CardioVascular and Interventional Radiology

Published Online: 20 May 2003

Cardiovasc Intervent Radiol (2003) 26:227–233
DOI: 10.1007/s00270-002-1875-3

Ovarian Artery: Angiographic Appearance, Embolization and Relevance to Uterine Fibroid Embolization

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Abstract

Purpose: To describe the angiographic appearance of the ovarian artery and its main variations that may be relevant to uterine fibroid embolization.
Methods: The flush aortograms of 294 women who had been treated by uterine artery embolization for fibroids were reviewed. Significant arterial supply to the fibroid, and the origin and diameter of identified ovarian arteries were recorded. In patients with additional embolization of the ovarian artery, the follow-up evaluation also included hormonal levels and Doppler imaging of the ovaries.
Results: A total of 75 ovarian arteries were identified in 59 women (bilaterally in 16 women and unilaterally in 43 women). All ovarian arteries originated from the aorta below the level of the renal arteries with a characteristic tortuous course. Fifteen women had at least one enlarged ovarian artery supplying the fibroids. Fourteen women (14/15, 93%) presented at least one of the following factors: prior pelvic surgery, tubo-ovarian pathology or large fundal fibroids.
Conclusion: We advocate the use of flush aortography in women with prior tubo-ovarian pathology or surgery or in cases of large fundal fibroids. In the case of an ovarian artery supply to the fibroids, superselective catheterization and embolization of the ovarian artery should be considered.

Key words: Interventional radiology—Uterine embolization—Uterine fibroids—Arterial anatomy—Ovarian artery

Transcatheter arterial embolization has been used to control life-threatening bleeding associated with pelvic tumors [1] or obstetric disorders [2, 3]. More recently, percutaneous transcatheter uterine arterial embolization has offered a successful alternative to surgery in the treatment of uterine fibroids [4–6].

The goals of our study were threefold: we wanted firstly to investigate the frequency with which the ovarian artery was identified on the flush aortogram and was supplying the uterus, secondly to review the main variations in the origin, course and diameter of the ovarian artery, and thirdly to discuss, in selected patients, the strategy of embolization of the ovarian artery in the management of uterine fibroids.

Materials and Methods

Patients

Three hundred and sixteen women who were referred for uterine fibroid embolization (UFE) between December 1996 and January 2001 were included in the study. Indications to perform embolotherapy were symptomatic uterine fibroids with failed medical treatment and/or planned surgery. The potential risks and benefits of the procedure were explained to the women and informed consent was obtained in all cases. All women with prior embolization of the uterine arteries were excluded from the study.

Angiography

All angiographic studies were performed using a unifemoral approach. Before embolization, a flush aortogram was performed with a 5 Fr pigtail catheter located at the level of the renal arteries. Superselective catheterization of the ovarian artery was performed when the following criteria were met: (1) enlarged ovarian artery identified on the flush aortogram, (2) ovarian artery obviously supplying the fibroids (i.e., significant antegrade flow extending to the pelvis) or (3) small, absent or not satisfactorily embolized (due to spasm) ipsilateral uterine artery, and only when the patient gave consent for additional embolization of the ovarian artery.

Assessment of Results

Angiographic evaluation and anatomic study of patients were retrospectively performed by two senior vascular radiologists. In the case of discrepant findings, a consensus opinion was obtained by

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discussion. During the review of angiographic films, the observers determined whether the ovarian artery was visible. If identified on the aortogram, the origin, course and supply to the uterus was noted. The diameter of the ovarian artery was also evaluated using a three-grade scale (1 = small, 2 = moderately enlarged, 3 = enlarged) (Figs. 1–4). The past history of the patients with enlarged ovarian arteries was recorded with special emphasis on prior surgery (tubal ligation, tuboplasty, cesarean section) or adnexal pathology (ectopic pregnancy, hydrosalpinx, tubo-ovarian abscess).

