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Application of cone-beam computed tomography angiography in a uterine fibroid embolization procedure: A case report

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ABSTRACT

One of the main causes of failure in uterine fibroid embolization procedures is incomplete infarction of the fibroid due to alternate vascular supply to the fibroid which was not identified by the operator. Cone-beam computed tomography angiography was used in this case to avoid nontarget embolization via a uterine artery, as well as identify incomplete embolization of the fibroid. This prompted a search for variant vascular supply to the fibroid, which was found to be originating from the right ovarian artery. Therefore, the use of cone-beam computed tomography angiography led to a successful outcome, which otherwise may not have been achieved.

Introduction

Cone-beam computed tomography (CBCT) angiography is an established radiographic study that is increasingly being used in the interventional radiology suite to guide and facilitate interventional procedures. It is performed by a 200° rotation of a C-arm while acquiring data continuously at different projections. The dataset is then processed to provide a CT study. This imaging modality allows excellent delineation of arterial anatomy, and has the advantage of providing cross-sectional evaluation of tissue perfusion. It enables the operator to deduce which arteries or arterial branches give supply to certain organs or specific regions of an organ.

This modality was initially used in oncologic interventional radiology procedures, such as transcatheter arterial chemoembolization and Y-90 radioembolization planning. Its use has recently expanded to other procedures, such as prostate artery embolization and aortic endoleak embolization. We report a case where CBCT angiography was used effectively in a uterine fibroid embolization (UFE) procedure.

Our ethics review board exempted this case report from institutional review.

Procedure

The patient on whom the procedure was performed is a 42-year-old woman who presented with menorrhagia and

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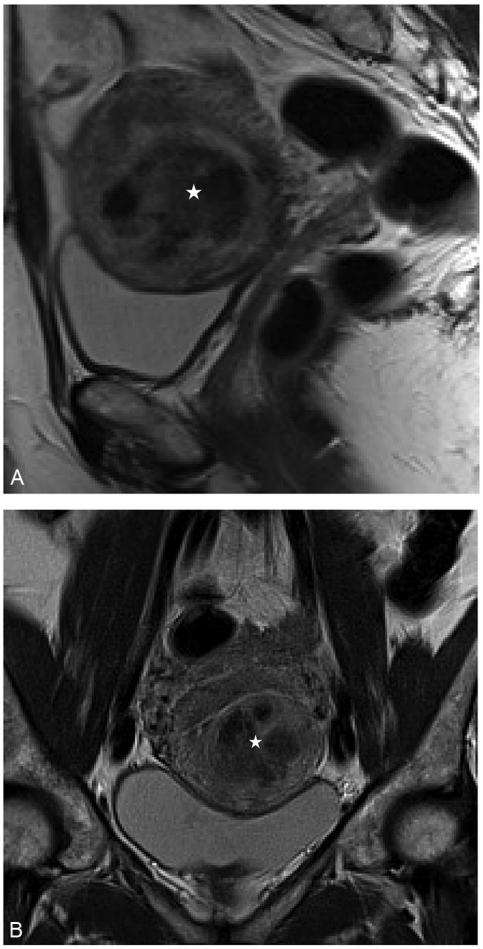

Fig. 1 – (A, B) Sagittal T2 magnetic resonance image showing low-intensity lesion in the myometrium abutting the endometrial canal, representing a large submucosal fibroid (star). Coronal T2 magnetic resonance image showing the same lesion (star).

