

## ORIGINAL ARTICLE

## Evaluation of Uterine Artery Origins on Contrast-Enhanced Magnetic Resonance Images

## Kontrastlı Manyetik Rezonans Görüntülerinde Arteria Uterina'nın Orijinlerinin Değerlendirilmesi

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## ABSTRACT

**Background/Aims:** The origin of the uterine artery varies widely. The branching patterns of the internal iliac artery are also quite variable. Branching of the internal iliac artery in different ways is important in pelvic surgery. In our study, fertile and infertile groups were created, and the arteries that gave rise to the uterine artery were examined.**Methods:** A total of 152 uterine arteries (n = 152) were evaluated retrospectively on 3D contrast-enhanced magnetic resonance images. Based on the study of Gomez-Jorge, the types of origin of the uterine artery were obtained. With regards to the incidence of types, differences between the fertile and infertile groups were examined.**Results:** There was no statistically significant difference between the groups in terms of the incidence of origin types (p = 0.214). Based on the study of Gomez-Jorge, five different types of origins were obtained. The most common was type I (the uterine artery being the first branch of the inferior gluteal artery) origination.**Conclusions:** There are studies investigating the origin of the uterine artery in literature. We believe that our findings will also contribute to the body of knowledge available.**Keywords:** Magnetic resonance, uterine artery, variation

## ÖZ

**Amaç:** Arteria uterina'nın kökeni büyük ölçüde değişiklik gösterir. A. iliaca interna'nın dallanma paternleri de oldukça değişkendir. A. iliaca interna'nın farklı şekillerde dallanması pelvik cerrahide önemlidir. Çalışmamızda fertil ve infertil gruplar oluşturuldu ve a. uterina'nın köken adı arterler incelendi.**Metod:** Toplam 152 arteria uterina (n = 152), 3D kontrastlı manyetik rezonans görüntüleme yöntemi ile retrospektif olarak değerlendirildi. Gomez-Jorge'un çalışmasına dayanarak, arteria uterina'nın orijin tipleri elde edildi. Tip insidansı ile ilgili olarak, fertil ve infertil gruplar arasındaki farklılıklar incelendi.**Bulgular:** Gruplar arasında orijin tipleri insidansı açısından istatistiksel olarak anlamlı bir fark yoktu (p = 0.214). Gomez-Jorge'un çalışmasına dayanarak 5 farklı orijin tipi elde edildi; buna göre en yaygın olanı Tip I (a. uterina, a. glutea inferior'un ilk dalıdır) orijiniydi.**Sonuç:** Literatürde a. uterina'nın kökenini araştıran çalışmalar mevcuttur. Bulgularımızın da mevcut bilgi birikimine katkıda bulunacağına inanıyoruz.**Anahtar Kelimeler:** Manyetik rezonans, arteria uterina, varyasyon

## Introduction

The main artery of the uterus is the uterine artery. On both sides, it is separated from the anterior portion of the internal iliac artery. These vessels curve around the uterus and run inferomedially into the broad ligament of the uterus. The uterine artery gives off a branch that passes superiorly to the uterine tube. When it comes to the hilum of the ovary, it anastomoses with the ovarian artery. In addition to the nutrition of the uterus, it also contributes to the nutrition of the uterine tubes, ovaries and vagina (1). During pregnancy, some changes occur in the uterine artery. Due to the increase in blood flow through it, its volume increases and it becomes even more curved (2). In the embryological period, the uterine artery originates from the foetal umbilical arteries. After birth, the peripheral segment of the umbilical artery obliterates while the central segment develops to provide vascularization with the internal iliac artery and external iliac artery (3). Adachi grouped the branching patterns of the internal iliac artery with

the embryological approach in 1928 (4). The uterine artery shows great variation in origin and these variations should be considered in pelvic surgeries, especially operations such as hysterectomy, myomectomy, and gynecological oncology procedures. In operations requiring high vascular ligation of the uterine artery, knowing the origin of the uterine artery is crucial to prevent complications such as bleeding (5,6). It is vital to know beforehand the variations in the decision of emergency operation in bleeding complications that may develop after delivery (7). Differences in the origin of the uterine artery are also associated with poor pregnancy outcomes. In addition, serious problems such as accidental ligation and cutting of the ureter due to variations are encountered (8,9). We aim to contribute to literature on the origin differences of the uterine artery and to emphasize the significance of this important variation in pelvic surgeries.