Correlation with Clinical Outcome

The clinical outcome of uterine artery embolization was recorded for all patients with enlarged ovarian artery supplying the fibroids. In addition, in patients treated by superselective embolization of the ovarian artery, the clinical outcome with the focus on menses and biological tests including FSH, LH and 17β-estradiol levels were recorded. In this study, blood test abnormalities were only considered in combination with symptoms commonly associated with menopause (including amenorrhea or irregular menstrual bleeding, hot flashes, vaginal dryness, bleeding after sexual intercourse, mood swings and weight gain). Pelvic sonographic examination with color and pulsed Doppler study was also performed to verify the perfusion of the ovary and the patency of the previously embolized ovarian artery.

Angiographic Results

Aortograms

Three hundred and sixteen flush aortograms were available for review. Of these, 22 were excluded because the pigtail catheter was located below the level of the renal arteries. Of the 294 remaining aortograms, a total of 75 ovarian arteries were identified (25%) in 59 (20%) women. Bilateral identification of the ovarian artery was observed in 16 women and unilateral identification of the ovarian artery (right, 26; left, 17) in 43 women. The arterial diameter evaluated on hard copy films was considered small (grade 1), moderately enlarged (grade 2) or enlarged (grade 3) in 21, 12 and 10 of 43 cases, respectively, for the patients with unilateral identification (Figs. 1–3).

In the case of bilateral visualization of the ovarian arteries, five women presented at least one enlarged (grade 3) ovarian artery (right, left or both in 3, 1 and 1 women respectively). The diameter of the 32 ovarian arteries identified in this group was considered small, moderately enlarged and enlarged in 15, 11 and six of 32 cases, respectively.

All ovarian arteries originated from the aorta below the level of the renal arteries. In one patient, both ovarian arteries originated at the level of the inferior mesenteric artery (Fig. 3).

In all cases in which it was visible, the ovarian artery had a characteristic tortuous course (Figs. 1–4). In addition, when the ovarian artery was enlarged (grade 3) in diameter, it was supplying fibroids in all cases (Figs. 2, 4).

Enlarged Ovarian Arteries on the Flush Aortogram

Of the 59 women with ovarian arteries identified on the aortogram, 15 had at least one enlarged (grade 3) ovarian artery supplying the fibroids (Table 1). From the past history of these patients, we found that 11 of 15 (73%) presented with large fundal fibroids (mean diameter 9.7 cm) and three women (20%) had had prior pelvic surgery or tubo-ovarian pathology (myomectomy, cesarean section or tubal surgery). One woman only (patient 14 of Table 1) had no prior surgery and no evidence of a fundal fibroid, but a multifibroid uterus was found (estimated volume 920 cm^3). Thus 93% of patients with ovarian artery supply of uterine fibroids had at least one risk factor (prior pelvic surgery, tubo-ovarian pathology or large fundal fibroids).

Ovarian Artery Catheterization and Embolization

Superselective catheterization of the ovarian artery (right $n = 3$) was successfully performed in three patients (meeting the criteria described before) using a 4 Fr Cobra catheter (Terumo, Japan) and 3 Fr microcatheter (Tracker 325) (Figs. 2, 4). A Simmons-reverse curve was given to the 4 Fr catheter allowing easier catheterization of the ovarian artery. In these three women past history included prior cesarean section in two and multiple myomectomies in one case (Table 2).

Embolization using polyvinyl alcohol particles was performed in two women only, after full explanation of the benefits and risks of the additional embolization (Table 2; Fig. 4). One woman decided to wait for the result of bilateral uterine artery embolization before accepting embolization of the ovarian artery (Fig. 2).

Clinical Outcome

Clinical Outcome of Women with Uterine Fibroids Supplied by an Enlarged Ovarian Artery

All patients (15/15, 100%) presented with menorrhagia. Ten women (67%) had associated pressure symptoms. After a mean follow-up of 8 months (range 1–24 months), 11 of 13 women (84%) without additional embolization of the ovarian artery are symptom-free. One woman had to be treated by hysterectomy for failure and insufficient shrinkage at 6 months. The analysis of the hysterectomy specimen showed that one fibroid was viable whereas the other were degenerative. The myometrium and endometrium were of normal appearance.