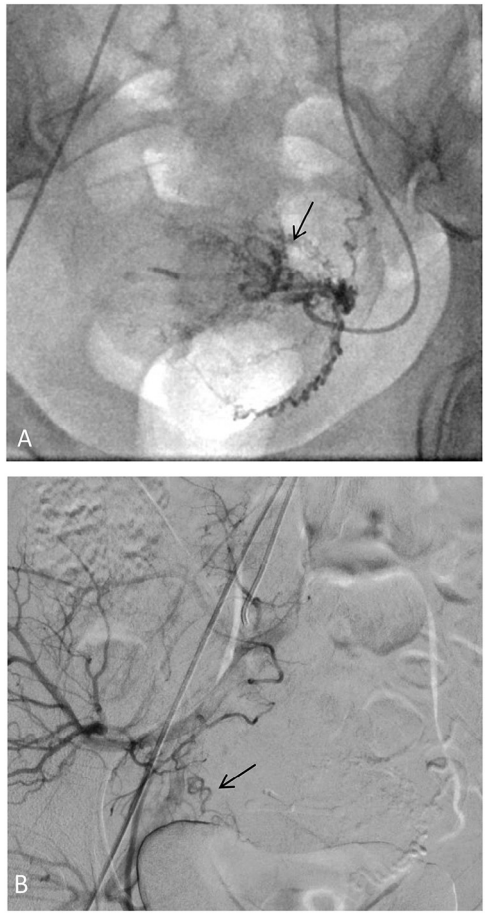

Fig. 2 – (A) Fluoroscopic screenshot with contrast media injected via the normal left uterine artery shows vascular perfusion of the left side of the uterus with expected increased vascularity at the body and fundus containing a uterine fibroid (arrow). (B) DSA performed via the anterior division of the right internal iliac artery shows a right uterine artery (arrow) that is of much smaller caliber than would be expected in a premenopausal woman with a large uterine fibroid.

dysmenorrhea. Her medical history was unremarkable, as was her surgical history except for 3 deliveries by cesarean section. A magnetic resonance imaging (MRI) study was obtained of her pelvis (Fig. 1A and B). The result demonstrated a large submucosal endometrial fibroid, measuring approximately $3.1 \times 4.2 \times 4.7$ cm in size with an estimated volume of 30.6 cc. After a discussion with the patient regarding all available treatment options, she accepted to undergo a UFE procedure (Figs. 1-8).

The procedure started in an uneventful fashion. The left uterine artery was cannulated using a hydrophilic Cobra 2 catheter (Glidecath, Terumo). Fluoroscopic screening with contrast media injected via the catheter demonstrated normal appearance of the uterine artery, with expected uptake of the contrast media at the fundus and body of the uterus containing the fibroid (Fig. 2A). Embolization was performed without complication using a solution of 700 μm microspheres (Embozene, Boston Scientific) mixed with iodinated water-soluble contrast media until stasis of flow was achieved.

The anterior division of the right internal iliac artery was then cannulated and digital subtraction angiography was performed. This demonstrated a right uterine artery of much smaller caliber than would be expected in a premenopausal woman with a large submucosal fibroid (Fig. 2B). To ascertain if embolization of this artery would be of any benefit, CBCT angiography was performed with the catheter within the right uterine artery (Fig. 3 and Fig. 4). The C-arm used was a Siemens Artis Q with PURE software. The CBCT protocol was a 5-second rotation with DR Body Care.

Axial, coronal, and sagittal reconstructions of the CT angiographic images were reviewed. They demonstrated no contrast media uptake within the right half of the fibroid, and no vascular supply to most of the body and fundus of the uterus from the right uterine artery. Small branches from the artery were seen to supply the cervix and a part of the lower body of the uterus. Furthermore, it showed static contrast within the left half of the fibroid, indicating the portion of the fibroid that had been treated by the embolic material injected via the left uterine artery.

Fig. 3 – Maximum intensity projection axial reconstruction of the cone-beam computed tomography angiography performed with the catheter in the right uterine artery shows arterial branches supplying the cervix and lower portion of the uterine body (arrows), with no vascular supply to most of the uterine body and fundus, including the fibroid (star). Opacification of the left half of the uterine body and fundus is observed due to uptake and retention of the microspheres and stasis of flow in the branches of the left uterine artery (arrowhead).

In view of these findings, it was decided that embolization of the right uterine artery would be of little or no use in achieving the end point of fibroid infarction. It also indicated that an alternate vascular supply to the fibroid was almost certainly present, which led to the decision to cannulate the right ovarian artery.

