvises. Dissections were performed as per the standard protocol to expose the internal iliac artery and its branching pattern. The origin of major branches and anatomical variations was recorded.

Results: In the 60 hemipelvises from 30 cadavers, A classic bifurcation of the internal iliac artery into the anterior and posterior divisions was observed in 75% of cases. Trifurcation was found to be present in 13.3%, early branching in 8.3% cases, and unusual branching in 3.3% cases. The origin of the superior gluteal artery was predominantly from the posterior division in 86.7%, and the inferior gluteal and internal pudendal arteries shared a common trunk in 66.75 cases. The obturator artery arose from the anterior division in 83.3% and 16.7%, arising, from the external iliac artery. A bilateral symmetrical pattern was noted in 73.3% of cadavers, and minor gender-basedvariations were observed.

Conclusion: This study showed the anatomical diversity in the branching pattern of the internal iliac artery. Therefore, its importance should be highlighted in anatomical education and training. Understanding of the variations is also essential for clinicians to understand the complexity of pelvic vasculature. While classic bifurcation is the most common variant, such trifurcation and aberrant obturator origin shows the need for individualized anatomical assessment during pelvic surgeries.

Keywords: Internal Iliac Artery, superior gluteal artery, obturator artery, Anatomical variations

Introduction

The internal iliac artery (IIA), also known as the hypogastric artery it is a major branch of the common iliac artery. It plays an important role in supplying blood to the pelvic organs, perineum, and parts of the lower limb. Knowledge of its complex and often variable branching pattern is crucial for pelvic surgery, interventional radiological procedures, and trauma management. Anatomical variations of the internal iliac artery from its origin and the course of its branches are very common and clinically significant. Conventionally, the internal iliac artery is divided into anterior and posterior branches and then further into the parietal and visceral branches. The posterior division supplies the iliolumbar, lateral sacral, and superior gluteal arteries, and the anterior division divides the arteries into umbilical, obturator, inferior vesical, or vaginal if female, middle rectal, internal pudendal, and inferior gluteal arteries. However, it must be noted that there have been several variations in this pattern, which have been frequently documented in different studies and may not conform to the classical description [1].The important implications of variation of the internal iliac artery occur during internal iliac ligation, embolization for pelvic hemorrhage, pelvic lymphadenectomy, or pelvic lymphadenectomy, which may lead to inadvertent injury or insufficient perfusion of pelvic organs [2]. In addition, those that originate from the external iliac or inferior epigastric artery (corona mortis), for instance, the obturator artery, have a high tendency to cause severe hemorrhage during hernia repair and pelvic fracture surgeries [3]. Cadaveric studies remain indispensable when aiming at a given kind of diagnosis. They offer a direct view and help a person; in contrast, they make

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it easier to record structural variations. Some authors have performed anatomical studies in various populations and found that there are significant differences in the location and distribution of the IIA by ethnicity, sex, and level of development of the subject [4, 5].The classification proposed by Adachi and Yamaki to classify different variations in IIA branching has been widely used to describe internal iliac artery variations [6]. These classifications are useful in ensuring that anatomical observations are consistent and, hence, can be compared with other research findings. Although this knowledge is valuable, there is a dearth of research on IIA with regard to its regional differences, especially in the Indian context. Owing to the variation in connectivity and the rising popularity of pelvic surgeries and endovascular procedures, it is necessary to revise the current knowledge of IIA anatomy with the help of human cadaveric specimens. This study aimed to determine the branching pattern of the internal iliac artery among adult human cadavers and document any existing anatomical variation to provide a reference for future clinical and academic studies.

Materials and Methods

This descriptive observational study was conducted in the Department of Anatomy, Prathima Institute of Medical Sciences, Naganoor, Karimnagar, Telangana. This study followed the ethical standards of the institution and cadaveric dissection permission that were obtained prior to the commencement of the study.

This study included 30 embalmed adult human cadavers (60 hemipelvises) of both sexes. Cadavers with visible pelvic trauma, previous surgery performed, or pathological lesionsin the pelvic area were not included in order to limit anatomical error.Cunningham's Manual of Practical Anatomy was followed in carrying out dissections. A midline abdominal incision was performed, which was extended laterally to reflect the abdominal wall. The intestines and peritoneal contents were gently mobilised to reveal the bifurcation of the common iliac artery. The IIA was localized bilaterally and was traced to its terminal parts.

Particular care was taken to determine the division of the IIA into anterior and posterior trunks, and all the following branches were carefully dissected, observed, and listed. The observation of the origin, course, and numbers of branches were mentioned, and photographs were taken for recording and analysis. The noted branching pattern was compared with the classical anatomical description and classified according to the classification of Yamaki et al. [6], which classifies branching IIA according to the origin and distribution of its twigs into four primary types. The data were grouped and analyzed according to the frequency of each branching pattern. Sex-based and laterality (right vs. left) differences were also noted if relevant.

