

ORIGINAL ARTICLE

Computed tomography angiogram for failed uterine artery embolization

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Abstract

It was the aim of this study to discuss the efficacy of computed tomography angiography after failed uterine artery embolization. We performed a review of cases where embolization of myomata failed to relieve symptoms, or shrink myomata. If MRI showed continued uptake, patients were offered CT angiograms to better direct therapy. Repeat embolization details were compared with findings on CT angiogram. During the study, 675 patients underwent uterine artery embolization. 229 patients underwent follow-up MRI with intravenous contrast, 29 of which showed persistent uptake into myomata. Twelve patients had CT angiogram of the abdomen following MRI and six elected to undergo repeat UAE after CT angiogram. There was a 75% concurrence between CT angiograms and live studies (angiogram during repeat uterine artery embolization). With CTA, five patients showed a unilateral non-uterine blood supply, one showed a bilateral non-gonadal supply to the uterus, and two showed a normal blood supply, with all but two cases confirmed on live angiogram. Based on post-repeat MRI, one of the six repeat UAE patients shows no continued uptake of intravenous contrast to myomata. Four show continued uptake, however, one patient did show decreased size of myomata. CT angiography is a valuable tool to identify collateral and persistent uterine artery supply, and offers great potential for accurate identification and evaluation of extra-gonadal supply to the uterus. It will allow for pre-operative planning, as well as discussion of risks and benefits with patients.

Key words: *Computed tomography angiogram, embolization, myoma, unilateral*

Introduction

Management of the patient who has failed a uterine artery embolization (UAE) is an important part of the care of the patient. Often a repeat procedure will change an initial negative result (1). Selection of the patient for such a repeat procedure, versus a surgical referral, is an important decision. Magnetic resonance imaging (MRI) of the pelvis with intravenous contrast will inform the surgeon of continued uptake of contrast into myomata, and the failure of the embolization (2).

However, the failure may be for one of two reasons. The uterine arteries may have been incompletely embolized, or an extra-uterine supply to the uterus may exist (3,4). If the reason for failure can be clearly demonstrated, a more successful result will occur. First the patient will be able to make an informed

decision. Should an extra-uterine supply exist, the patient will have a higher risk of premature menopause following repeat embolization. For the surgeon, knowledge of the source of continuing blood flow to the myomata will allow for appropriate preparation for surgical intervention. We have performed computed tomography angiograms (CTA) of the abdomen and pelvis on patients with persistent symptoms, and obtained MRI evidence of uptake of contrast into myomata two months post embolization. Our results and correlation to findings during angiography are discussed.

Material and methods

During the time period from June 2001 to April 2008, we analyzed our total number of patients

undergoing UAE. Patients were considered failures if they had persistent symptoms or if their myomata did not shrink by at least one-third. All of our patients routinely underwent MRI imaging to evaluate success of the UAE (5,6). The patients who failed by our criteria were offered either a surgical intervention in the form of hysterectomy or myomectomy, or a repeat UAE.

Patients who did elect to undergo repeat UAE were offered CTA of the abdominal and pelvic vessels. Patients were told of the small additional risk of radiation exposure from CTA. They were likewise informed of the benefits which might accrue to them. Namely, allowing the surgeon to better plan for their repeat procedure, and to have pre-operative discussion of possible risk of premature menopause if the CTA revealed an ovarian blood supply to the uterus (7). Since CTA is a recognized form of diagnostic procedure, we did not require Institutional Review Board approval.

All patients were scanned using a 64-slice multi-detector CT scanner (GE Volumetric VCT 64-Slice CT scanner; General Electric Medical Systems, Milwaukee, WI, USA). Patients had a peripheral upper extremity IV placed of 20 gauge or greater size, usually in the antecubital fossa. Patients were placed on the CT scanner gantry supine, feet first. 100 ml of Isovue 370 (Iopamidol 76%; Bracco Diagnostics, Princeton, NJ, USA) was injected at a rate of 4 cc/sec during the study followed by a 65 ml saline bolus chaser at the same rate utilizing a Stellant Medrad dual head injector. A low dose automated timing bolus (GE Smart Prep, GE Healthcare, Chalfont St. Giles, GB) was used over the aorta at the level of the renal arteries for an average delay of 12-15 seconds.

