Practical Application of a Coronal MR Image during a Uterine Fibroid Embolization (UFE)*

Jin Young Jung, M.D., Man Deuk Kim, M.D., Hyun Seok Lee, M.D., Mee Hwa Lee, M.D.*, Hee Jin Kim, M.D., Jin Ho Cho, M.D.*, Sun Hee Cha, M.D.*

Purpose: To assess the role of coronal MR images during uterine fibroid embolization (UFE).

Materials and Methods: A prospective study of 100 consecutive patients who underwent a uterine fibroid embolization was performed. The average age at embolization was 40.2 years (range, 19-49 years). The size of the predominant fibroids ranged from 2.5 cm to 21.0 cm (mean, 7.5 cm). The embolic agents included non-spherical polyvinyl alcohol particles. The angiographic and spot images after embolization were compared with coronal MR images. The patterns were divided into three categories: Matching, Undetermined, and Mismatching.

Results: Coronal MR images were correlated with angiographic or single shot images of the uterus after embolization in 94 cases, undetermined in three cases, and mismatched in three cases. Post-embolization aortographies were not helpful in patients showing complete matching images. In three cases of mismatching, two had ovarian collateral supplies to predominant fibroids in the uterine fundus and the remaining patient had an internal pudendal artery of collaterals to fibroid. Mismatching spot images combined with MRI allowed us to find other collateral vascularities.

Conclusion: Coronal MR images provided comprehensive information for the appropriate UFE. When perfectly matched, we could make sure that a particular UFE is appropriate without concern for collaterals.

Index words: Magnetic Resonance Imaging
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The Uterine Fibroid Embolization (UFE) is gaining acceptance for its efficacy and safety at long-term follow up (1-3). However, ovarian collateral supply is known as a main cause of treatment failure (4-6). The only way to identify ovarian collateral vascularity is to undergo an aortography. However, in a study by White et al, a postembolization aortography was of limited value in identifying residual fibroid perfusion and contributed to the main proportion of radiation exposure. Consequently, White et al. suggested that the use of the aortography should be limited in routine UFE (7, 8).

Therefore, many interventional radiologists might hesitate to perform a post-embolization aortography. The
The purpose of this study is to determine whether either fluoroscopic or single shot images of the uterus after embolization, matching or not with coronal MR images, would be effective in identifying collateral vascularities of the fibroid. Moreover, another purpose is to make sure that the UFE procedure is appropriate and does not create concern for treatment failure immediately after embolization.

**Materials and Methods**

The institutional review board gave approval for the entire study, and each patient provided written informed consent. A total of 100 consecutive patients who underwent a UFE between September 2006 and August 2007 were prospectively analyzed. The average age at embolization was 40.2 years (range, 19-49 years). The size of the predominant fibroids ranged from 2.5 cm to 21.0 cm (mean, 7.5 cm). The embolic agents consisted of non-spherical polyvinyl alcohol particles. A MRI (1.5-T Signa HD/HDx; GE Healthcare, Waukesha, Wisconsin) of the pelvis was performed on all patients before UFE. Moreover, all patients underwent axial, sagittal, and coronal fast spin-echo T2-weighted imaging (TR/effective TE, 3,500/99; matrix size, 225 × 300; field of view, 340 × 340 mm; section thickness, 5 mm), as well as contrast-enhanced T1-weighted sagittal imaging. Contrast-enhanced MRI was performed 2 minutes after an IV infusion of 10 mL of gadolinium (gadoterate dimeglumine, Dotarem, Aulnay-sous-bois, France) with

![Fig. 1. A 36-year-old woman with uterine leiomyoma. A. T2 weighted coronal MR image shows intramural myoma with a maximum diameter of 6 cm (arrows). B. Single shot image after embolization reveals perfect matching with a coronal MR image (arrows). C. Gadolinium-enhanced T1-weighted MR images at a 3-month follow-up examination after a UFE revealed volume reduction of the fibroid and no contrast enhancement, suggesting complete necrosis of the uterine leiomyoma.](image-url)
fast low-angle shot sequences (TR/TE, 117.3/4.1; flip angle, 80°; matrix size, 140 × 256; section thickness, 5 mm). Co-axial 3-F microcatheters (MicroFerret; Cook, Bloomington, IN) were advanced distally into the uterine artery. The primary embolic agent was polyvinyl alcohol (PVA) particles (Contour, Boston Scientific, Natick, Massachusetts) mixed with 60 mL of a 1:1 saline-contrast agent mixture. Single shot images after embolization were compared to T2 weighted or contrast enhanced coronal MR images.

