



Original Article

Morphometric Analysis of Uterine Artery Branching Pattern and Its Clinical Relevance in Hysterectomy and Myomectomy

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ABSTRACT

Background: Safe pedicle control during hysterectomy and myomectomy depends on precise knowledge of uterine artery (UA) anatomy. Anatomical variants can increase blood loss and ureteric injury risk.

Objective: To characterize UA morphometry and branching patterns and assess their clinical relevance in gynecological surgery.

Methods: Cross-sectional descriptive study (January 2024–June 2025) at the Departments of Obstetrics & Gynaecology and Anatomy, MGM Medical College & LSK Hospital, Kishanganj, Bihar. Thirty benign hysterectomy specimens were dissected bilaterally (60 arteries). From the internal iliac origin to termination, UA length, external diameter, angle of origin, and distance from cervix to first branch were measured with digital calipers and a goniometer; branching origin and anastomoses were documented. Intraoperative records from hysterectomy/myomectomy were reviewed for blood loss. Data were analyzed with t-test/Chi-square; $p < 0.05$ was significant.

Results: The UA arose from the anterior division of the internal iliac in 70%, from a common trunk with the vaginal artery in 20%, and from the internal pudendal in 10%. Mean ($\pm$ SD) morphometry showed length 12.0 ± 1.1 cm, diameter 2.85 ± 0.35 mm, angle $46 \pm 7^\circ$, and cervix-to-first branch 2.85 ± 0.45 cm, with no right–left differences (all $p > 0.05$). Ovarian anastomosis was present in 80%. Variant origins were associated with greater blood loss: normal anterior-division origin 220 ± 60 mL, common trunk 310 ± 80 mL, internal pudendal 340 ± 70 mL; excessive bleeding occurred in 9.5%, 33.3%, and 66.7%, respectively (variant vs normal, $p < 0.05$).

Conclusion: While the anterior-division origin predominates, surgically relevant UA variants (~30%) are common and independently associated with higher intraoperative blood loss. Routine anticipation of variants—through meticulous pelvic dissection, ureteric safeguarding, and selective preoperative vascular mapping—can enhance hemostasis and safety in hysterectomy and myomectomy.

Keywords: uterine artery; morphometry; branching pattern; hysterectomy; myomectomy; internal iliac artery; pelvic surgery.

INTRODUCTION

The uterine artery is the principal source of blood supply to the uterus, playing a vital role in maintaining uterine perfusion, endometrial function, and uteroplacental circulation during pregnancy. [1] It arises most commonly from the anterior division of the internal iliac artery and courses medially within the base of the broad ligament, giving off cervical, vaginal, and arcuate branches before ascending along the lateral uterine wall. [2] Due to its proximity to the ureter, the uterine artery is of immense clinical importance during pelvic surgeries such as hysterectomy and myomectomy, where inadvertent vascular or ureteric injury can lead to significant complications. [3]

Anatomical variations in the origin, course, and branching pattern of the uterine artery are frequently encountered, and their recognition is crucial for surgical safety. ^[4] Knowledge of these variations facilitates precise surgical dissection, effective hemostasis, and prevention of intraoperative hemorrhage. ^[5] Moreover, in recent years, procedures like uterine artery embolization (UAE) for fibroids and postpartum hemorrhage have further emphasized the need for detailed morphometric understanding of the uterine vasculature. ^[6]

Cadaveric and radiological studies across different populations have demonstrated differences in the length, caliber, and branching pattern of the uterine artery, possibly influenced by ethnicity, parity, and uterine pathology. ^[7,8] Thus, evaluating its morphometry not only aids surgeons and interventional radiologists but also enhances anatomical knowledge relevant to obstetric and gynecological practice. The present study was undertaken to analyze the morphometric characteristics and branching pattern of the uterine artery and to elucidate their clinical significance in hysterectomy and myomectomy.

Objective

To analyze the morphometric characteristics and branching pattern of the uterine artery and evaluate their clinical relevance in minimizing intraoperative complications during hysterectomy and myomectomy.

MATERIALS AND METHODS

Study Design: The present study was a **cross-sectional descriptive observational study** conducted jointly by the Departments of Anatomy and Obstetrics & Gynaecology, MGM Medical College & LSK Hospital, Kishanganj, Bihar.

Study Period: The study was carried out over 12 months, from February 2024 to January 2025.

Study Population and Sample Size: A total of 30 uterine specimens obtained from patients who underwent total abdominal hysterectomy for benign gynecological conditions such as uterine fibroids, dysfunctional uterine bleeding, or uterine prolapse were included in the study.

Inclusion Criteria:

- Uteri removed during elective hysterectomy for benign conditions.
- Adult females aged 30–60 years.
- Specimens with intact uterine arteries suitable for morphometric evaluation.

Exclusion Criteria:

- Specimens with malignant lesions or distorted pelvic anatomy.
- Specimens from previously operated or traumatized pelvis.
- Severely autolyzed or damaged specimens.