Clinical Outcome of Women Treated by Additional Embolization of the Ovarian Artery

Both women resumed normal menstruation after embolization with no symptom consistent with menopause and have

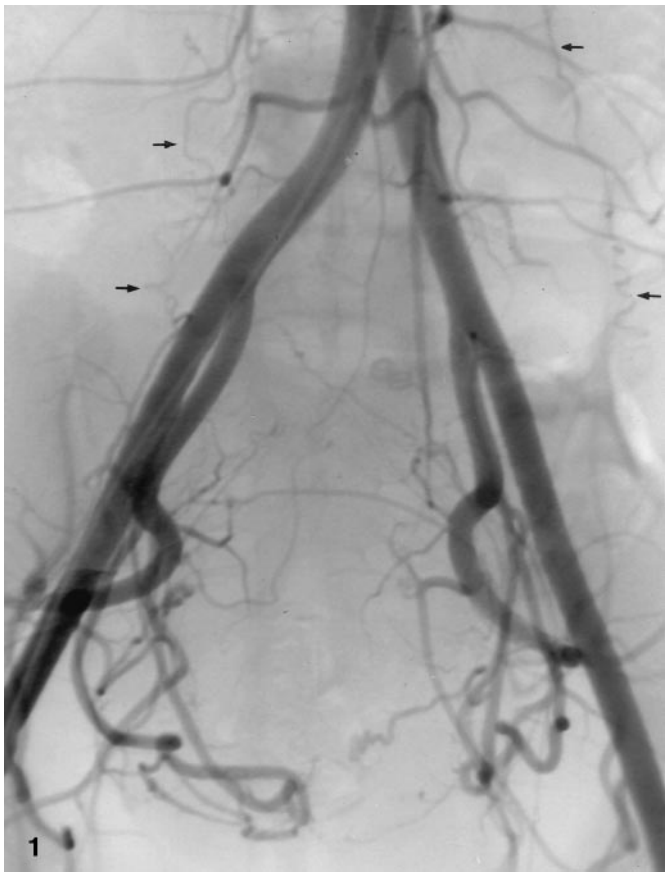

Fig. 1. Flush aortogram demonstrates both ovarian arteries originating below the renal arteries (arrows). Both arteries are graded as small (grade 1).

