Vascular Bed Volume Change of Uterine Fibroids after GnRHa Treatment: Assessment with Gadolinium-enhanced Dynamic R2* Imaging

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Introduction: Gonadotropine releasing hormone analogue (GnRHa) is widely used for reducing volume and vascularity of uterine fibroids, especially for the patients who are performed the myomectomy, the reduction of bleeding during surgical procedures is expected by using GnRHa. However, vascular bed volume change before and after GnRHa administration is not clearly known. We evaluated the vascular bed volume change of the uterine fibroids with Gadolinium-enhanced dynamic R2* imaging (Gd-R2*I) which enables to assess the vascular bed volume by using susceptibility derived from the contrast material in the vessels (1-3).

Methods: This study was approved by the institutional review board and informed consent was obtained. In addition to routine MR study including T2-weighted axial and sagittal, and T1-weighted axial images, Gadolinium-enhanced dynamic images were acquired in 30 patients (age range, 23-44 years old; average, 35.6) at 1.5 Tesla scanner (GE SIGNA Excite, HD) before and after either of two or three occasions of GnRHa administration.

An in-house single-section double-echo fast spoiled gradient recalled acquisition in the steady state (SPGR) sequence was used for the dynamic study with the following parameters: TR of 13 msec, TE1/TE2 of 3.5 / 8.6 msec, flip angle of 20°, band width of 16.63 kHz, matrix size of 128x128, NEX of 1, and FOV of 24 cm with a thickness of 10 mm. Each set of images of different TE was obtained every 1.5 seconds for two minutes. Eighty sets of images were acquired including 20 sets of baseline images. A single sagittal plane was selected to acquire the largest cut surface of uterine fibroid for the imaging. The largest fibroid was targeted when the patient had more than one. The contrast agent (Omniscan, Gadodiamide hydrate; 0.15 mmol/kg) was injected at a rate of 4 mL/sec, followed by a 15 mL saline solution flush after the baseline images.

Gd-R2*I was generated with the following equation: $R2^* = \ln[S(TE1)/S(TE2)]/(TE2-TE1)$, TE1 and TE2 reflect the first and second TE, and S(TE1) and S(TE2) are the signal intensities on the images acquired with the first and second TE, respectively.

For measurement of signal, the region of interest (ROI) was identified with 16x16 voxel matrix (3-cm-square) placed in the center of the fibroid on R2*I. The signal intensity (SI) in the ROI was plotted in time-series and the gamma-fitting curve was generated through all data points. Area-under-the-curve (AUC) was calculated for the signal peak on R2*I, excluding the recirculation following the first pass.

The volume of fibroids was measured with volumetry technique by manually tracing fibroids on sagittal T2WI. The paired *t* test was applied to assess the changes in AUC and volume of fibroids before and after GnRHa treatment. $P < .05$ indicated a significant difference.

Results: Gd-R2*I was successfully obtained from all patients. Five patients were excluded from the analysis because of the occurrence of massive degenerative change after GnRHa treatment (2 pts) and extended interval of two MR examinations with more than 6 months (3 pts). The mean interval of MR studies was 92.1 days. The averaged values of AUC before and after GnRHa treatment were 40.2 and 19.0, respectively ($P < .0001$). The mean reduction rate of AUC was calculated as 46.6 %. Statistical difference was observed between AUCs before and after GnRHa treatment; however, AUC of the second examination was greater than the first study with mean increasing rate of 13.0 % in four cases. The reduction of fibroid volume after GnRHa treatment was observed in all patients, from the average of 645.6 ml to 446.5 ml with mean reduction rate of 29.3 % with significant difference ($P < .0001$).

Discussions and Conclusions: Volume reduction of fibroids was observed even in the four patients with increase of AUC. The usage of GnRHa is justified in accordance with the aims of volume and/or vascularity reduction. Although a previous study revealed that the vascularity before GnRHa treatment had a correlation with volume reduction, many other factors were reported to regulate the fibroid shrinkage (3, 4). Further investigate is necessary to reveal the reasons why vascularity of some fibroids increased after GnRHa treatment.

References: 1. Kuperman VY, et al. J Magn Reson Imaging 1999; 9: 172-176. 2. Uematus H, et al. Radiology 2000; 214: 912-917. 3. Okuda S, et al. Radiology 2008; 248: 917-924. 4. Crow J et al., Int J Gynecol Pathol 1995; 14: 235-242.

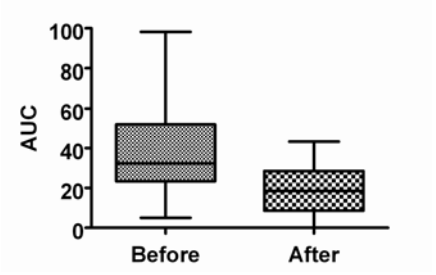

Figure 1: Box plots of AUC (minimum, 25% quartile median, 75% quartile, and maximum values)

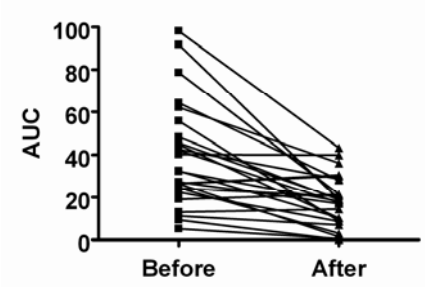

Figure 2: AUC change of each patient.

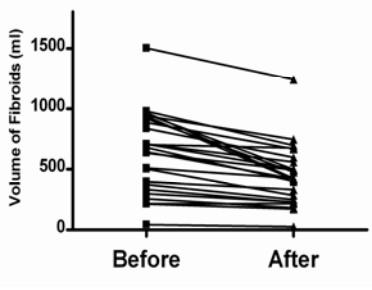

Figure 3: Volume change of each patient.