

## Research Article

# Uterine artery embolization angiography and fertility related aspects

Irina A. Horhoianu<sup>1</sup>, Răzvan V. Scăunașu<sup>2</sup>, Vasile V. Horhoianu<sup>1</sup>, Monica Cîrstoiu<sup>1</sup>

<sup>1</sup>Carol Davila University, Department of Obstetrics and Gynecology, Bucharest, Romania

<sup>2</sup>Colțea Clinical Hospital, Department of General Surgery, Bucharest, Romania

### Abstract

**Purpose.** Uterine artery embolization is a minimally invasive technique. It applies the principle of targeted anatomical structure devascularisation with utility in fibroid conservative therapy, including for future fertility preserving status. The objective of our paper represents a description and evaluation of angiography utility as a predictive method for fertility maintenance.

**Material and Methods.** The angiography and ultrasound aspects obtained from a prospective study in which selected patients have undergone uterine artery embolization for fertility preservation are detailed.

**Results.** The following angiography aspects have been detected: left- right shunt and utero-ovarian collaterals; these have been compared with the ultrasound aspects related to the fibroid evolution from a volumetric and Doppler ultrasound point of view. The angiographical description predicts the impact on post embolization fibroid evolution and upon fertility. An analysis is made in order to assess the way in which angiography can contribute to fertility alteration.

**Conclusions.** The angiography aspects during embolization and the following ultrasound aspects can represent predictive factors as to fertility evolution after uterine artery embolization.

**Keywords:** uterine, embolization, ultrasound, angiography, fertility



Correspondence should be addressed to: Irina A. Horhoianu; e-mail: [irinah7@gmail.com](mailto:irinah7@gmail.com)

## Introduction

Uterine artery embolization is a minimally invasive technique consisting of devascularisation of the targeted tissues with use among many others in the conservatory therapy of uterine leiomyomas, including in the purpose of future fertility preservation. The scope of the current paper consists in describing the angiographical results of the ongoing study and in establishing the level of angiographical predictability for future fertility preservation; all in the hope of finding an ideal method which is able to assess and predict the positive or negative impact of uterine artery embolization on fertility and proper volume shrinkage.

## Materials and methods

A prospective ongoing (June, 2014 – May, 2015) evaluation of 15 fertile age patients which underwent uterine artery embolization as a fertility sparing technique for fibroids was conducted. All the patients signed an informed consent and were instructed regarding the benefits, risks and possible complications involving the procedure. The embolization angiography aspects were gathered and compared to the ones in general literature and with the ultrasound images (shrinkage or fibroid growth and Doppler aspect before and at 1 month after embolization). A General Electric Innova 4100 interventional guided system was used to perform all angiographies with consecutive uterine artery embolization and the ultrasound images used for comparison were achieved by a portable Loqiq E - General Electric- ultrasound device. The images of interest were captured on angiography before particle injection and in the moment of embolization angiographical end-point (near stasis on uterine arteries). The gathered information was used to delineate the type of fibroid vascularisation, the left to

right shunting and the utero-ovarian collateral circulation.

## Results

The angiography aspects describe the following results: of the 15 dominant fibroids, 8 (53%) had right dominant uterine artery vascularization (fig.1) whereas only 5 (33%) were predominantly irrigated by the left uterine artery (Fig. 2); the remaining 2 (13%) had almost equal bilateral vascularization. All of the above mentioned cases have achieved correct embolization endpoints with apparent complete dominant fibroid devascularisation. 11 of the 15 patients had uneventful normal fibroid vascularization, 1 patient was discovered to have a right to left uterine shunt irrigating the dominant fibroid (Fig. 3) and 3 patients utero-ovarian collateral circulation (Fig. 1, 2, 3). The collateral utero-ovarian circulation depicted in the 3 patients mentioned above consists of 1 right anastomosis and 2 left with one patient having both left and right anastomoses as follows (Table 1):