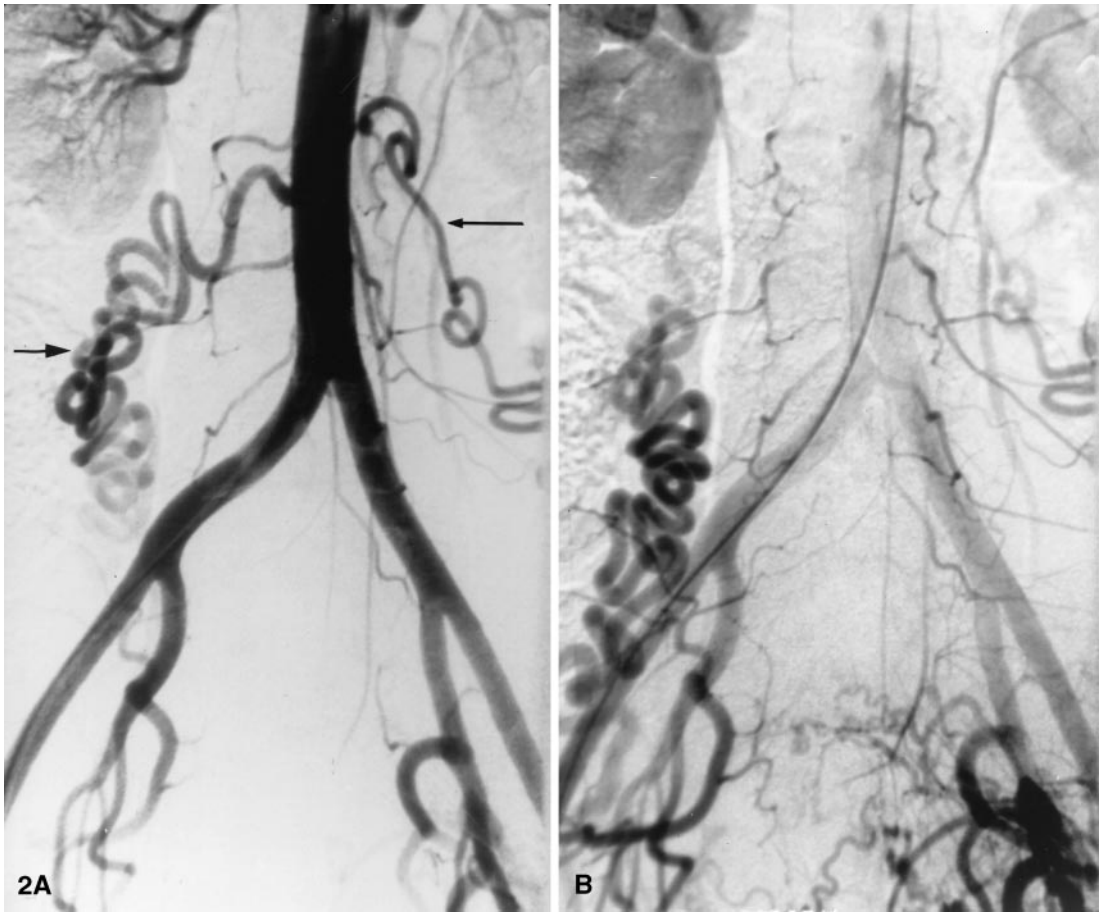

Fig. 2. **A** Flush aortogram demonstrates both ovarian arteries originating below the renal arteries (arrows). The right ovarian artery is graded as enlarged (grade 3) and the left as moderately enlarged (grade 2). **B** Parenchymal phase of the same aortogram shows bilateral ovarian artery supply to the uterus.

Fig. 3. Flush aortogram demonstrates both ovarian arteries (arrows) originating from the aorta at the level of the inferior mesentric artery. Both ovarian arteries are graded as moderately enlarged (grade 2).

Fig. 4. **A** Flush aortogram demonstrates both ovarian arteries originating below the renal arteries (arrows). The right ovarian artery is graded as enlarged (grade 3) and the left as small (grade 1). **B** Superselective injection confirms that the fibroids (arrowheads) are supplied by the right ovarian artery.

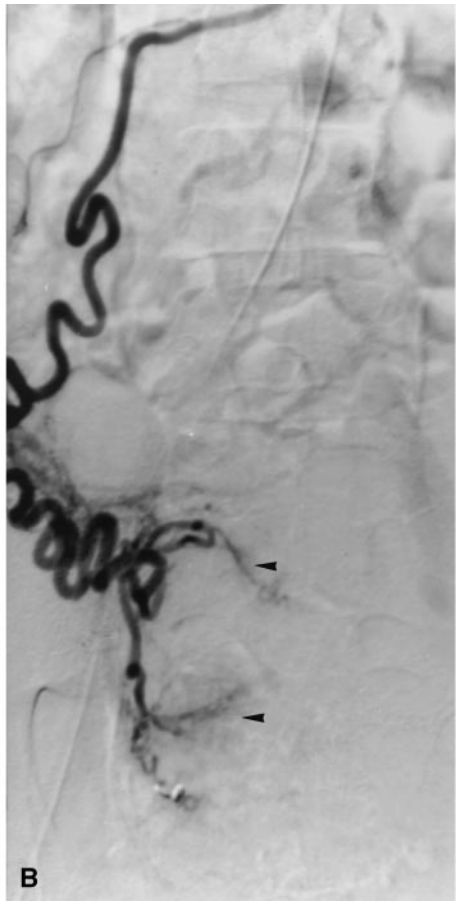

Table 1. Patients presenting at least one enlarged ovarian artery on the flush aortogram