Statistical analysis: All the available data were refined, segregated, and uploaded to an MS Excel spreadsheet and analyzed by SPSS version 22 in Windows format. The continuous variables were represented as frequencies, mean, standard deviation, and percentages. The categorical variables were calculated by chi-square tests. The values of P (<0.05) were considered significant.

Results

Table 1 shows the demographic characteristics of the cadavers studied. A critical analysis of the table shows that a total of 30 cadavers, contributing 60 hemipelvises for anatomical dissection, were utilized in this study. Among them, 18 (60%) were male and 12 (40%) were female cadavers. The majority of cadavers, 20 (66.7%), belonged to the 40–60 years age group, while the remaining 10 (33.3%) were above 60 years.

Table 1: Demographic Distribution of Cadavers

Parameter	Number (%)
Total Cadavers	30
Hemipelvises	60
Sex	
Male	18 (60%)
Female	12 (40%)
Age group	
40 – 60	20 (66.7%)
> 60	10 (33.3%)

Table 2 classifies the branching patterns of the internal iliac artery observed in 60 hemipelvises. The results show that classic bifurcation into anterior and posterior divisions was the most common pattern, observed in 45 cases (75%). Trifurcation was noted in 8 hemipelvises (13.3%), where a common trunk gave rise to anterior, posterior, and additional branches. Early branching with no clear division was found in 5 cases (8.3%). Unusual asymmetric or mixed branching patterns were present in 2 hemipelvises (3.3%).

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Table 2: Branching Pattern of Internal Iliac Artery (n=60 Hemipelvises)		
Branching Type	**Number (%)**	**Illustration**
Classic Bifurcation	45 (75%)	Anterior + Posterior Division
Trifurcation	8 (13.3%)	Anterior + Posterior + Common Trunk
Early Branching (No Clear Division)	5 (8.3%)	Multiple direct branches from the main trunk
Unusual Branching	2 (3.3%)	Mixed/Asymmetric pattern

Table 3 depicts the origins of important branches of the internal iliac artery. The superior gluteal artery originated from the posterior division in 52 cases (86.7%) and directly from the main trunk in 8 cases (13.3%). The inferior gluteal and internal pudendal arteries shared a common trunk in 40 cases (66.7%), while in the remaining 20 cases (33.3%), they arose separately. The obturator artery originated from the anterior division in 50 hemipelvises (83.3%), while in 10 cases (16.7%) it originated from the external iliac artery, a variant relevant in pelvic and groin surgeries.

Table 3: Origin of Major Branches		
Branch	**Origin**	**Frequency (%)**
Superior Gluteal Artery (SGA)	Posterior Division	52 (86.7%)
	Directly from the Internal Iliac Trunk	8 (13.3%)
Inferior Gluteal Artery (IGA)	Common Trunk with Internal Pudendal	40 (66.7%)
	Isolated from the Posterior Division	20 (33.3%)
Internal Pudendal Artery (IPA)	Common Trunk with IGA	40 (66.7%)
	Directly from the Anterior Division	20 (33.3%)
Obturator Artery (OA)	Anterior Division	50 (83.3%)
	External Iliac Artery (Variant)	10 (16.7%)

The analysis of the symmetry of branching in 30 cadavers on the right as well as the left side is given in Table 4. A bilaterally symmetrical pattern was found in 22 cases (73.3%). However, 8 cadavers (26.7%) showed asymmetry. Among these 8 cadavers, 4 (13.3%) had a trifurcation on the left and classic bifurcation on the right side, and 3(10%) showed early branching on the left side with classic bifurcation on the right. One cadaver (3.315) showed a unilateral variant obturator artery origin.

Table 4: Symmetry of Branching Patterns (n=30 Cadavers)	
Symmetry	**Number(%)**
Bilateral Symmetry	22 (73.3%)
Asymmetry	8 (26.7%)
Common Asymmetric Patterns	
Left: Trifurcation; Right: Classic Bifurcation	4 (13.3%)
Left: Early Branching; Right: Classic Bifurcation	3 (10%)
Unilateral Variant Obturator Origin	1 (3.3%)

Table 5 compares internal iliac artery patterns based on gender. Among 36 male hemipelvises, classic bifurcation was noted in 28 (77.8%), compared to 17 out of 24 (70.8%) in females ($p = 0.53$) was not significant. Variation in the obturator artery origin from the external iliac artery occurred equally in males and females (16.7%). A common trunk for inferior gluteal and internal pudendal arteries was seen slightly more often in males (69.4%) than females (62.5%) ($p = 0.58$). The lack of statistically significant differences suggests minimal gender influence on branching patterns.