**Table 1.** Utero-ovarian collateral circulation

patients	fibroid vascularization	utero-ovarian collaterals
patient1	right	left
patient2	left	right
patient 3	right	left

## Discussions

The exact angiographic fibroid location or number cannot be precisely foretold as only vessels are seen, it is rather estimated as according to (1) as it has a typical appearance. The leiomyoma arterial sources are represented by mostly peripheral arcuate arteries

forming a perifibroid plexus, usually 6, to which the fibroid connects (1, 2, 3); they become enlarged, and with abnormal coiled architecture very different from the normal vessel arborisation (1, 2, 3) (Fig. 1). The central part of the fibroid is hypovascular being nourished by a few centripetal enlarged arteries growing from the perifibroid plexus mentioned above (2, 3). The dominant uterine artery is also enlarged and has a stronger flow (1, 4). The remaining myometrium is depicted to be hypervascular due to and in comparison with the large fibroids (1, 5). Thus, in our study the predominant vascular fibroid source was represented by the right uterine artery (53% right uterine artery, 33% left uterine artery, 13% double equal vascularization). In a former study of ours, which included a larger number of subjects, no

favoured uterine artery was discovered (39% both for left or right sources, 23% bilateral) (6).

Utero-ovarian collaterals are source of major concern being among the angiographically visualizable factors for embolization failure and also representing a main cause for fertility impairment due to nontarget embolization of the ovaries. In order to assess and foretell the possible impact of uterine artery embolization on fertility one must first be accustomed to the anatomical Dubreuil-Chambardel (7) and angiographical Razavi et al. (8) and personal (9, 6) utero-ovarian anastomoses classification which describes the location of the anastomosis, the direction and pressure flow (6- 9). The anatomical classification according to Louis Dubreuil-Chambardel, 1925 is as follows (Table II) (7, 10).

**Table 2.** The Louis Dubreuil-Chambardel classification

Type	location of anastomoses	tubal vascularization	ovarian vascularization
I	along the uterine corpus (Dominant ovarian artery)	ovarian artery	ovarian artery
II	anastomoses between ovary -uterus	uterine artery	ovarian artery
III	anastomoses at the uterine pole of the ovary	uterine artery	mostly ovarian artery
IV	anastomoses along the ovary	uterine artery	ovarian + uterine artery
V	anastomoses at the tubal pole of the ovary (dominant uterine artery)	uterine artery	mostly uterine artery

According to the anatomical classification system, types IV and V have a higher predisposition for ovarian misembolization. See below the angiographic classification according to Mahmood K. Razavi et al. (8).

**Table 3.** The angiographic classification – anastomoses between utero-ovarian arteries

direct flow	initial uterine angiography aspect with direct visualization of the ovarian artery via retrograde flow through the uterine arteries
indirect flow	initial uterine angiography aspect associated with indirect visualization of the ovarian artery via the ovarian blush – also retrograde flow through the uterine arteries
reflux	post particle injection angiography with visualization of the ovarian artery/ ovarian blush – retrograde flow after embolization due to opening of collateral circulation/ remission of temporary spasm – can be associated with direct and indirect flow
absent flow	none of the above mentioned aspects

According to (8), the type 1 anastomosis links the ovarian artery to the intramural segment of the uterine artery via the tubo-ovarian segment with the link taking place before the fibroid supply, thus enabling the ovarian artery to be a major supply of the fibroid; type 1 a anastomoses represent a strong direction of flow into the tubo-ovarian segment towards the uterus, stronger than the uterine one (thus undetectable on initial preembolization aortography and postembolization sequence), whereas type b delineates a weaker flow in the same direction, below the pressure of the uterine artery, ensuring backward – pre and postembolization reflux (flush), but with washout towards the uterus upon end of embolization (8).