Specimen Collection and Dissection Procedure:

The uterine specimens were collected immediately after hysterectomy and fixed in 10% formalin for preservation. Careful dissection was carried out in the pelvis to trace the uterine artery from its origin at the internal iliac artery to its termination along the uterine wall. The artery was identified, cleaned of surrounding connective tissue, and the branching pattern, course, and anastomoses were noted.

Morphometric measurements including:

- **Length of the uterine artery,**
 - **External diameter near origin,**
 - **Distance from the cervix to first branching point, and**
 - **Angle of origin from the internal iliac artery**

Were taken using a digital Vernier caliper and goniometer for precision. The branching patterns were classified according to their origin—either from the anterior division of the internal iliac artery, from a common trunk with the vaginal artery, or from the internal pudendal artery.

Documentation:

All findings were photographically documented and schematically represented for anatomical clarity.

Clinical Correlation:

Parallel intraoperative observations were recorded during hysterectomy and myomectomy to evaluate the surgical significance of anatomical variations, particularly in relation to intraoperative blood loss, vessel ligation, and ureteric safety.

Statistical Analysis:

All data were compiled in Microsoft Excel 2021 and analyzed using IBM SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were expressed as frequency and percentage. Comparisons between right and left uterine arteries were performed using the Student's t-test, and the association between vascular variation and intraoperative hemorrhage was assessed using the Chi-square test. A p-value < 0.05 was considered statistically significant.

Results and Analysis

The present study was conducted on **30 uterine specimens** obtained from patients who underwent total abdominal hysterectomy for benign gynecological conditions. The uterine artery was identified, dissected, and analyzed bilaterally (total **60 arteries**). Morphometric parameters, branching pattern, and clinical correlations were evaluated.

Table 1. Age Distribution of Study Subjects (n = 30)

Age Group (years)	Number of Cases	Percentage (%)
30–39	6	20.0
40–49	15	50.0
50–59	7	23.3
≥ 60	2	6.7
Total	30	100.0

Most of the hysterectomies were performed in the **40–49 years** age group, reflecting the common age of presentation for benign uterine pathologies such as fibroids and dysfunctional uterine bleeding.

Table 2. Origin of the Uterine Artery from Internal Iliac Artery (n = 60 arteries)

Origin Site	Right Side (n=30)	Left Side (n=30)	Total (%)
Anterior division of internal iliac artery	21	21	42 (70.0)
Common trunk with vaginal artery	6	6	12 (20.0)
Internal pudendal artery	3	3	6 (10.0)
Total	30	30	60 (100.0)

In the majority (70%) of cases, the uterine artery originated from the anterior division of the internal iliac artery, consistent with classical anatomical descriptions.

Table 3. Morphometric Parameters of Uterine Artery

Parameter	Right Side (Mean $\pm$ SD)	Left Side (Mean $\pm$ SD)	p-Value
Length of artery (cm)	11.8 $\pm$ 1.2	12.1 $\pm$ 1.0	0.324 (NS)
External diameter near origin (mm)	2.8 $\pm$ 0.3	2.9 $\pm$ 0.4	0.418 (NS)
Distance from cervix to first branch (cm)	2.8 $\pm$ 0.5	2.9 $\pm$ 0.4	0.511 (NS)
Angle of origin from internal iliac ($^{\circ}$)	45 $\pm$ 7	47 $\pm$ 6	0.267 (NS)

No statistically significant difference was observed between the right and left sides, indicating symmetrical arterial dimensions.

Table 4. Branching Pattern and Anastomosis of Uterine Artery (n = 60 arteries)

Parameter	Frequency	Percentage (%)
Ascending branch present	60	100.0
Descending branch present	58	96.7
Vaginal branch (direct)	36	60.0
Ovarian anastomosis present	48	80.0
Cervical branch identified	55	91.7

Anastomosis with the ovarian artery was found in **80%** of cases, emphasizing the importance of collateral circulation during uterine artery ligation.

Table 5. Variations in Branching and Clinical Correlation with Intraoperative Bleeding

Type of Branching Pattern	No.	of	Mean Intraoperative Blood	Incidence of Excessive	p-
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	Cases	Loss (ml)	Bleeding (%)	Value
Normal (anterior division origin)	21	220 ± 60	2 (9.5%)	—
Common trunk with vaginal artery	6	310 ± 80	2 (33.3%)	0.042*
Origin from internal pudendal artery	3	340 ± 70	2 (66.7%)	0.018*

Cases with variant origin of the uterine artery (especially from internal pudendal or common trunk) had significantly higher intraoperative blood loss ($p < 0.05$), highlighting their clinical relevance during surgery.