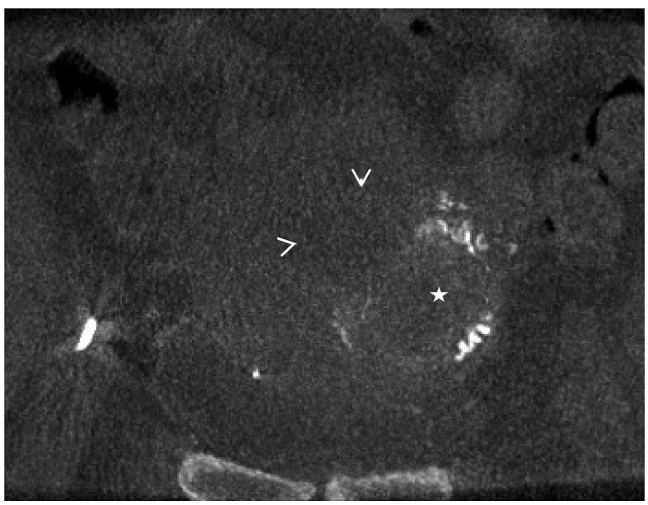

Fig. 4 – MIP coronal reconstruction of the same study further demonstrates lack of vascular supply of the left half of the fibroid from the left uterine artery (arrowheads), whereas retention of contrast media in the right half after embolization via the right uterine artery is noted (star).

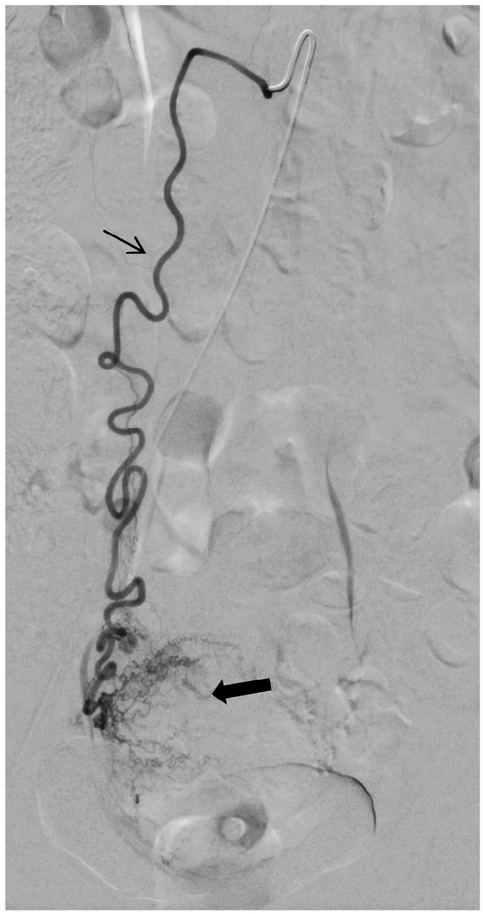

Fig. 5 – Digital subtraction angiography performed with the catheter in the right ovarian artery origin shows an enlarged ovarian artery (thin arrow) with extensive collateral vascular supply to the uterine fundus and body (thick arrow).

The right ovarian artery was cannulated using a Sos Omniselective catheter (Soft-Vu, AngioDynamics). Digital subtraction angiography was then performed, demonstrating a large and tortuous ovarian artery giving extensive collateral vascular supply to the right half of the uterine body and fundus (Fig. 5). A 2.8F microcatheter (Renegade, Boston Scientific) was advanced into the ovarian artery, and embolization was performed in the same fashion as previously described. No further complications were encountered and the patient made an uneventful recovery.

A postprocedural MRI study was obtained 3 months later, showing a significant reduction in size of the fibroid, which measured approximately $2.0 \times 2.2 \times 3.2$ cm, with an estimated volume of 7.1 cc.