As found on angiography, type 1a anastomoses do not reveal the ovarian artery whereas type 1b anastomoses show a patent reflux in the ovarian artery on the preembolization images and also after embolization, thus making it possible for ovarian misembolization with consequent temporary or permanent menopause (8). According to the elements listed above, it is important to carefully observe the embolization procedure and following the authors suggestions mostly to stop the injection of particles on redistribution of flow (in the ovarian artery) in order to avoid misembolization (8).

According to (8), type II anastomoses represent a direct communication between the ovarian artery– via the tubo-ovarian segment – to the fibroid, without any communication to the uterine branches. Therefore, after embolization, complete fibroid infarction is not achieved and the residual ovarian flow towards the uterus leads to continuous fibroid volume enlargement and to embolization failure (8). Type III anastomoses are depicted as a tuboovarian segment direction of flow towards the ovary with major partial supply of the ovary belonging to the uterine artery; pre and postembolization images show flow towards the ovary without any washout afterwards in the direction of the uterus as in type Ib anastomoses. In such cases as with the Ib type anastomoses a high risk of ovarian

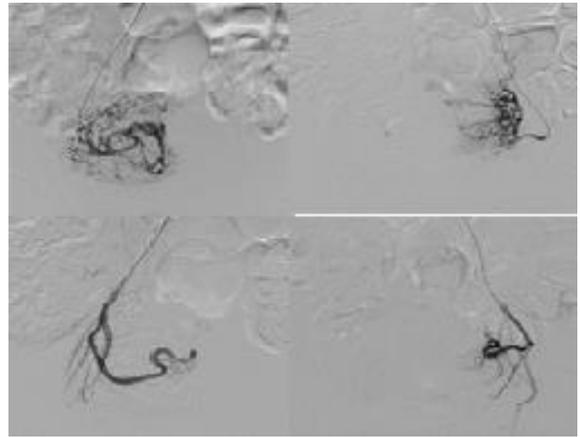
misembolization exists. According to (8, 11) this type of substitutive dominant uterine vascularization pattern may be caused by exogenous factors affecting the ovarian artery like inflammatory conditions, tumors, occlusive diseases or endogenous factors such as ovarian artery hypoplasia or aplasia. Such a description and classification is possible in the cases in which uterine artery embolization is preceded by a screening aortography, which according to (8, 12) is compulsory when fertility sparing is wanted despite a minor increase in radiation dose, 2.1 milisieverts (8, 12). Due to the fact that ascending aortography is not custom in our clinic, we developed a more plain classification system based upon the angiography aspects before and after particle injection (Table 3) (6, 9).

A comparison of the 2 angiographical classification systems would consider the direct, indirect and reflux categories to be represented by type Ib+III anastomosis, the type II and Ia being visualisable solely on aortography. This fact is confirmed as, according to (9) the absent flow was associated with good fibroid reduction rates, whereas association of anastomoses assured growth in 56% of cases at least (chi-square teste  $p=0,009$ ) with possible associated ovarian misembolization (9). When comparing and analysing all the three classification systems the anatomical classification details and numbers described cannot be correlated and are not found in either angiographical classification systems, thus raising the question related to correct fertility prediction on angiographical evaluation. Still we consider utero – ovarian anastomoses to be an important cause for reduced fertility attainment.

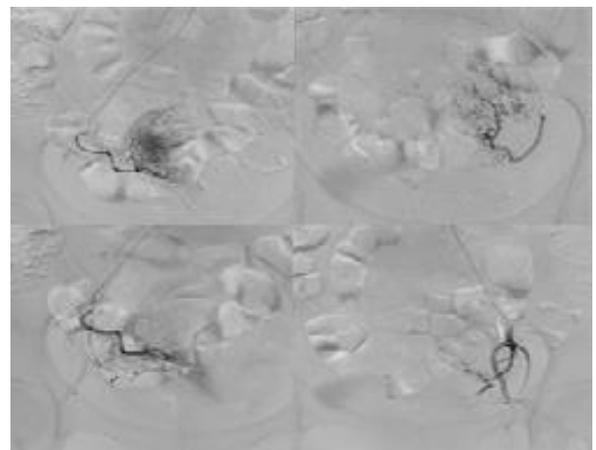
Reviewing our study, the general angiographical utero-ovarian anastomoses rate is of about 20% per patient (3/15) and 13% per anastomoses (4/30), smaller than the data mentioned in the general literature, 40-50% (13), even 58% (9) probably also due to the small number of subjects. Not finding any anastomoses does not necessarily mean absence of but