Patterns of single shot images about matching with coronal MR images were divided into three categories: Matching, Undetermined, and Mismatching. Two interventional radiologists reviewed all the patient angiographies and MRIs and categorized them by consensus. The “Matching” category was defined as fluoroscopic or single shot images of the uterus after embolization that were perfectly correlated with the outline of the fibroid or the whole uterus of the coronal MR images. The “Mismatching” category was defined as fluoroscopic or

Fig. 2. A 43-year-old woman with uterine leiomyoma.
A. T2-weighted coronal images demonstrates subserosal myoma with a maximum diameter of 7 cm (arrows) located in the uterine fundus submucosal myoma
B. Single shot image after embolization reveals mismatching with the coronal MR image. Hence, the subserosal myoma was not visualized, which resulted in a search for ovarian collaterals.
C, D. Selective ovarian angiography shows staining of leiomyoma perfectly matching with the coronal MR image (arrows).
single shot images that were not correlated with the outline of the fibroid or the whole uterus of the coronal MR images, which makes us look for collaterals. The “Undetermined” category is defined as fluoroscopic or single shot images that were neither clearly matched nor mismatched with the outline of the fibroid.

Results

Of the 100 patients, 94 were categorized as “Matching”, 3 were categorized as Undermined, and 3 were categorized as Mismatched. Among the 94 patients who had matching images, all (100%) showed no visible ovarian collaterals (Fig. 1). Moreover, of the 94 patients who demonstrated perfect matching images, 92 (97.9%) achieved complete necrosis of leiomyomas at a 3 month follow-up MRI. Of the two patients with residual viable myomas following UFE, their submucosal myomas were 3.0 cm and 2.5 cm and had nothing to do with collateral vascularity. Therefore, post-embolization aortographies were not helpful in patients showing complete matching images. In three cases categorized as “mismatching”, two had ovarian collateral supplies to the predominant fibroid in the uterine fundus (Fig. 2), while the third had an internal pudendal artery of collaterals to the fibroid. In the three patients categorized as “undertermined”, the deposition of embolic materials mixed with contrast into the uterus were faintly visualized and the recognition of matching or mismatching images with a coronal MRI could not be determined.

Five patients with questionable leiomyoma vascularity from angiography results were easily identified as ovaries (n=3) and focal bulging contours of fibroids (n=2) after assessing their respective coronal MR images.

Discussion

UFE is recently growing and becoming one of the main treatment modalities for symptomatic fibroids (9-11). However, 5-10% of the patients who underwent UFE are refractory; one of the most common causes is ovarian collateral to the fibroids (12-14).

Moreover, most patients have to wait for MRI results whether fibroids are infarcted or not and the same is true for fibroid volume reduction. This study was initiated to determine the appropriateness of the UFE procedure which requires the incorporation of concern for treatment failure at the moment immediately after embolization.

The MRI has become popular as a screening diagnostic modality since it is useful for determining the size and number of fibroids, as well as the location and associated disease (i.e., adenomyosis or endometrial pathology and so on). However, the role of coronal images has not yet been studied. Perfect matching single shot or fluoroscopic images with coronal MR images could make sure the embolization is appropriate and without collaterals. Spies et al. reported that the post-embolization aortographies were helpful in less than 1% of patients and insisted that performing an aortography should be of limited value in routine UFE. Moreover, the aortography represents a major proportion of patient radiation exposure but, generally must still be performed to rule out ovarian collaterals. However, many interventional radiologists are still performing the post-embolization aortography following UFE to rule out ovarian collaterals.

In our study, patients who showed fluoroscopic or single shot images of the uterus perfectly matching with the coronal MRI demonstrated no ovarian collaterals. Moreover post-embolization aortographies were not helpful, which might have a role in assuring UFE is appropriate without performing a post-embolization aortography in the future. When mismatched, it led us to search for collateral supplies to the fibroid; we could find two ovarian and one internal pudendal collaterals. In our study, for patients with a bulging contour bordering the large intramural or subserosal myoma, matching or mismatching is more easily identified. Even if some patients showed fibroids with hypovascularity or if the angiographic images were not deterministic in figuring out the contour of the fibroid, fluoroscopic or single shot images after embolization facilitated the recognition of the fibroid contour. In addition, when we encountered unusual vascularity in the uterine arteriography concerning a non-target organ embolization in UFE, a coronal MRI provided comprehensive information indicating that the issue was the ovary or focal bulging contour of myoma.

A few limitations to this study that must be acknowledged; first, a small intramural or submucosal fibroid is hard to recognize on fluoroscopic or single shot images unless it has hypervascularity. Second, in theory, collateral vascularity supplying the posterior part of the fibroid would not be recognized, even in patients whose fluoroscopic images matched with coronal MRI results after embolization. Though quite rare, the aforemen-
tioned is the reason why fluoroscopic or single shot images following embolization are not appropriate surrogates to the post-embolization aortography.

In conclusion, coronal MR images provide comprehensive information about UFE.

Perfect matching images suggest that embolization is appropriate in most cases when there is no concern for collaterals. Mismatching images led to searching for collateral supplies, which could be helpful in reducing treatment failure.

References