Patient no.	Age (years)	Ovarian artery identified	Enlarged Ovarian artery	Prior pelvic surgery	Prior tubo-ovarian pathology	Fundal fibroids (no.)	Diameter (cm)
1	51	Right	Right	None	None	1	7
2	51	Right	Right	None	None	1	8
3	49	Right	Right	None	None	1	11
4	41	Right	Right	None	None	1	10
5	52	Right	Right	None	None	1	12
6	39	Right	Right	Cesarean section for cervical fibroid	None	0	—
7	41	Left	Left	None	None	2	4 4
8	30	Left	Left	Myomectomy, tubal surgery	Tubal blockade	1	12
9	42	Left	Left	None	None	1	6
10	37	Left	Left	None	None	1	11
11	47	Both	Right	None	None	1	14
12	31	Both	Right	None	None	1	12
13	45	Both	Right	Cesarean section	None	?[a]	?[a]
14	42	Both	Left	None	None	?[b]	?[b]
15	43	Both	Both	Multiple myomectomies	None	?[c]	?[c]

[a]Polymyomatous uterus (volume 490 cm^3), [b]Polymyomatous uterus (volume 920 cm^3), and [c]Polymyomatous uterus (volume 1747 cm^3): precise location and size of the fibroids not achievable with MRI or sonography

Table 2. Patients in whom superselective catheterization of the ovarian artery has been performed

Patient no.	Age (years)	Gravidity/Parity	Prior surgery	Ovarian artery supply	Ipsilateral uterine artery	Embolic agent (volume or no.)
6	39	G2/P4	Cesarean section	Right side	Small	PVA 355–550 μm: 0.4 ml
13	45	G1/P1	Cesarean section	Right side	Spasm[a]	PVA 355–550 μm: 0.2 ml Gelfoam: 2 pledgets
15	43	G0/P0	Three myomectomies	Right side	Enlarged	Not embolized

[a]Spasm leading to insufficient embolization

resolution of menorrhagia. Hormonal levels (FSH, LH and estradiol) were normal after embolization.

Pelvic sonography and Doppler examination was performed 6 weeks and 12 months after embolization in two women respectively. The ovaries were normal with homogeneous perfusion. The right ovarian artery was patent with a normal duplex spectrum in both patients.

Discussion

Various methods to analyze the variations in the arterial anatomy of the female genital tract have been used. For many years, dissections of cadavers and dissection performed during surgical procedures have provided the major accounts in the literature [7]. Angiography has been used occasionally to establish the anatomy of the ovarian artery [8–10]. The reason is that the ovarian arteries are visualized in few patients examined by standard aortography because of their small diameter [8, 10]. In our study, we identified the origin of the ovarian artery on a flush aortogram in 20% of the patients. It is usually assumed that when the ovarian artery is identified on abdominal aortography, its diameter is more than 1 mm [11]. Aortic compression permitting better visualization of the small aortic branches has been abandoned because of renal complications [8]. Superselective ovarian angiography can provide more precise anatomic information [9, 11]. The distribution to the tubes, the ovaries and the fundus uteri as well as anastomoses between the ovarian artery and the ipsilateral adnexal branches of the uterine artery are optimally demonstrated by arteriographic studies [9, 12]. In most patients, a single pair of ovarian arteries that arises from the anterolateral part of the abdominal aorta is visualized [8–12]. There are various possible levels of origin of the ovarian artery from the aorta. The artery usually originates from the anterolateral part of the abdominal aorta at the level of the second lumbar vertebra [8–12]. However, the origin may vary from L1 to L4 (2 to 35 mm below the superior mesenteric artery) due to the migration of the ovary along the gubernaculum [13]. Vascular radiologists should be aware of these possible anatomic variations to ensure more accurate and targeted catheterization. In our study we found that after its origin, each ovarian artery passes inferolaterally in the retroperitoneum, with a characteristic tortuous course (corkscrew appearance), crosses anterior to the ureter and enters the pelvis where it supplied the ovary and anastomoses with the uterine artery [11, 13].

It has been stated that the use of flush aortography results in unnecessary utilization of contrast and radiation compared with selective internal iliac injections only [14]. Flush aortography provides information on ovarian arterial supply to

the fibroids if performed with appropriate catheter placement. However, in the anteroposterior projection, the origin of the uterine artery is not clearly shown due to imposition of pelvic branches [10]. Some would advocate substitution of the initial flush aortography with a completion aortogram allowing identification of the ovarian arterial supply and confirming occlusion of both uterine arteries. In the case of prior pelvic surgery or large fundal fibroids, the use of flush aortography is therefore obviously helpful.