can also suggest vasospasm as a means of temporary occlusion, as a comparison of the discordant number of anastomoses found constantly in the specimens of anatomical studies (4, 13). Out of the 3 patients with utero-ovarian anastomoses 1 patient (dominant fibroid vascularized by the right uterine artery) had a direct flux (most likely type 1b/III) left anastomosis with fibroid growth registered on ultrasound (much reduced Doppler intensity) thus raising the suspicion of a type 2 right angiography utero-ovarian collateral and most likely minor impairment of ovarian function due to the Ib anastomosis (no menstrual disorder, hormonal tests are still in work) (Fig. 1).

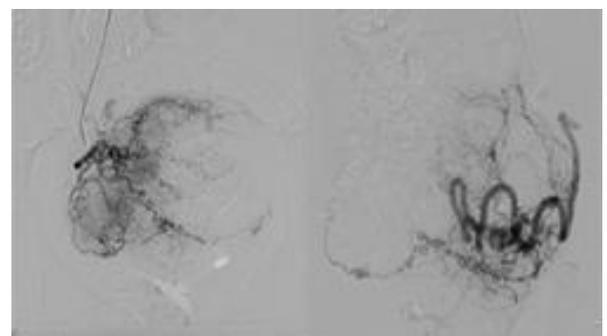
Patient 2 had a dominant fibroid nourished predominantly by the left uterine artery with an indirect right ovarian collateral (right utero-ovarian type 1b/III) anastomosis and corresponding to correct shrinkage and possible mild hormonal impairment (Fig. 2); patient 3 had a right dominant fibroid vascular source with a left direct and reflux utero-ovarian anastomosis (type 1b/III) with volume shrinkage and with the hope of not altering the hormonal status as after embolization there was patent reflux in the ovarian collateral (reflux) (Fig. 3). Patient 6 registered a left to right uterine shunt also with an equal uterine supply, probably due to the extensive fibroid size (Fig.3); in this case bilateral uterine artery embolization associated with no collateral circulation had a favorable effect on fibroid shrinkage and most probably also on fertility (14). Viewing the cases mentioned above and comparing with the ultrasound volume aspect which was concordant, we concluded that both angiography classification systems appear to be able to predict rather well the future volume reduction and fertility outcome. As mentioned above the collateral circulation is not the only cause for fertility impairment; an additional proven and logical source is considered to be the age at which embolization is proceeded. Some find it to be even more important in fertility prediction (13, 15).



**Figure 1.** Patient 1, right dominant fibroid vascularization with direct ovarian collateral and fibroid growth despite low to absent Doppler image, possibility of type II left ovarian collateral Bucharest University Emergency Hospital–Interventional radiology department.



**Figure 2.** Patient 1, left dominant fibroid vascularization with indirect right ovarian collateral and fibroid shrinkage (absent Doppler image), Bucharest University Emergency Hospital–Interventional Radiology Department