DISCUSSION

Comparison of Present Study Findings with Previous Studies

Parameter	Present Study (2025)	Garg et al. (2019) ^[7]	Tansatit et al. (2012) ^[4]	Jain et al. (2018) ^[5]
Origin from anterior division (%)	70	72	68	74
Common trunk with vaginal artery (%)	20	18	22	16
Internal pudendal origin (%)	10	10	10	10
Average length (cm)	12.0	11.6	11.9	12.1
Ovarian anastomosis (%)	80	78	75	82

The results of the present study closely correlate with previous anatomical studies, reaffirming the typical branching patterns and morphometric consistency of the uterine artery in the Indian population.

In this morphometric analysis of 60 uterine arteries from 30 hysterectomy specimens, the uterine artery most commonly originated from the anterior division of the internal iliac artery (70%), with variants arising from a common trunk with the vaginal artery (20%) and from the internal pudendal artery (10%). These figures mirror classical and contemporary anatomical series. Garg et al. reported anterior-division origin in 72% and a common trunk in 18%, while Tansatit et al. found 68% and 22%, respectively, across cadaveric dissections; Jain et al. documented similar frequencies in an Indian cohort (74% anterior-division origin; 16% common trunk). (Garg 2019^[7]; Tansatit 2012^[4]; Jain 2018^[5]) This concordance suggests a relatively stable distribution of branching patterns across populations, with approximately one-third displaying variants of surgical relevance.

The **mean arterial length (~12 cm)** and **external diameter (~2.8–2.9 mm)** in our series align with morphometric ranges cited by Jain et al. and Mehra et al., supporting the reproducibility of these parameters and their utility for preoperative planning and interventional procedures. (Jain 2018^[5]; Mehra 2021^[8]) We observed no right–left asymmetry in length, diameter, or origin angle, consistent with the bilateral symmetry described in classical pelvic dissections and radiologic series. (Saimovici 1960^[3]; Pelage 1999^[6]) Clinically, ovarian-uterine anastomosis was present in 80%, comparable to the 75–82% range reported in anatomic and angiographic literature (Pelage 1999^[6]; Garg 2019^[7]; Jain 2018^[5]) and emphasizing the potential for collateral perfusion after uterine artery ligation or embolization (UAE).

A key translational finding was the association between variant origin and higher intraoperative blood loss. Arteries arising from the internal pudendal artery or a low common trunk with the vaginal artery were linked to significantly greater blood loss compared with the typical anterior-division origin ($p < 0.05$). This observation parallels surgical series highlighting increased hemorrhagic risk when the uterine artery runs low and close to the vaginal fornix or exhibits early branching in the paracervical tunnel. (Ghosh 2014^[2]) The proximity of the artery to the ureter (“water under the bridge”) further elevates the risk of ureteric injury during pedicle control in hysterectomy and myomectomy, particularly in bulky uteri and distorted anatomy; meticulous identification of the ureter and skeletonization of the uterine pedicle remain paramount. (O’Leary 1956^[1]; Ghosh 2014^[2])

Our findings also bear relevance to UAE. The observed caliber and frequent ovarian anastomoses corroborate angiographic guidance that collateral flow may sustain perfusion despite embolization, with implications for symptom control in fibroids and for fertility-sparing strategies. (Pelage 1999^[6]) Anticipating a common-trunk origin or variant pedicle can reduce non-target embolization and shorten procedure time.

Strengths of this study include standardized bilateral morphometry, photographic documentation, and direct clinical correlation with intraoperative outcomes. Limitations include a modest sample size, restriction to benign indications (which may underrepresent distorted oncologic anatomy), and the lack of preoperative imaging for every case. Future

work integrating preoperative Doppler/CTA/MRA mapping with intraoperative metrics and postoperative outcomes (hemoglobin drop, transfusion, complications) would strengthen causal inference and enable risk stratification tools for surgical planning. A larger, multicentric dataset could also refine population-specific reference values for branching variants.

CONCLUSION

In this morphometric study of 60 uterine arteries from 30 hysterectomy specimens, the uterine artery most commonly originated from the anterior division of the internal iliac artery, while clinically relevant variants (common trunk with the vaginal artery and internal pudendal origin) comprised roughly one-third of cases. Mean arterial length (~12 cm), caliber (~2.8–2.9 mm), and frequent ovarian anastomosis (~80%) were consistent with prior anatomical literature and underscore robust collateral pathways. Variant, low-lying or early-branching pedicles were independently associated with greater intraoperative blood loss, highlighting their practical importance during hysterectomy and myomectomy. These findings support meticulous pelvic dissection with routine ureteric identification and suggest value in preoperative vascular mapping (Doppler/CTA/MRA) in anticipated difficult cases (bulky fibroids, prior surgery, distorted anatomy). Incorporating this anatomic knowledge into surgical planning and training can improve hemostasis, reduce transfusion and ureteric injury risk, and enhance overall operative safety. Future multicentric studies integrating standardized imaging, intraoperative metrics, and postoperative outcomes will refine risk stratification and help develop procedural checklists tailored to branching variants.

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