Discussion

UFE is an established procedure in the management of symptomatic uterine fibroid disease that has not responded to conservative medical treatment. Although UFE leads to effective symptomatic relief in the majority of patients, failure is

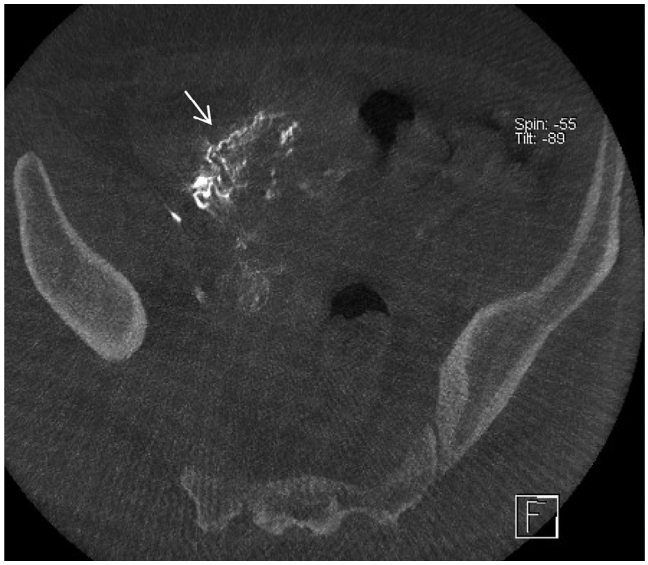

Fig. 6 – Axial MIP image from a cone-beam computed tomography angiography sequence performed with the catheter in the right ovarian artery shows vessels originating from the right ovarian artery perfusing the body of the uterus (white arrow).

encountered in approximately 20% of patients, who go on to require further intervention [1]. One of the main causes of failure of the procedure is incomplete infarction of the fibroid due to alternate vascular supply to the fibroid, which may originate from the ovarian artery [2].

The ovarian artery anastomoses with the uterine artery in approximately 10% of cases and may hypertrophy to provide supplementary vascular supply in pathologic processes such as uterine fibroid disease [3]. In this case, it is believed that the right uterine artery was damaged at some point as a result of

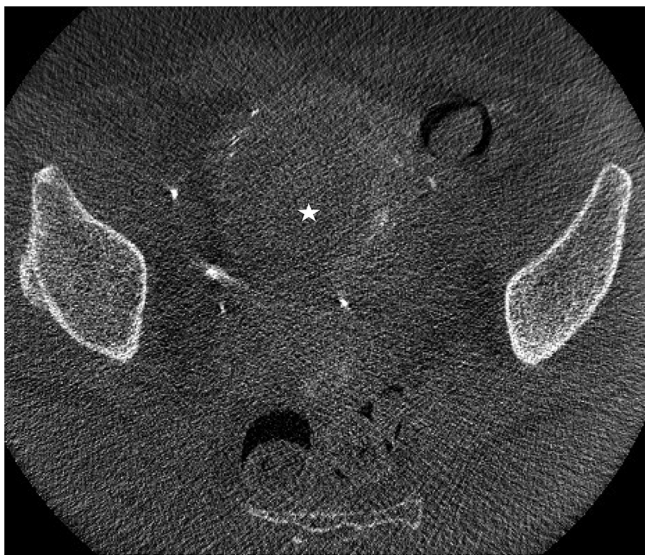

Fig. 7 – Axial image from the same sequence shows perfusion of the right side of the fibroid, supplied by the right ovarian artery (star).