**Figure 3.** Right-left uterine shunt Bucharest University Emergency Hospital – Interventional radiology department

According to (8, 16) an age beyond 45 years has a higher risk of early menopause (none of the patient under 45 became menopausal indifferent of collaterals), probably due to or associated with diminished ovarian reserve and the higher risk for benign ovarian pre-existent pathology at this certain age (8, 16). In our ongoing study the hormonal results are needed in order to establish the correct impact on fertility and to detect the angiographical feasibility in fertility prediction as all the patients are under 45 years of age. As a means for further aiding embolization impact on fertility a series of actions have also been proposed- such as: using a higher particle diameter > 500micrometers (ovarian arteries being 500 micrometres or under), selective coiling of the visible and big collaterals, unilateral embolization when possible, end of particle injection at viewing a retrograde flow in the ovarian arteries (Ib) etc. (1, 13, 14, 17). We only use particles over 500 micrometers even more and establish the right endpoint also according to the flow towards the ovarian arteries I order to prevent fertility loss; unfortunately, no coiling nor unilateral embolization has been yet achieved. In the cases in which a single uterine artery supply is detected, for the purpose of fertility sparing a unilateral embolization can be achieved with protection of the contralateral ovarian site and remaining myometrium, also resulting in lower fluoroscopy time, less uterine artery embolization symptoms and less medication, according to general literature (14).

## Conclusions

The angiography aspects indifferent of the classification type are a useful tool in fertility prediction. More detailed analysis is needed in order to establish new aspects and to correctly foresee this situation.

## Acknowledgments

The result described in this paper have been obtained during the postdoctoral studies which were

co-financed from the European Social Fund, through the Sectorial Operational Programme Human Resources Development 2007-2013, project number POSDRU/159/1.5/S/138907 "Excellence in scientific interdisciplinary research, doctoral and postdoctoral, in the economic, social and medical fields -EXCELIS", coordinator The Bucharest University of Economic Studies".

## References

1. Pelage JP, Cazejust J, Pluot E, Le Dref O, Laurent A, Spies JB, Chagnon S, Lacombe P. Uterine Fibroid Vascularization and Clinical Relevance to Uterine Fibroid Embolization. *RadioGraphics*. 2005; 25(1): 99-117. PMID: 16227501  
<https://doi.org/10.1148/rg.25si055510>
2. McCluggage WG, Ellis PK, McClure N, Walker WJ, Jackson PA, Manek S. Pathologic features of uterine leiomyomas following uterine artery embolization. *Int J Gynecol Pathol*. 2000; 19(4): 342-347. PMID: 11109163  
<https://doi.org/10.1097/00004347-200010000-00008>
3. Singh A, Guleria K, Vaid NB, Jain S. Evaluation of maternal early obstetric warning system (MEOWS chart) as a predictor of obstetric morbidity: a prospective observational study. *Eur J Obstet Gynecol Reprod Biol*. 2016; 207: 11-17. PMID: 27792988  
<https://doi.org/10.1016/j.ejogrb.2016.09.014>
4. Liu Q, Li XL, Liu JJ, Song XH, Jiang XY, Li W, Zhang H, Pan CQ. J Efficacy and safety of endometrial ablation for treating abnormal uterine bleeding in pre- and postmenopausal women with liver cirrhosis. *Obstet Gynaecol Res*. 2016; 42(12): 1753-1760. PMID: 27647778  
<https://doi.org/10.1111/jog.13124>
5. Pelage JP, Le Dref O, Soyer P, Jacob D, Kardache M, Dahan H, Lassau JP, Rymer R. Arterial anatomy of the female genital tract: variations and relevance to transcatheter embolization of the

