Entropy of T2-weighted Imaging and Apparent Diffusion Coefficient of Uterine Leiomyoma in Prediction of Leiomyoma Volume Reduction Following Uterine Artery Embolization

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Introduction:
Uterine artery embolization (UAE) has become an alternative option for symptomatic leiomyomas1. Many recent studies have investigated the role of MRI features of leiomyomas before UAE for prediction of leiomyoma volume reduction (VR) following UAE2,3,4. However, many of the results were contradictory and there is lack of a consensus on which is the most reliable feature to predict the outcome after embolization2,3,4. In this work, we for the first time employed entropy of T2-weighted imaging as the morphological parameter, together with apparent diffusion coefficient (ADC) as the functional parameter, to determine their utility for predicting the leiomyoma VR after UAE.

Materials and Methods:
In this prospective study, 11 patients (age range 29 to 56 years; mean 42 years) with symptomatic uterine leiomyomas who underwent pelvic MRI including diffusion weighted imaging (DWI) before and 6 months after UAE were included. Pre-UAE and post-UAE MRI was all obtained on a 3.0 T system (HDxt; GE healthcare) equipped with a phased-array pelvic coil. Imaging sequences include fast spin-echo T2-weighted imaging, axial DWI using a single-shot spin-echo echo-planar sequence (b-values = 0, 1000 s/mm2) and axial contrast-enhanced T1-weighted imaging using a 3D volumetric interpolated technique (LAVA) prior to and after administration of intravenous Gd-DTPA contrast.

The volumes of each leiomyoma before and after UAE were determined using software ITK-SNAP on contrast-enhanced T1-weighted images, and the percentage change in volume was calculated. Entropy of T2-weighted imaging and ADC before UAE were assessed using the following equations: 
\[ \text{ADC} = - \frac{\ln (Sb/S0)}{b} \]
where b is the diffusion-sensitizing factor (b-value), and Sb and S0 the signal intensity at a non-zero b-value and zero b-value, respectively; 
\[ \text{Entropy} = \sum_i (- \pi_i \log(\pi_i)) \]
where \( \pi_i \) represents the probability of signal intensity (SI) i in the image and is calculated by dividing the pixel number of each SI by the total pixel number.

Results:
A total number of 16 leiomyomas larger than 2 cm in diameter were evaluated. The mean leiomyoma volume before UAE was 72.6 cm³ (range 7.3–347.1 cm³), while the mean volume 6 month after UAE was 34.6 cm³ (range 1.5–174.8 cm³), resulting in a mean leiomyoma VR of 58.9% (range 25.8%–95.0%). The mean ADC of leiomyomas was 1.37 × 10⁻³ mm²/s (range 1.05 × 10⁻³–2.32 × 10⁻³ mm²/s) and the mean entropy of T2-weighted imaging was 5.36 (range 4.62–5.91) before UAE. ADC and entropy were significantly correlated with VR (Pearson correlation \( r = 0.61, P = 0.012; r = 0.73, P = 0.001 \)). On multiple regression analysis, a combination of ADC and entropy constituted the best model for determining leiomyoma VR using the Akaike information criterion. For predicting ≥ 50% VR, receiver operating characteristic (ROC) curve analysis showed that the cutoff value of ADC was 1.39 × 10⁻³ mm²/s (sensitivity 45.5%, specificity 80.0%) and the cutoff value of entropy was 5.15 (sensitivity 90.9%, specificity 60.0%).

Conclusion:
Entropy of T2-weighted imaging and ADC of leiomyomas were significantly correlated with VR after UAE. A combination of entropy and ADC may have predictive value for VR after UAE.

References: