Anatomical variants of the uterine artery: 214 angiotomographies

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SUMMARY

The aim of the work is to know the changes that the uterine artery undergoes with age, the determination of its origin and its possible variants. Cross-sectional, comparative, descriptive, retrospective study Angiotomographies of the abdomen and pelvis of female patients were obtained, reformatted in 3D, analyzing the uterine arteries (thickness, origin and trajectory). Measurements were carried out by two medical specialists in diagnostic imaging. 107 CT angiograms of patients with a mean age of 56.62±16.97 years (range 1890) were included. The average thickness of the uterine arteries was 2.16 mm (±0.38 mm). Divided by laterality and age groups, they were 2.35 mm, 2.19 mm and 2.36 mm on the right side and 2.19 mm, 2.07 mm and 2.15 mm on the left side, respectively. There was no statistically significant difference in thickness between the three groups (p=0.08). Five types of anatomical variants are described with prevalence of 85.1% in type I, 6.75% in type II, 5.4% in type III, 2.02% in type IV and 0.67% in type V, the latter coming directly from the left ovarian artery. There are five different anatomical variants in our population, Type I is the most predominant. There are no significant morphological changes with age, except for an increase in vascular lesions, mainly atherosclerosis, in people over 50 years of age.

Keywords: Anatomy – Angiotomography – Gynecology – Uterine artery – Variants

INTRODUCTION

The classic anatomy of the uterine artery arises directly from the internal iliac artery, although it can also arise from the umbilical artery. It is the homologue to the artery of the vas deferens in man, and the one that gives the main irrigation to the uterus (Moore et al., 2013; Lockhart, 1959).

Gynecological surgical anatomy mentions that it arises exclusively from the internal iliac artery. However, there are reports of its origin independently, and of a common origin with the internal or vaginal pudendal artery (Rock et al., 2006; Sutton, 1997; Reich et al., 1989).

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Submitted: May 7, 2022. **Accepted:** May 18, 2022

https://doi.org/10.52083/GFWA3583

Hysterectomy is one of the most frequently performed surgical procedures in the United States. The most common indications are uterine fibroids (40.7%), endometriosis (17.7%) and uterine prolapse (14.5%) (ACOG, 2011; Lefebvre et al., 2002; Liu et al., 2006).

The conventional surgical technique via the abdomen is still relevant. However, minimal invasion and the use of natural orifices, such as the vaginal one, are promoted nowadays (Rock et al., 2006; CGP, 2009).

The uterus is pulled cranially and deviates to one side of the pelvis, stretching the inferior ligaments. A curved Heaney clamp is placed perpendicular to the uterine artery, taking care of the vasculature, to divide the ligament. The procedure is repeated on the contralateral side (Rock et al., 2006).

Aging produces changes in the structure and function of the arteries, giving rise to various cardiovascular diseases, such as hypertension, atherosclerosis, coronary disease, among others (Floryn et al., 2005)

The elderly population isthe group with the highest burden of cardiovascular diseases worldwide, especially coronary heart disease and myocardial infarction (Mirea et al., 2012) Atherosclerosis and loss of vascular elasticity can be observed in most elderly patients, but a more exaggerated response has been observed in hypertensive patients (Lahoz et al., 2007).

Hysterectomy is one of the most common gynecological surgical procedures. It is important to know its anatomical variants in relation to the vasculature and the expected changes with age. Our objective was to determine the prevalence of variants in our population, and to stratify the changes according to the age of the patient.

MATERIALS AND METHODS

A descriptive, observational, cross-sectional, comparative study was carried out. Angiotomographies were obtained from the database of the Radiodiagnosis Department of a hospital in Northern Mexico.

Mexican patients who for some reason underwent computed tomography angiography of the abdomen and pelvis were included. All those patients whose reason for study was trauma to the pelvis, hip, findings of congenital malformations of the pelvis, pregnancy, primary and secondary infectious processes of their corresponding organs, or with malformations of female organs were excluded. All those studies whose images did not allow a reconstruction, or whose quality made the evaluation of vascular structures difficult, were eliminated.