- uterus. *Am J Roentgenol.* 1999; 172(4): 989-994. PMID: 10587133  
<https://doi.org/10.2214/ajr.172.4.10587133>
6. Ainsworth A, Wood A, Kurtin P, Burnett T. An unusual case of abnormal uterine bleeding due to classical Hodgkin lymphoma identified by endometrial biopsy. *Int J Gynaecol Obstet.* 2016; 135(3): 331. PMID: 27609742  
<https://doi.org/10.1016/j.ijgo.2016.07.003>
  7. Billow MR, El-Nashar SA. Management of Abnormal Uterine Bleeding with Emphasis on Alternatives to Hysterectomy. *Obstet Gynecol Clin North Am.* 2016; 43(3): 415-30. PMID: 27521876  
<https://doi.org/10.1016/j.ogc.2016.04.002>
  8. Razavi MK, Wolanske KA, Hwang GL, Sze DY, Kee ST, Dake MD. Angiographic classification of ovarian artery-to- uterine artery anastomoses. *Radiology* 2002; 224(3): 707-712. DOI: 10.1148/radiol.2243011513 PMID: 12202703  
<https://doi.org/10.1148/radiol.2243011513>
  9. Horhoianu I. A., Horhoianu V. V., Joita D., Carstoiu M, Dorobat B. Uterine artery embolization for leiomyomas, ultrasonography and angiography aspects. *J Med Life.* 2012; 5(4): 491-495. PMID: 23346257 PMCID: PMC3539832
  10. Billow MR, El-Nashar SA. Management of Abnormal Uterine Bleeding with Emphasis on Alternatives to Hysterectomy. *Obstet Gynecol Clin North Am.* 2016; 43(3): 415-30. PMID: 27521876  
<https://doi.org/10.1016/j.ogc.2016.04.002>
  11. Karlsson S, Persson PH. Angiography in uterine and adnexal tumors. *Acta Radiol Diagn.* 1980; 21(1): 11–20. PMID: 7376930  
<https://doi.org/10.1177/028418518002100103>
  12. Binkert CA, Andrews RT, Kaufman JA. Utility of nonselective abdominal aortography in demonstrating ovarian artery collaterals in patients undergoing uterine artery embolization for fibroids. *J Vasc Interv Radiol.* 2001; 12(7): 841–845. PMID: 11435540  
[https://doi.org/10.1016/S1051-0443\(07\)61509-7](https://doi.org/10.1016/S1051-0443(07)61509-7)
  13. Nebgen DR, Rhodes HE, Hartman C, Munsell MF, Lu KH. Abnormal Uterine Bleeding as the Presenting Symptom of Hematologic Cancer. *Obstet Gynecol.* 2016; 128(2): 357-63. PMID: 27400009  
<https://doi.org/10.1097/AOG.0000000000001529>
  14. Stall L, Lee J, McCullough M, Nsrouli-Maktabi H, Spies JB. Effectiveness of Elective Unilateral Uterine Artery Embolization: A Case-control Study. *J Vasc Interv Radiol.* 2011; 22(5): 716-22. PMID: 21514525  
<https://doi.org/10.1016/j.jvir.2011.01.442>
  15. Lanciego C, Diaz-Plaza I, Ciampi JJ, Cuena-Boy R, Rodríguez-Martín N, Maidonado MD, Rodríguez-Gomez O, Cañete ML, García-García L. Utero-ovarian anastomoses and their influence on uterine fibroid embolization. *J Vasc Interv Radiol.* 2012. 23(5): 595-601. PMID: 22440591  
<https://doi.org/10.1016/j.jvir.2012.01.077>
  16. Chrisman HB, Sakter MB, Ryu RK, Nemcek AA Jr, Gerbie MV, Milad MP, Smith SJ, Sewall LE, Omary RA, Vogelzang RL. The impact of uterine fibroid embolization on resumption of menses and ovarian function. *J Vasc Interv Radiol.* 2000; 11(6): 699–703. PMID: 10877413  
[https://doi.org/10.1016/S1051-0443\(07\)61627-3](https://doi.org/10.1016/S1051-0443(07)61627-3)
  17. Wolanske KA, Gordon RL, Wilson MW, Kerlan Jr RK, LaBerge JM, Jacoby AF. Coil embolization of a tuboovarian anastomosis before uterine artery embolization to prevent nontarget particle embolization of the ovary. *J Vasc Interv Radiol.* 2003; 14(10): 1333-8. PMID: 14551282  
<https://doi.org/10.1097/01.RVI.0000092906.31640>