In past decades, superselective catheterization of the ovarian arteries was used for the angiographic diagnosis of malignant or benign adnexal tumors [9, 11]. Because of the advances in noninvasive imaging, pelvic angiography is no longer performed for diagnostic purposes. Superselective catheterization and embolization of the ovarian artery has been reported in cases of postoperative bleeding or to treat pseudoaneurysm [3, 15, 16]. Prior to the use of uterine fibroid embolization, it had already been suggested that uterine fibroids derive their main peripheral blood supply almost exclusively from the uterine arteries [17]. Recently, the presence of fibroid blood supply from the ovarian artery has been reported as the potential cause of failure of uterine artery embolization [14]. Frates described a simple method to identify the ovarian artery and its origin on the aortogram [9]. He states that "We look for the corkscrew appearance of the ovarian artery at the top of the sacroiliac joint, and then follow this vessel antegrade on earlier films to its point of origin" [9]. From these results, we consider that if an enlarged ovarian artery is the main supply to the fibroids, ovarian artery embolization should be considered. Superselective catheterization of enlarged ovarian arteries has not been performed routinely in our study. We considered that a large ovarian artery (identified on the flush aortogram) extending to the pelvis with a significant flow to the uterus was likely to be an additional arterial supply to the fibroids.

Selected patients should be informed about the risk of failure of uterine artery embolization due to a parasitic blood supply from the ovarian artery. The possibility of additional embolization of the ovarian artery should therefore be discussed and informed consent obtained before the procedure. This is the reason why superselective catheterization of the right ovarian artery was performed in three women only and embolization was carried out in two (one patient refusing at the last minute to be treated). Even though successful cases of ovarian artery embolization have already been reported, the potential ischemic damage to the ovary makes the choice of performing embolization difficult [18, 19]. Thus, in our series embolization was performed in two women after full explanation of the benefits and risks of the additional procedure. Both women had no desire for future pregnancy (Table 2).

In our study we found that 11 of 15 (73%) women with a large ovarian artery supplying fibroids presented with large fundal fibroids (mean diameter 9.7 cm). It may be hypothesized that uterine artery embolization alone may not provide symptom control [14]. In the group of 13 patients not treated with additional embolization of the ovarian artery, we had an 8% rate of failure leading to hysterectomy in a patient with a viable fibroid at pathologic study. The strategy of embolization could be temporary using proximal occlusion with large gelfoam pledgets as previously reported [18] or distal devascularization of the fibroid leaving intact the main ovarian artery. Both women resumed normal menstruation after embolization. Biological tests including FSH levels were normal. With the follow-up of 10 and 2 months respectively, both women are currently symptom-free.

In conclusion, knowledge of the main variations in the origin of the ovarian arteries is required to perform fibroid embolization. The reason is that the fibroids may be supplied by the ovarian arteries, especially in women with prior surgery or pathology involving the fallopian tubes or the ovaries. We also found that women with large fundal fibroids are likely to have an ovarian artery supply of their fibroids. Even if a flush aortogram should not be routinely performed during uterine fibroid embolization, we have demonstrated its particular value in women with prior pelvic surgery and/or large fundal fibroids. The pigtail catheter should be carefully placed at the level of the renal arteries in order to optimize the identification of the ovarian arteries. It may be hypothesized that a postembolization aortogram will be more sensitive to identify residual flow to the fibroids after uterine artery embolization.

Additional catheterization of the ovarian artery should be performed in cases of small or absent ipsilateral uterine artery and/or non-opacification of part of the uterus. Additional embolization of the ovarian artery should be performed only after careful discussion with the patient. More experience is required before deciding whether it should be performed during the same session or in a delayed procedure waiting for the results of uterine artery embolization alone. Training of interventional radiologists should be a priority given the widespread acceptance of uterine fibroid embolization.

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