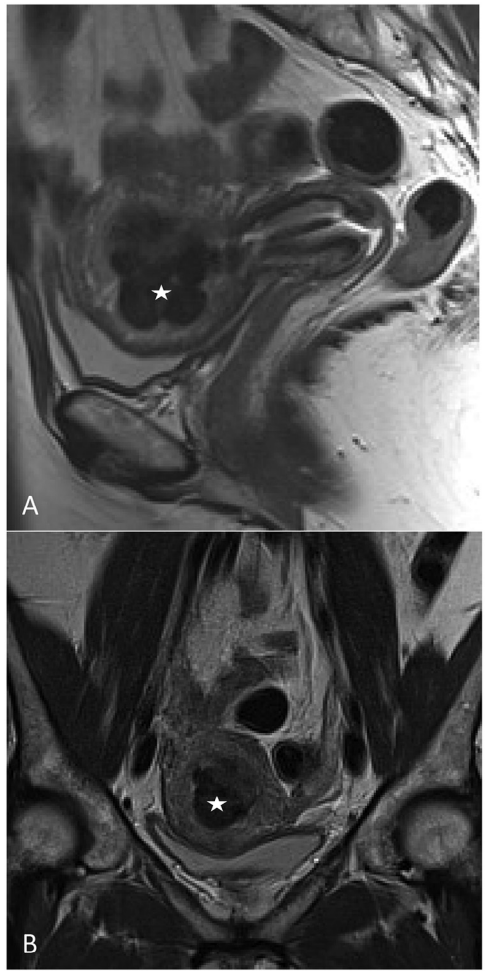

Fig. 8 – (A, B) Selected sagittal and coronal T2 images from the magnetic resonance imaging obtained 3 months after embolization demonstrates a significant reduction in size of the fibroid (star).

the 3 cesarean section operations previously performed. This might have spurred increased flow through collaterals from the ovarian artery with subsequent enlargement in caliber and flow.

The utility of postprocedure CBCT to assess for incomplete embolization of a uterine fibroid was first described by Golowa et al. [4]. Their study demonstrated retrospectively that the postprocedural CBCT assessment had identified lack of contrast retention in a significant portion of a target fibroid in 6.25% of the patients in their cohort, which amounted to a single patient. The authors also recorded the mean added dose area product from the CBCT study, which amounted to 2228 cGy cm^2 and accounted for 8% of the total dose area product of the study on average.

The use of CBCT angiography in this case was useful not only in demonstrating that embolization of the right uterine artery would be of no benefit to the procedure, but also that a significant portion of the fibroid was not embolized via the left uterine artery. This prompted a search for variant vascular supply to the fibroid, which was found to be originating from the right ovarian artery. The information obtained by CBCT angiography enabled us to avoid unnecessary embolization, while

identifying incomplete embolization of the fibroid at that stage by illustrating regions within it that were not permeated by the previous embolic injection.

Although some authors advocate routine flush aortography to assess for collateral supply to uterine fibroids by ovarian arteries, this approach has been shown to have a low sensitivity for identification of significant vascular supply to fibroids [5]. Similarly, preprocedural MR angiography, which is routinely performed in our department, may not adequately demonstrate enlarged ovarian arteries, which would lead to suspicion of alternate vascular supply to uterine fibroids.

The amount of fibroid infarction is an important technical end point in UFE procedures. Studies have demonstrated that a higher rate of clinical failure is seen in cases where a lesser percentage of the fibroid burden undergoes infarction [6]. For this reason, complete penetration of the fibroid disease with embolic material is essential to achieve a reasonable chance of clinical success. With the ability to demonstrate penetration of the fibroid by intraprocedural cross-sectional imaging, CBCT offers greater confidence in establishing a technical end point when performing these procedures.

As demonstrated by this case, we present CBCT angiography as a potential valuable tool in UFE procedures. By demonstrating the vascular distribution and tissue perfusion of a particular artery in excellent detail, it provides greater confidence in making decisions than assessment of planar digital subtraction angiography images. The information gained from this additional acquisition may justify the added radiation dose. However, the role of CBCT angiography in UFE procedures is not established at this point in time. Further randomized studies investigating the value of an additional high dose acquisition (CBCT) need to be conducted. These studies should compare clinical end points and radiation doses with those of conventional procedures (where CBCT is not used) to definitively justify the added radiation dose of CBCT.

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