## Material and Method

With the approval of the Selcuk University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee, we conducted a retrospective examination of the uterine artery origins of infertile and fertile women aged 20–45 years admitted to Selcuk University Medical Faculty Hospital In Vitro Fertilization (IVF) Polyclinic between October 2015 and October 2019. For our study, two separate groups of infertile and fertile individuals were formed. There were 28 infertile women in Group I and 48 healthy fertile women with normal uterine anatomy in Group II. Women who did not have fibroids, polyps and cervical nabothian cysts were included in the study. The mean age of Group I was 29, while the mean age of Group II was 28 years. A total of 76 women's right and left uterine artery origins (152 uterine arteries in total) were evaluated. Images obtained from a contrast-enhanced magnetic resonance imaging (MRI) device (Aera, Siemens Healthcare, Erlangen, Germany) with a section thickness of 5 mm were transferred to Syngo via (Syngo.via version VB30A, Siemens Healthcare) program and T1-weighted arterial phase images were analyzed.

The study of Gomez-Jorge et al. (2003) was used as a reference to aid the classification of the origin of the uterine artery. The term "unclassifiable" was used for cases when the uterine artery could not be distinguished or its origin could not be determined. In this study, we added the 5th type (the origination of the internal pudendal artery) in addition to the four types in the study of Gomez-Jorge et al. (2003) (10). Accordingly, the types were shown in 5 groups and given schematically in Figure 1. Also, MRI images are shown in Figure 2.

Type 1: In this case, the uterine artery is the first branch of the inferior gluteal artery.

Type 2: The uterine artery separates as the second or third branch of the inferior gluteal artery.

Type 3: The uterine artery, inferior gluteal artery, and superior gluteal artery come out of the same level and trifurcate.

Type 4: The uterine artery separates from the proximal of the place where the inferior gluteal artery and superior gluteal artery originate.

Type 5: The uterine artery separates from the internal pudendal artery.

It was examined whether there was a statistically significant difference in the incidence of uterine artery origin types between the fertile and infertile groups. For this, the Pearson's chi-squared test method was used ( $p < 0.05$  was considered significant).

## Results

In our study, a total of 152 uterine arteries were examined, including the right and left sides in 76 women. The study by Gomez-Jorge et al (2003) was used as a point of reference for the origin typing of the uterine artery. In total, 56 uterine arteries were examined in Group I and 96 in Group II on the right and left. MRI images are shown in Figure 2. The numbers and percentages of uterine artery origin types according to the groups are given in Table 1.

In total, type I (53.29%) was the most common type. The second most common type was type II (15.79%) and the least common type of origin was type V (2.63%). The origin of 18 (11.84%) uterine arteries could not be classified. The absence of the uterine artery was not found. There was no statistically significant association between the groups in the incidence of uterine artery origin types ( $p=0,170$ ).

**Table 1.** Numerical and percentage distributions of uterine artery origin types by groups.

|          | Type 1      | Type 2      | Type 3     | Type 4     | Type 5    | Unclassifiable | Total |
|----------|-------------|-------------|------------|------------|-----------|----------------|-------|
| Group I  | 32 (%57,14) | 8 (%14,29)  | 7 (%12,5)  | 1 (%1,79)  | 3 (%5,36) | 5 (%8,93)      | 56    |
| Group II | 49 (%51,04) | 16 (%16,67) | 8 (%8,33)  | 9 (%9,38)  | 1 (%1,04) | 13 (%13,54)    | 96    |
| Total    | 81 (%53,29) | 24 (%15,79) | 15 (%9,87) | 10 (%6,58) | 4 (%2,63) | 18 (%11,84)    | 152   |