The equipment used for the acquisition of the images was the Light Speed VCT Model with 64 slices per rotation (General Electric, Milwaukee, WI), with a continuous scan with a thickness of 2.5 mm. To better visualize the images, reformatting with maximum intensity projection (MIP) and Volume Rendering (VR) were used, with software number 12HW14.6_SP1-1-1V40_H_H64_G_GTL. The reconstructed images were transmitted to workstations "Advantage Workstation AW 4.4" (General Electric, Milwaukee, WI), with a linear precision of 0.01 millimeters. Workstation calibration was predetermined by the manufacturer.

A Carestream Vue PACS Version 12.1.5.6009 workstation was used for the assessment of the uterine arteries, using reconstructions that were stored on a separate workstation.

Reconstructions and measurements were performed independently by 2 radiology experts.

Computed Tomography Angiography (CTA) were studied for their anatomical variant and were classified as type I to V. The internal diameter of the vessel was recorded at its site of origin (M1), and at its ascending portion (M2). The data were recorded in an Excel table to determine their frequencies, mean and standard deviation. Carrying out this analysis did not interfere in any way with the normal protocols for carrying out, storing and delivering the results of the study to the patient or doctor requesting it. No CTA was performed for the purpose of the study, and there was no radiation exposure for the purpose of this investigation.

This research protocol was previously reviewed and approved by the ethics and research committees of the University, with registration GI 17-003.

The sample size was determined using a formula for calculating a prevalence or proportion, with a Z value of 1.96 and a confidence level of 95%, and a precision of 10% expecting a proportion of 50%, a sample of 140 arteries to carry out this study.

RESULTS

107 studies were included, of which 74 (69.16%) could be reconstructed. The remaining 30.84% (n 33) with a mean age of 56.62 ± 16.97 years was included for determination of variants, but not in vessel morphometry due to elimination criteria (Table 1).

Table 1. Reason for elimination of studies in 3D reconstruction for morphometries.

Pathology	Average Ages (years)	Sample (n 33)
Atherosclerosis	58 ± 7.2	17
Hysterectomy	62 ± 9.4	11
Myoma	49 ± 10.2	4
Adnexal mass	48 ± 5.2	1

The patients were stratified into three groups according to their age (Table 2). When comparing the calibers of the uterine arteries between the 18-40 and 41-60 age groups, a statistically significant difference was found (p= 0.04). However, when comparing the three groups through ANOVA, no difference was found between the three groups (p = 0.08), although there was a positive trend.

Table 2. Age groups and measurement of uterine arteries. Ranges expressed in years. Values expressed in millimeters (mm) n: sample size; M1: diameter at its origin; M2: diameter in its ascending portion.

Age ranges	Uterine artery			
	Right		Left	
	M1	M2	M1	M2
18-40 (n 26)	2.41±0.38	2.3±0.49	2.15±0.28	2.23±0.61
41-60 (n 60)	1.97±0.49	2.05±0.41	2.01±0.40	2.13±0.49
60-90 (n 62)	2.36±0.45	2.530.39	2.2±0.39	2.1±0.38
Average	2.14±0.46	2.17±0.42	2.14±0.35	2.15±0.51

Variants of the uterine arteries

From the findings found in the analyzed studies, the following order is proposed for the categorization of the variants in the origin of the uterine arteries.

- Type I. - The origin of the uterine artery is directly from the anterior trunk of the internal iliac artery (Fig. 1).
- Type II. - The origin of the uterine artery comes from the branch of the anterior trunk of the internal iliac artery, called the inferior gluteal/superior vesical artery (Fig. 2).
- Type III. - The origin of the uterine artery is independent and comes directly from the internal iliac artery to one side of the bifurcation of the inferior and superior gluteal arteries (Fig. 3).
- Type IV. - The origin of the uterine artery comes from the umbilical branch of the anterior trunk of the internal iliac artery (Fig. 4).

A unique variant was found, not previously described, which is proposed as a Type V variant (with an origin directly from the ovarian artery, which in turn came from the left renal artery, instead of the abdominal aorta, as classically described).

Table 3 outlines the distribution of the types regardless of whether it is right or left.

Table 3. Categorization of the anatomical variants of the uterine artery.