Patients were scanned at .625 mm collimation, reconstructed at 2.5 mm from the level of the renal arteries down below the pubis symphysis. Detector coverage was 20 mm, kVp was 140, and mAs was approximately 420. The FOV was set at 36. Images were sent to an online workstation (GE Advantage Workstation), and CT angiographic images were produced using maximum-intensity projection (MIP) algorithm in the sagittal and frontal views; 3D volume-rendered images were obtained as well.

We compared the CTA to findings at the time of angiography. We also evaluated the success of repeat procedures.

Results

During the study period 675 patients underwent UAE procedures. 229 (33.9%) patients underwent a

follow-up MRI with intravenous contrast; 29 patients showed persistent uptake of contrast into myomata (12.7%). These patients were offered CTA to better direct therapy. A total of 20 follow-up CTAs were done and six patients elected to undergo eight repeat UAE procedures after CTA. As of yet, one patient shows no continued enhancement of myomata, indicating successful UAE. Four patients still show continued uptake of contrast, however, one patient does show decreased size of myomata. The findings on CTA are listed in Table I. Five patients showed a unilateral non-uterine blood supply to the uterus. One patient showed a bilateral non-gonadal supply to the uterus. No patient had a combination of non-gonadal blood supply plus a persistent uterine artery supply to the uterus.

These findings were discussed with the patients undergoing a repeat procedure. Three patients agreed with the decision to embolize a non-uterine blood supply to the uterus, as well as any residual supply coming from the uterine arteries. Table II reveals the concordance between the CTA findings and the findings at the time of repeat UAE. The CTA findings were confirmed with angiographic findings in all but two cases. In one case, a "normal" CTA was found to show a bilateral ovarian supply in pre-embolization pelvic angiogram. In the other case, CTA showed a left extra-gonadal supply, but pre-embolization angiogram showed a left uterine artery supply only. In one case the patient was desirous of maintaining her fertility, and asked that only one of two ovarian arteries be embolized (Figure 1).

Post-embolization interview follow-up is available in one patient who underwent a repeat UAE. Follow up MRI after the repeat procedure is available in five patients. No uptake of contrast was revealed in one patient after repeat embolization.

Of note, 200 patients had MRI performed two months after UAE showing no uptake of contrast into the myomata. For different reasons 12 underwent CT angiograms of the abdomen and pelvis after a follow-up MRI. One patient showed persistent pelvic arterial supply to the uterus. Two patients had an extra-pelvic blood supply to the uterus. None of these patients showed continued symptoms of their myomata.

Table I. CTA results

Blood Supply on CTA	No. of Patients	%
Unilateral, extra-gonadal	5	0.833333
Bilateral, extra-gonadal	1	0.166667
Total	6	

Table II. Concordance: CT angiograms performed post embolization with follow-up angiograms during repeat embolization

CTA Supply	Repeat UAE Angiogram Supply: Concordant	Repeat UAE Angiogram Supply: Disconcordant
Normal		Bilateral Ovarian
L extra gonadal (hypogastric)		Left Uterine Artery
Bilateral extra gonadal (ovarian)	Same	
IMA feeding R side of uterus	Same	
Normal	Same	
Unilateral (L) vessel from aorta to L side of uterus	Same	
Unilateral (R) ovarian artery supply to R side of uterus	Same	
Unnamed vessel to R side of uterus	Same	

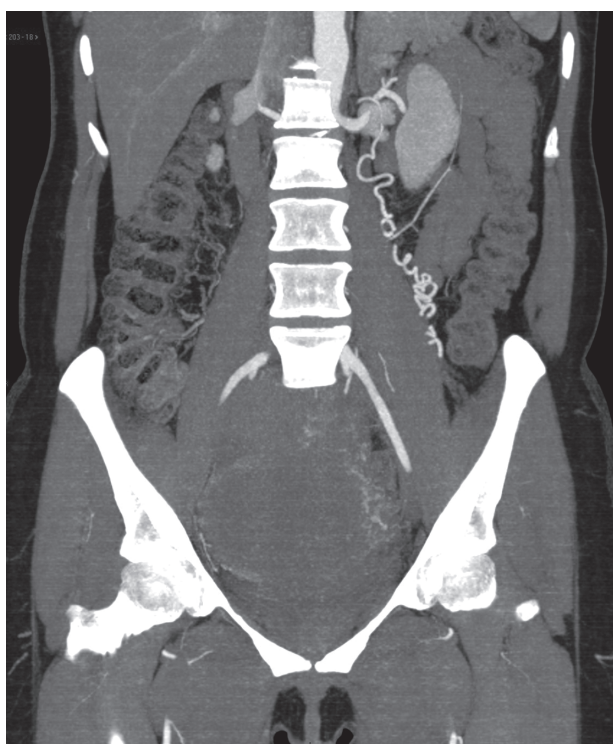


Figure 1. Coronal Reformatted MIT Image which illustrates a completely embolized right gonadal artery and a well developed, easily visualized left gonadal artery. Unilateral embolization due to patient's request.

Discussion

Uterine artery embolization offers patients a success rate of >90% (8). Poor patient selection may add to the failure rate. For example, UAE will be inefficient over time for patients suffering from a combination of myomata with adenomyosis (9,10). Most failed UAE procedures occur for two reasons: Failure to completely embolize the uterine arteries, or a collateral supply to the uterus from outside the pelvic cavity (3).

Initially, reports of premature menopause following UAE prompted surgeons to embolize less thoroughly in hopes of avoiding reflux of particles into the ovarian arteries (11,12). The "end point" of uterine artery embolization became a bit more subjective. Whereas a completely embolized artery was easy to identify (Figure 2), a less thoroughly embolized artery was not so easy to visualize under fluoroscopy (Figure 3). In addition, some surgeons embolize with a four or five French catheter to minimize radiation exposure and cost to the patient compared to procedures performed with a microcatheter. Those surgeons who prefer routine use of the microcatheter argue that larger catheters lead to a high incidence of arterial spasm (13). Spasm has been postulated as another cause of failure in the embolization process (3).

An extra-uterine supply to the myomatous uterus was described soon after UAE became widespread (14). The role of the extra-gonadal blood supply to myomata has remained more elusive. Some surgeons advocate embolization of the extra-gonadal supply when it is appreciated on abdominal angiography during initial UAE (15). Others point to the increased risk of premature menopause which accompanies embolization of the ovarian arteries (7,16). In addition, the right ovarian artery often arises from the right renal artery, which presents an additional challenge (17). The risk of dissection of the renal artery or perforation of the kidney during catheter placement may make surgeons reluctant to take the risk of embolizing the right ovarian artery from this source without proof of the contribution that blood supply is adding to the problem of the myomata. Because of this controversy some authors have questioned the performance of routine abdominal aortography during UAE (18).

Not all the non-uterine blood supply to myomata arises from the ovarian arteries. Other collateral supply that has been described has originated from the colon and omentum (19). *De novo* recruitment of



Figure 2. 3-D Coronal Volume-rendered MIT image showing an incompletely embolized right gonadal artery and a non-embolized left gonadal artery.

vascular supply has also been reported (20). The surgeon may not be aware of the value of embolizing such arteries, at the cost of additional radiation exposure to the patient.

Evaluation of success in our series was based on relief of symptoms, and diminution of the diameter of the myomata by at least 33%. Relief of menorrhagia is often described immediately after UAE (21,22). Shrinkage of myomata is not complete for at least six months (23). Thus, we, like others, rely on a pelvic MRI with intravenous contrast performed at two months to evaluate success of the embolization. All of our MRI examinations are done pre- and post-contrast. This allows for optimal assessment of the enhancement pattern of the uterine myometrium as

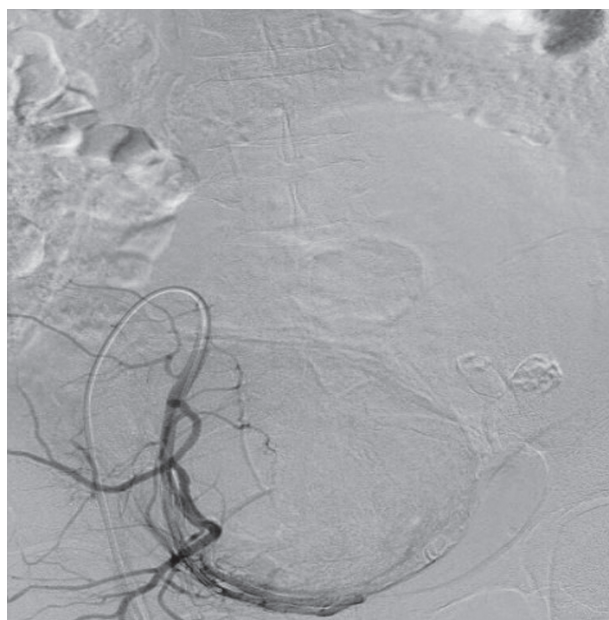


Figure 3. Angiogram showing a completely embolized right gonadal artery.

compared to the adjacent uterine myomata. Intense enhancement of the uterine myometrium with lack of enhancement of the myomata will indicate devascularization of the myomata compared to the surrounding myometrium. For patients in whom an MRI revealed persistent uptake of contrast within the myomata, and continued symptoms, we offered a CT aortoiliac angiogram using a 64-slice multi-detector CT scanner.

Patients were told of the risk of additional radiation exposure with the CTA. They were offered a repeat UAE without the CTA, or surgical correction of the myomatous uterus. We explained the value to the patient of being able to prepare to embolize the correct artery. A surgeon may want an assistant for embolization of a non-gonadal artery. Specialized equipment such as micro-coil may be needed to successfully embolize the smaller ovarian vessels. We also described the possibility of an increased risk of menopause for patients with an embolized ovarian artery. One patient who was considering childbearing elected not to undergo a repeat embolization, but chose a myomectomy, based on the ovarian blood supply to the uterus.

Our findings on CTA are listed in Table I. All patients with a continued uptake of contrast on MRI were found to have persistent blood supply on CTA. 6 (100%) had an extra-gonadal blood supply, with one patient having persistent flow to the uterus on one side. None had a bilateral uterine artery supply to the uterus. None had an extra-uterine and a uterine artery supply on CTA.

At the time of angiography, the CTA reconstructed views were a large aid to the surgeon performing the procedure. The origin of ovarian arteries arising from the abdominal aorta could be clearly seen to be anterior, posterior, or lateral in position. This allowed the surgeon to rapidly position the C-arm for best imaging of the take-off point. Of interest, those uterine arteries which did not reveal flow on CTA did not appear on angiography. There was no visualization at angiography of non-gonadal supply on any patient who did not show such on CTA.

Although this paper has focused on the utility of CTA for failed UAE, there may be a limited role for this modality in pre-operative evaluation. In the patient with a large uterus (anterior posterior diameter > 20 centimeters) there is a higher likelihood that the uterus will recruit another blood supply (24). For the high-risk patient, such as a patient with compromised renal function, there may be just one chance for embolization. These patients would likely benefit from a discussion of all possibilities prior to their procedure to best give informed consent.

Pre-operative CTA may be useful in the evaluation of patients planning to undergo UAE. Not only can it potentially detect serious benign or malignant processes that may require treatment prior to UAE, but it may also be used as a baseline for post-operative imaging comparison. Additionally, anatomic variants or disease states that would favor an arterial vascular approach on one side versus the other would be visualized in pre-operative CTA.

Having said this, we must be aware that not all extra-gonadal blood supply to the uterus is involved in nourishing the uterus. The reader is reminded of the one patient who had a non-visualizing myoma on MRI following their UAE, and was then noted to have an obvious ovarian supply.

Conclusion

Computed tomographic angiography is a valuable tool in the evaluation of failed patients after UAE. For the physician, the procedure allows a thorough preparation for the second procedure. This includes the presence of an assistant, and the selection of catheters which the surgeon may not routinely use.

For the patient, CTA will confirm the utility of a second procedure versus a surgical procedure. Patients with an ovarian artery supply may be counseled about the higher risk of premature menopause, and give an informed consent to a repeat UAE. An MRI should be performed prior to CTA since a few patients did show persistent flow to the uterus in the presence of devascularized myomata. We do not advocate widespread

use of pre operative CTA prior to the first procedure. An MRI will better image the size of the uterus, the ovaries, and the possible existence of adenomyosis. Nonetheless, for patients with a large myomatous uterus which is likely to recruit a non-pelvic blood supply, and for high-risk patients who may have only one chance at UAE, the CTA may have utility.

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