**Table 2.** Uterine artery origins in literature

| Article                   | Study type            | Number of patients | Origin of uterine artery |      |                      |       |
|---------------------------|-----------------------|--------------------|--------------------------|------|----------------------|-------|
|                           |                       |                    | IGA                      | SGA  | IGA-SGA trifurcation | IPA   |
| Lipshutz (1918)           | Cadaver               | 93                 | -                        | -    | -                    | %3    |
| Roberts et al. (1966)     | Cadaver               | 167                | -                        | -    | -                    | %2,1  |
| Gomez-Jorge et al. (2003) | Arteriography         | 257                | %51                      | -    | %6                   | -     |
| Holub et al. (2005)       | Laparoscopy           | 100                | -                        | -    | -                    | %23,5 |
| Naguib et al. (2008)      | MRI angiography       | 49                 | -                        | -    | -                    | %1    |
| Obimbo et al. (2010)      | Cadaver               | 53                 | %10,3                    | -    | -                    | -     |
| Chantalat et al. (2013)   | Arteriography         | 34                 | -                        | %8,8 | -                    | -     |
| Arfi et al. (2017)        | CT angiography        | 43                 | -                        | %9,3 | -                    | %2,3  |
| Hao et al. (2019)         | CT angiography        | 112                | %64,3                    | -    | %12,9                | -     |
| Orhan et al. (2019)       | Laparoscopy           | 378                | -                        | -    | -                    | -     |
| Our study                 | Contrast-Enhanced MRI | 152                | %53,29                   | -    | %9,87                | %2,63 |

IGA: Inferior gluteal artery, SGA: Superior gluteal artery, IPA: Internal pudendal artery.