Variants	Total n 214 (%)	Uterine artery	
		Right n 10 (%)	Left n 107 (%)
I	182 (85.04)	89 (83.17)	93 (86.91)
II	15 (7.00)	9 (8.41)	6 (5.60)
III	11 (5.14)	7 (6.54)	4 (3.73)
IV	5 (2.33)	2 (1.86)	3 (2.80)
V	1 (0.46)	0 (0.00)	1 (0.93)

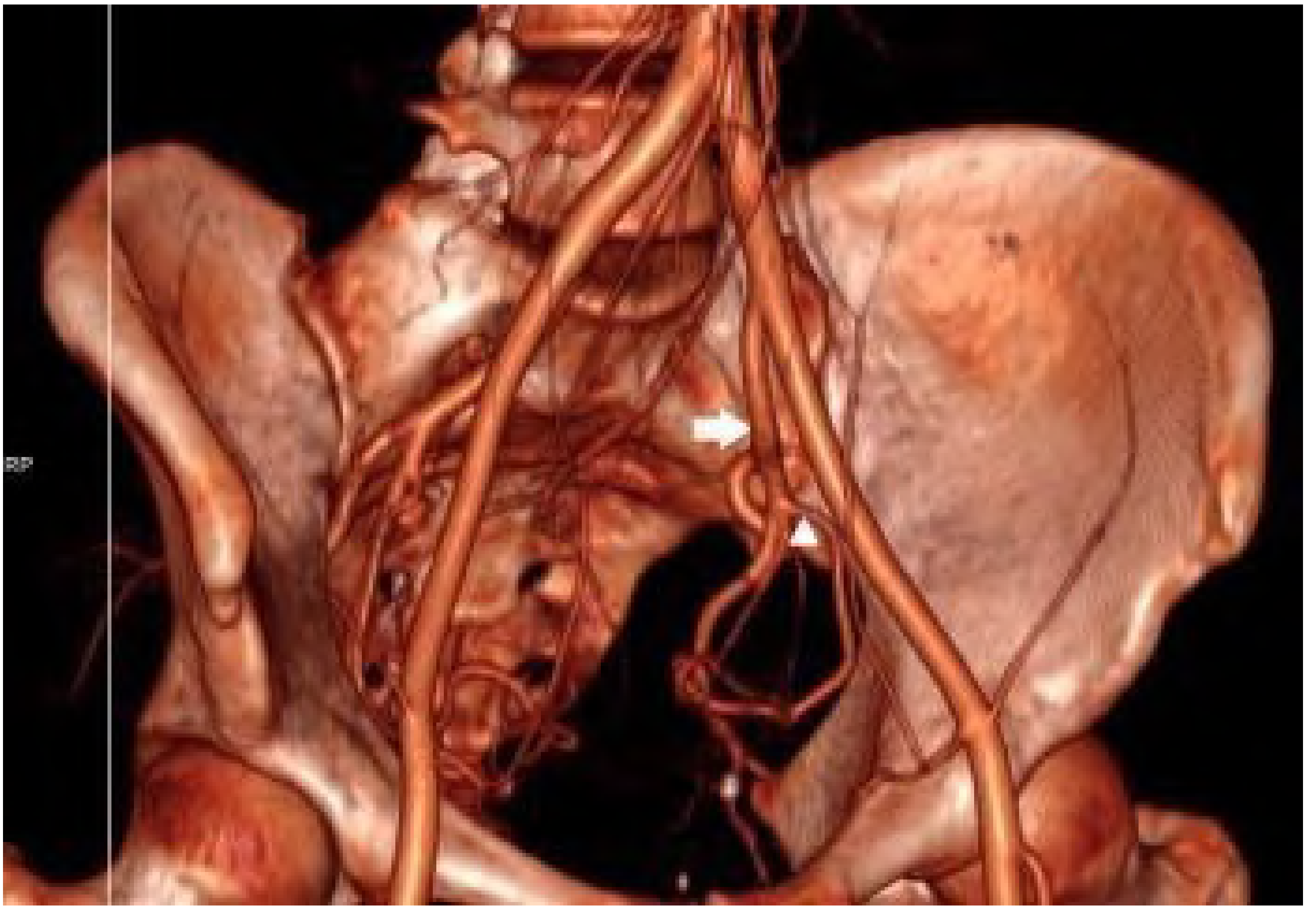

Fig. 1.- The origin of the uterine artery (arrowhead) is directly from the anterior trunk of the internal iliac artery (arrow).