Table 5: Gender-Based Variations			
Parameter	**Male (n=36 Hemipelvises)**	**Female (n=24 Hemipelvises)**	**p-value**
Classic Bifurcation	28 (77.8%)	17 (70.8%)	0.53
Obturator Artery from External Iliac	6 (16.7%)	4 (16.7%)	0.92
Common Trunk (IGA + IPA)	25 (69.4%)	15 (62.5%)	0.58

Table 6 outlines the clinically important anatomical variations observed. The obturator artery arising from the external iliac artery was found in 10 cases (16.7%), which has implications for avoiding iatrogenic injury during hernia repairs. Accessory pudendal arteries were seen in 5 cases (8.3%), potentially influencing urological and gynecological surgeries. Absence of the posterior division occurred in 2 cases (3.3%), altering gluteal perfusion

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routes. Double superior gluteal arteries were found in 3 cases (5%), contributing to variability in surgical landmarks. These variations are critical in planning pelvic surgeries and interventions.

Table 6: Clinically Significant Variations/Anomalies

Variation	Number (%)	Clinical Relevance
Obturator Artery from External Iliac	10 (16.7%)	Risk of injury during hernia repair
Accessory Pudendal Artery	5 (8.3%)	Important in pelvic surgery
Absent Posterior Division	2 (3.3%)	Altered vascular supply to the gluteal region
Double Superior Gluteal Artery	3 (5%)	Anatomical landmark variability

Discussion

The internal iliac artery (IIA) is the main arterial supplying the pelvic organs, gluteal region, and perineum. A thorough understanding of its anatomical distribution and branching pattern is essential for safe surgical dissection and endovascular interventions involving the pelvis. The current study was a cadaveric study conducted on 60 hemi-pelvises aimed at evaluating the anatomical variations of IIA and assessing its branching patterns. In this study, we found that classical bifurcation of IIA into anterior and posterior divisions was observed in 75% of hemipelvises. This finding was in agreement with previous studies, such as that by Yamaki et al. [6], who classified the branching pattern of IIA and reported that the classical bifurcation into anterior and posterior branches existed in 72% of cases. They reported that trifurcation, early branching, and unusual asymmetric patterns were observed in the remaining 25%, depicting considerable anatomical variability. We found trifurcation in 13.3% of hemipelvises, and it is of clinical importance because it can alter the orientation and accessibility of branches during the surgery of the pelvis. The origin of its major branches, such as the superior gluteal artery (SGA), the inferior gluteal artery (IGA), the internal pudendal artery (IPA), and the obturator artery (OA), showed considerable variations. In this study, we found that SGA arose from the posterior division in 86.7%, aligning with findings of Prakash et al. [7], where they found a similar pattern of origin in 85% of their cases. It was also found that 13.3% of cases originate directly from the main trunk, which is of surgical importance because it can complicate surgical interventions. This study found that the IGA and IPA most commonly originated from a common trunk in 66.7% of pelvises. Similar findings have been reported by Mamatha et al. [8], who found this variation to be present in 60 – 70% of the dissections. This common origin is particularly important during internal iliac artery ligation for postpartum hemorrhage or pelvic trauma, where injury to both branches can occur inadvertently.

The OA in our study showed a classical origin from the anterior division in 83.3% of dissections. However, in 216.7% it was found to be originating from the external iliac artery, a variation called corona mortis. These findings were in concordance with the observations of Rusu et al. [9] and are potentially critical in surgery during hernia repair or pelvic surgeries, where injury to aberrant OA can cause life-threatening hemorrhage. In the current study, we found a symmetrical branching pattern in 73.3% of cadavers, which indicates they are generally bilaterally symmetrical; however, asymmetry was also observed in 26.7% of cadavers. The common asymmetrical pattern included trifurcation, early branching on one side, and classic bifurcation on the other. Such differences underline the need for preoperative vascular imaging for patients undergoing pelvic oncological resections or vascular reconstructions. This study did not find any statistically significant differences in IIA branching patterns between male and female cadavers. Similar observations have been reported by Sakthivelavan et al. [10], who also found gender-independent variation. Although we found differences in origin types, such as the common trunk of IGA and IPA however the differences did not reach the level of statistical significance. Other clinically relevant anomalies that were found included variant origin of OA 16.7%, followed by accessory pudendal arteries 8.3%, and double superior gluteal arteries 5%. We also found a rare anomaly, which is the absence of the posterior division, 3.3%, which has important implications for surgical ligation and gluteal flap vascularization. Such anomalies can increase the risk of inadvertent vessel injury, inadequate perfusion, or surgical failure.

Conclusion

This study showed the anatomical diversity in the branching pattern of the internal iliac artery. Therefore, its importance should be highlighted in anatomical education and training. Understanding of the variations is also essential for clinicians to understand the complexity of pelvic vasculature. While classic bifurcation is the most common variant, such trifurcation and aberrant obturator origin show the need for individualized anatomical assessment during pelvic surgeries.

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