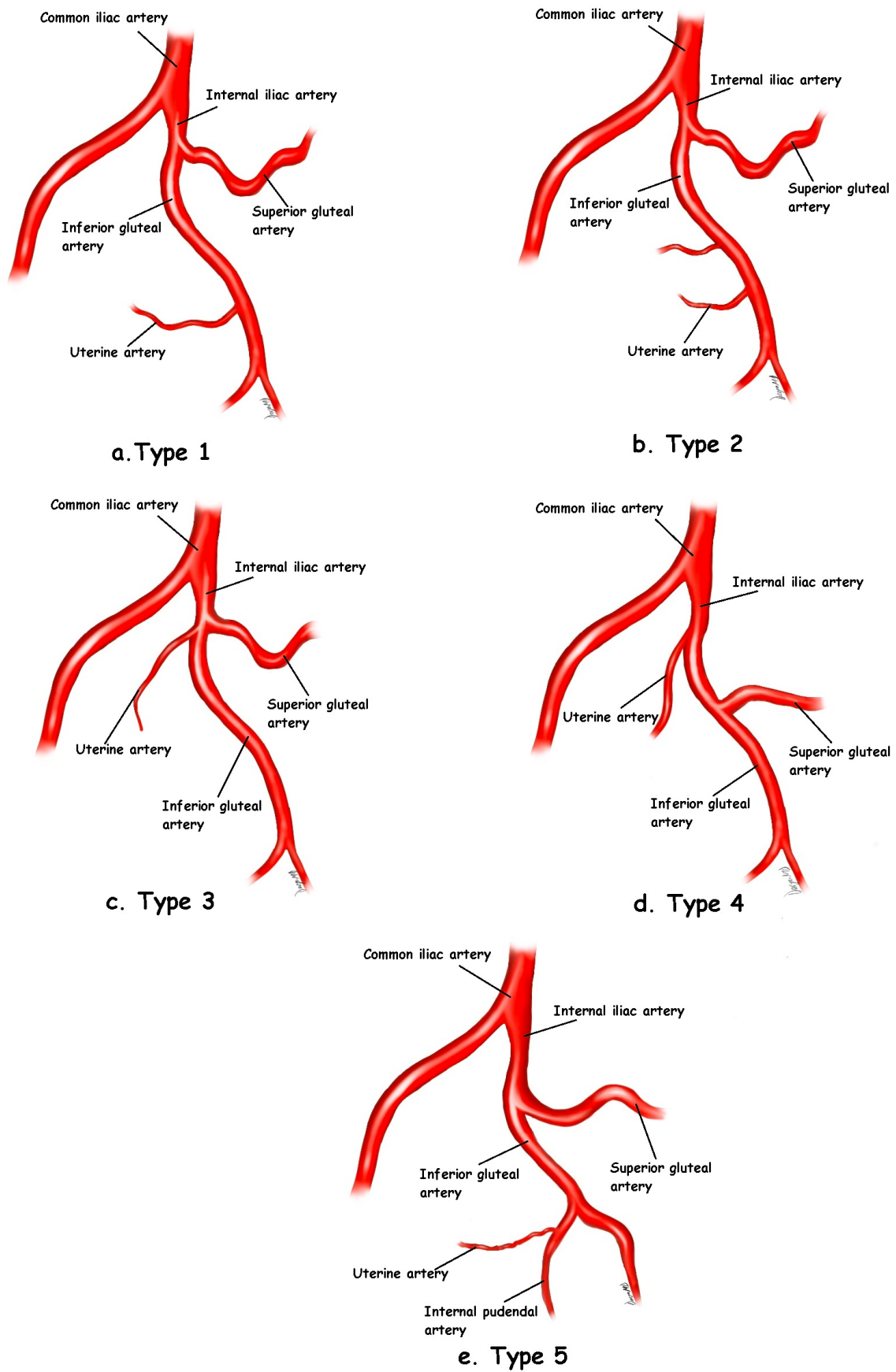
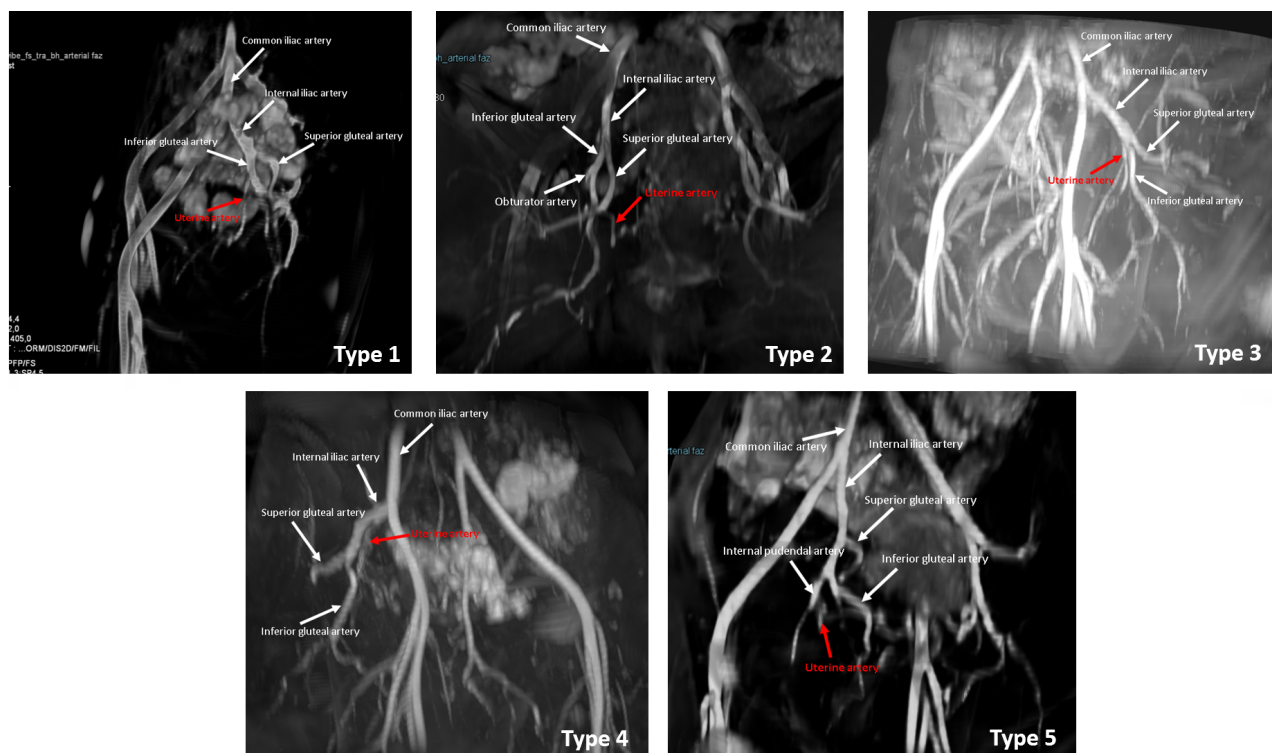


Figure 1. 3D schematic view of the uterine artery.