Fig. 2.- The origin of the uterine artery (arrowhead) is independent, and comes directly from the internal iliac artery (arrow) to one side of the bifurcation (Ray) of the inferior and superior gluteal arteries.

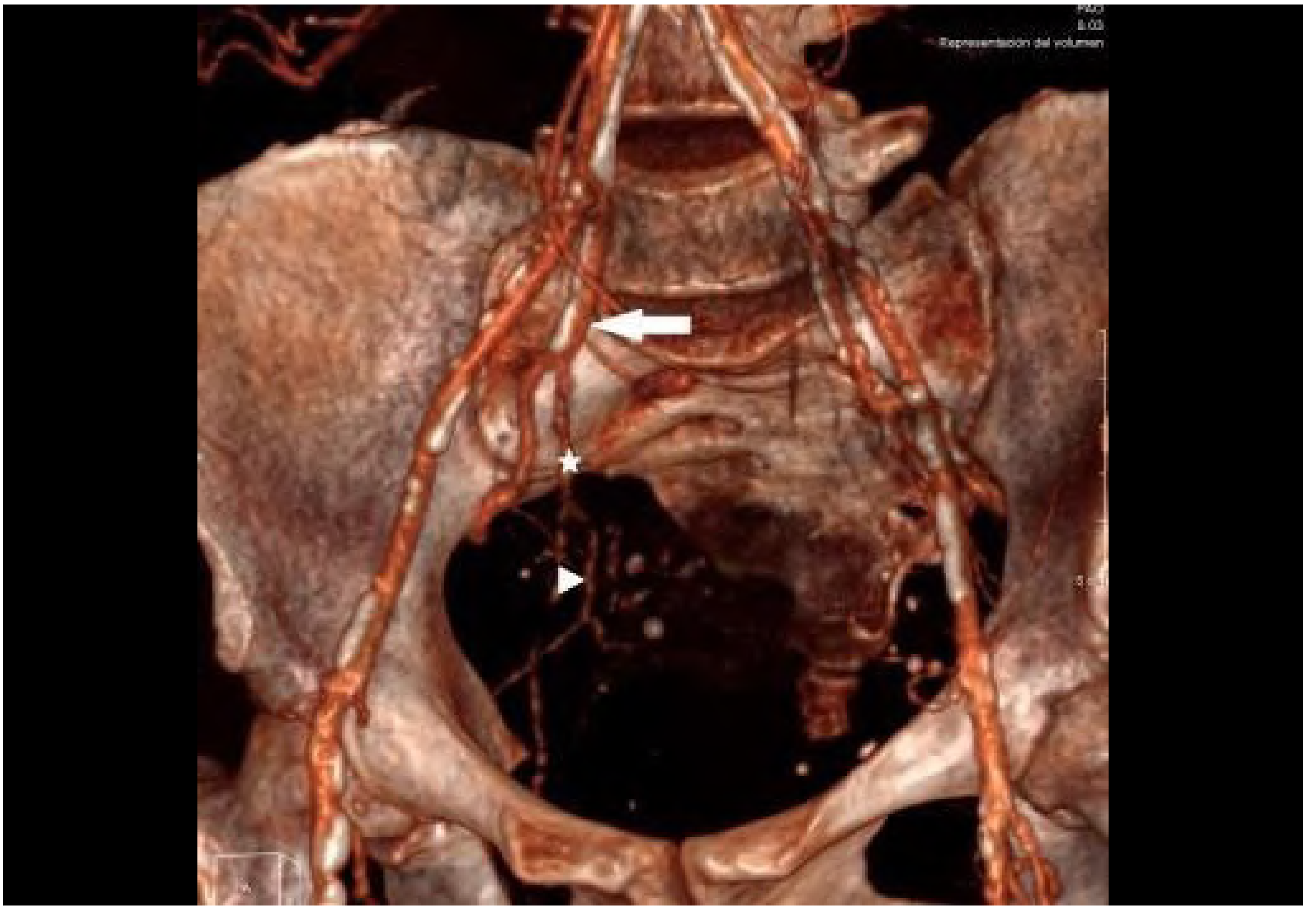

Fig. 3.- The origin of the uterine artery (arrowhead) comes from the branch of the anterior trunk (star) of the internal iliac artery (arrow) called inferior gluteal/superior vesical.

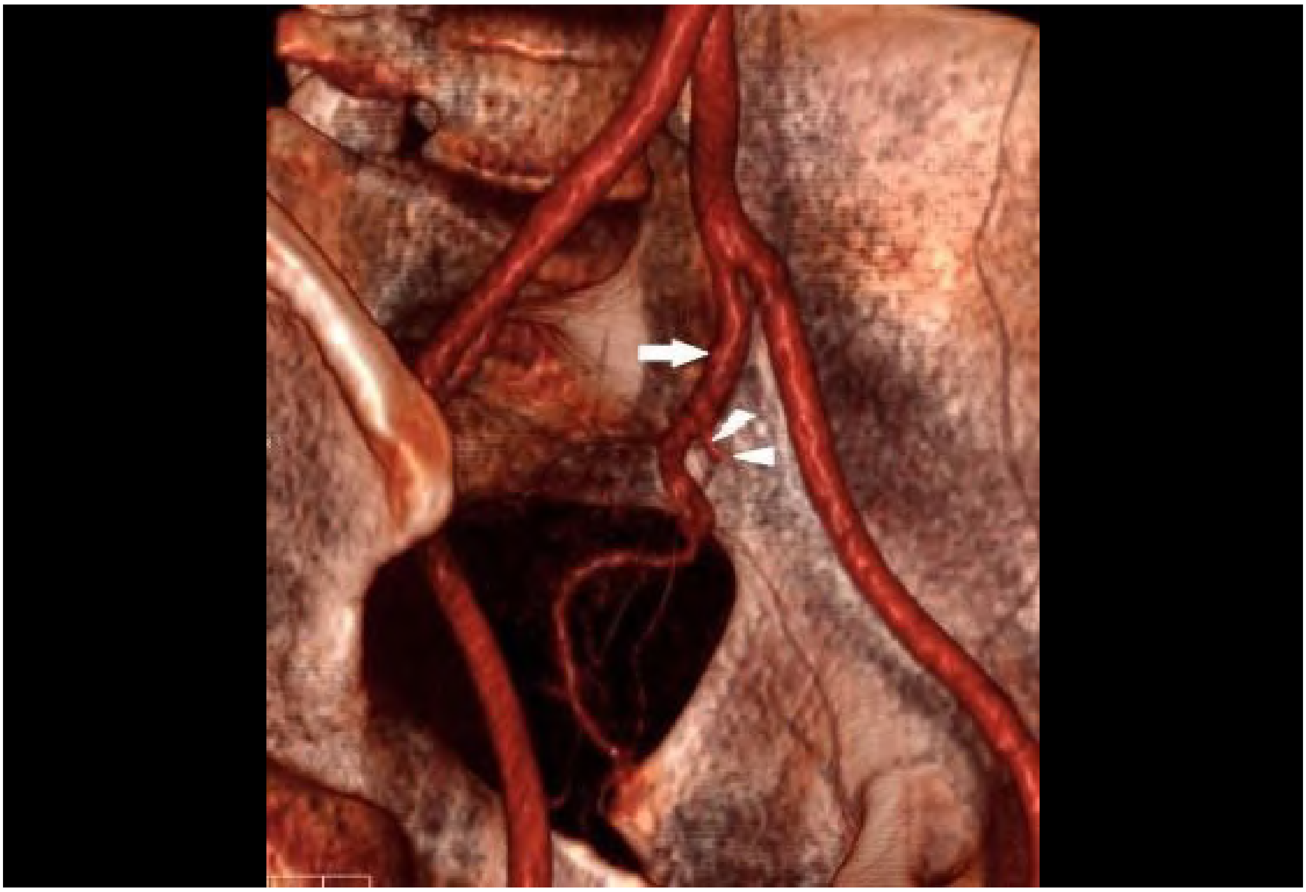

Fig. 4.- The origin of the uterine artery (arrowhead) comes from the umbilical branch (lightning) of the anterior trunk of the internal iliac artery (arrow).

