The Assessment of the Vascularity of Uterine Leiomyomas using Double-Echo Dynamic Perfusion MRI: Correlation with Histopathology

N. Kosaka[1], H. Uematsu[1], H. Kimura[1], Y. Ishimori[2], T. Kurokawa[3], H. Itoh[1]

[1]Department of Radiology, University of Fukui, Fukui, Fukui, Japan, [2]Radiological Center, University of Fukui Hospital, Fukui, Fukui, Japan, [3]Department of Obstetrics and Gynecology, University of Fukui, Fukui, Fukui, Japan

Introduction

Recently, perfusion-weighted MRI (PWI) has come to be applied to pelvic tumors to evaluate the aggressiveness of tumors and effectiveness of therapy. However, to the best of our knowledge, validation between relative tumor blood volume (rBV) calculated by PWI and histopathologic analysis has not been performed in pelvic organs. In this study, our aim was to evaluate the feasibility of PWI in the pelvic organs by correlating it with histopathologic analysis of uterine leiomyoma.

Methods

- Subjects Twelve patients with 15 uterine leiomyomas were included in this study.

- MR Imaging Techniques All leiomyomas were imaged with a 1.5T MR system (Horizon; GE) using a torso coil. PWI was performed using a double-echo spoiled gradient-recalled acquisition (SPGR) sequence to obtain a T1-bias-free estimate of the time-concentration curve. The scan parameters were as follows: TR=33.3 ms, TE= 7/23 ms, NEX=0.75, FA=20°, Matrix=256×128, FOV=24×18 cm, Slice thickness=7 mm. After 5 image sets were acquired, Gd-DTPA (0.1mmol/kg) was injected intravenously at a rate of 2 mL/s, followed by a 20 mL saline flush. After administration of Gd-DTPA, a dynamic series of 46 sets of double-echo images were obtained at 2.5-s intervals.

- Data analysis The MR data was analyzed by in-house software. Regions of interest (ROIs) were located in both the center of tumor and the external iliac artery. The steps in the data analysis were as follows: (a) obtain curves of signal intensity against time, (b) calculate the change in relaxation rate (ΔR2*), fit the ΔR2* curves of tumors with the function of gamma variates and their integral terms, which represent first pass and leakage to extra-vascular space of contrast media, respectively, then fit the ΔR2* curve of the external iliac artery with the function of gamma variates, (c) calculate the area under the fitted curve, and (d) calculate rBV in relation to the external iliac artery. We also produced parametric maps to visually evaluate the rBV of tumors (Fig. 1-B).

- Pathologic analysis We determined the sections of each tumor that corresponded to the PWI slice plane. Then, the sections were immunostained using an endothelial marker (CD34) (Fig.1-C and D). Three microscopic images of each section (original magnification ×100) were captured by digital camera. Vascular area (VA) was defined as the proportion of area inside of the immunostained blood vessels. The VAs of these 3 sections were averaged.

Results

The rBV calculated by PWI ranged from 0.06 to 0.55 (0.18 ± 0.13: means ± SD). The VA ranged from 1.7 to 8.5 (3.22 ± 1.63). The difference in rBV was visually apparent on the parametric map as shown in Figure 1-B. Microphotographs of leiomyomas immunostained with CD34 showed that the degree of VA matched with that of rBV. Because one tumor had significantly higher rBV and VA than the others (rBV=0.55, VA=8.5), we excluded it from the statistical analysis. The correlation between rBV and VA was statistically significant as shown in Fig.2 (r^2=0.67, $p<0.001$).

Conclusion

Our results suggest that the rBV calculated by PWI reflects the tumor vascularity, as determined by histopathology. Therefore, PWI may be reliable for further clinical applications in the pelvic organs.

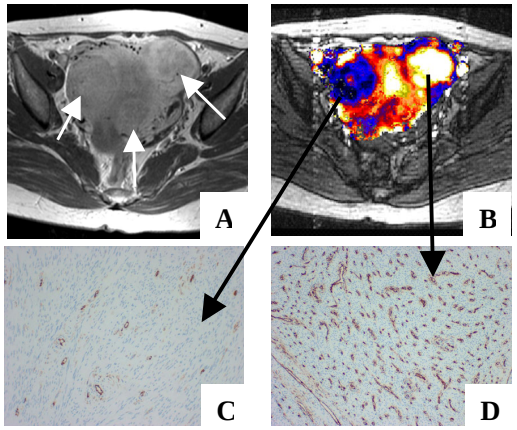

Fig.1 A) Contrast-enhanced T1-weighted MR image shows multiple uterine leiomyomas (white arrows).
B) The difference in rBV of each leiomyoma was visually apparent on the parametric map.
C, D) Microphotographs of leiomyoma immunostained with CD34 show that the degree of VA matched that of rBV (original magnification ×100).

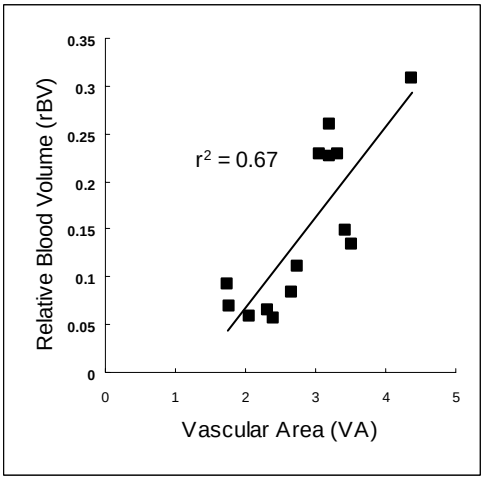

Fig.2 Scatter plot of rBV versus VA
The rBV has a significant correlation with VA.