**Figure 2.** Contrast-enhanced magnetic resonance images of uterine artery.

## Discussion

The vascular anatomy of the uterus is very important for surgeons during pelvic and gynecological operations (6). The nutrition of the uterus is provided by the uterine artery originating from the internal iliac artery (1). The course and variations of the artery in hysterectomy, myomectomy, and different oncological procedures should be well known with regard to high vascular ligation (5,11). The internal iliac artery, which nourishes the pelvic organs, has a highly variable branching pattern (4,12) (Table 2). Using a total of 396 cadavers, Jastschinski (1891) was the first to classify the branching pattern of the internal iliac artery. He classified the branches of the internal iliac artery into three groups; large (like a. glutea superior), medium (like a. obturatoria), and small (a. iliolumbalis) diameter arteries (13). According to him, only the origins of large-diameter arteries are more common and stable. Due to the difference in the branching patterns of the internal iliac artery, the origin of the uterine artery has been constantly studied by researchers. The uterine artery also shows much variation in origin; therefore, it is difficult to create a recognizable and acceptable classification (5,6,14). According to literature, the inferior gluteal artery, superior gluteal artery, their bifurcations or trifurcations, and the internal pudendal artery were identified as the arteries from which the uterine artery originates (Table 2). Naguib et al., (2008) evaluated 95 uterine arteries in 49 patients with MR angiography, as in our study, and reported that the uterine artery originates mostly (86%) from the anterior division (15). According to the laparoscopic typing of Orhan et al., (2020),

the uterine artery originates mostly from the anterior division. Roberts & Krishinger (1967) have also stated that the uterine artery separates from the anterior part of the internal iliac artery at a rate of 56% (16). There are also reports in the literature indicating that the most common origin is the umbilical artery (17,18) and Obimbo et al., (2010) on the other hand, have stated that the most common origin is the internal iliac artery itself, and it separates from here as the second or third branch (8). When the uterine artery separates directly from the internal iliac artery, it usually makes a bifurcation or trifurcation with the inferior gluteal artery and the superior gluteal artery (6). In the cadavers that Lipshutz (1918) examined, the internal pudendal artery as the origin was found at a rate of 1% (19). In our study, the internal pudendal artery origin was found at a rate of 5.3% in Group I and 1% in Group II. When the origin rates were compared between the groups, no statistically significant difference was found.

As can be understood from the reports, the places where the uterine artery originates are highly variable in the literature. In our study, we determined our types by taking the study of Gomez-Jorge et al., (2003) as a reference (10). In our study, the most common (57.5%; 51%) origin of the uterine artery in both groups was the inferior gluteal artery, and this was similar to the data of Hao et al., (2019) and Gomez-Jorge et al., (2003) (10,12). In total, the least point of origin was from the internal pudendal artery (2.63%), which was at a rate similar to that of other studies, except for the study of Holub et al. (17). The origination rate of the uterine artery from the most proximal part of the internal iliac

artery was determined as 3.1% in the study of Orhan et al and 6% in the study of Gomez-Jorge et al (2003) (10,20). In our study, the type IV origins had a total rate of 6.5% and were similar to the results in the literature. In the studies of Chantalat et al., and Arfi et al., the superior gluteal artery was found among the origins of the uterine artery, and it had a rate of approximately 9% in both studies (4,18). In our study, there was no uterine artery originating from the superior gluteal artery. Instead of isolated superior gluteal artery origin, we detected an origination in the form of trifurcation with the superior and inferior gluteal artery (9.8%). When we looked at the origination in the form of trifurcation, numbers similar to the rates in the literature were obtained. There are also some case reports of rare anatomical variations such as the origination of the uterine artery from the external iliac artery and the inferior epigastric artery. No such variation was found in our study. Although rare, it has been reported that there is no uterine artery in individuals, and the uterus is nourished by alternative vessels in these individuals. According to Saraiya et al., the absence of the uterine artery in an individual is compensated by the inferior epigastric artery (21,22). The uterine artery was present in all images we examined in our study.

There was no study in previous literature investigating whether the differences in the origination of the uterine artery make a difference between infertile and fertile individuals. There was no statistically significant difference in the rates of uterine artery origin types nourishing the uterus in infertility compared to fertile individuals.

#### Declarations

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**Disclosure of potential conflict of interest:** The authors declare that they have no conflict of interest.

**Ethical approval:** All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Ethical approval (approval number 2019/396) was given by the Local Ethics Committee of the Medical Faculty.

**Data statement:** All data supporting the findings of this study are available upon request.

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#### Author Contributions

Conception: B.S., N.U.D., O.S., Data Collection and Processing: B.S., O.S., E.U., Design: B.S., N.U.D., O.S., E.U., Supervision: N.U.D., Analysis and Interpretation: B.S., N.U.D., Z.F., A.K.K., Literature Review: B.S., Writer: B.S., Critical Review: N.U.D., O.S., E.U., Z.F., A.K.K.

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