DISCUSSION

Every doctor must have a broad knowledge of human anatomy and how it influences pathologies. This is even more important in surgical procedures, since ignorance can increase injuries. Knowledge of the prevalence of anatomical variations helps to reduce risks (Clayton, 2006).

In this study, we demonstrate that there are anatomical variants in the origin of the uterine artery, the most common being type I, with a prevalence of 85%.

Our study showed that, in 85.04% of cases, the origin of the uterine artery comes directly from the anterior trunk of the internal iliac artery. This is followed in 7.00% of cases by the variant that arises from a branch of the anterior trunk of the internal iliac artery called the inferior gluteal or superior vesical artery. It is reported that the variant called type III in our study, arising as an independent branch of the internal iliac artery, appeared in 5.1% of cases. Likewise, the appearance of the variant in the origin of the uterine artery from a branch of the anterior trunk, called the umbilical or superior vesical artery, was documented in 2.33% of the cases, a much lower proportion, unlike that reported in the study by Arfi et al. (2017), who reported observing this variant in up to 25.6% of cases.

They carried out a study in which they analyzed the anatomy of the arteries that make up the female genital tract, where they used angiography to determine their results, concluding that the best projection for visualizing the uterine artery, when it originated from the anterior division of the internal iliac artery, was the contralateral, oblique-anterior with 20- 30 degrees of inclination (Mori et al., 2010).

Three age groups were formed according to the stage of the woman's fertile life, and the diameters of the arteries were compared in two different portions and independently between the three groups, with no statistically significant findings.

In 2002, Razavi et al. conducted a study in which they analyzed and classified the place where the ovarian arteries anastomose with the uterine arteries in women who underwent uterine fibroid embolization. For this, they used 76 angiographies of female patients, finding variations in the course of the uterine artery, showing a pattern of three different types of anastomoses. In type I, the blood supply of the ovarian artery through the uterus came directly from the uterine artery; in type II, the ovarian artery supplied the fibroids directly; and in type III there was no ovarian artery, and the total blood supply to the ovary came directly from the uterine artery.

Albulescu et al. (2014) carried out a study in which the origin and trajectory of the uterine artery were analyzed in 110 angiographies of female patients, resulting in a classification with 4 types of variants.

A study led by Dr. Alexandra Arfi was conducted in 2017 at Hospital Intercommunal de Cretéil in Paris, France, where 43 3D CTA reconstructions were performed to determine the origin of the uterine artery, and the results were: direct origin of the anterior trunk together with the umbilical artery in 62.7% of cases; from a direct branch of the internal iliac artery in 25.6% of cases; directly from the superior gluteal artery in 9.3% of cases; and from the internal pudendal artery in 2.3% of cases (Arfi et al., 2017).

To our knowledge, this is the first study that, apart from determining the origin of the uterine artery, evaluates its diameters at two different points in a standardized manner. A 3D reconstruction technique is used, which allows the artery to be assessed from all angles, and to determine the incidence of other vascular diseases that affect its morphology.

According to the findings found in our study, the origin of the uterine artery is in the same proportion as that reported in the previously described literature (Wu et al., 2007; Akerman, 2019; Barodka et al., 2011).

It is worth highlighting the finding of a variant that has not been previously described, which was called Type V, and which had its origin in the left ovarian artery, which is a branch of the left renal artery.

Previous series of studies may be difficult to compare due to different descriptions of the pelvic vascular anatomy in the radiological and surgical literature, with substantial differences in the nomenclature of the branches of the internal iliac artery.

The present study has several limitations. It is a retrospective evaluation of healthy patients, whose specific medical history is unknown, as well as their gynecological history. Nor is the height and weight of the patient taken into consideration.

This study reports five different anatomical variants in the origin of the uterine artery, categorized according to the order of appearance and frequency. The fifth variant is described for the first time and arises directly from the ovarian artery, which in turn arises directly from the left renal artery. Uterine artery diameters were determined at two different sites, without identifying statistically significant findings when grouping patients by different stages of female fertile life. Age is not a factor that favors variability in uterine arterial thickness.

The blood vessels suffer injuries with age, which correlates with the findings found in the analyzed studies of patients over 50 years of age, mainly the incidence of atherosclerosis.

ACKNOWLEDGEMENTS

To all the work team and colleagues of the institution who helped in the preparation of this study.

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