

Feasibility of T2*-weighted image(T2*W) in the assessment of non-perfused volume (NPV) inside uterine fibroids response to MR-guided high intensity focused ultrasound (HIFU) ablation

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Introduction: Magnetic resonance (MR) guided high intensity focused ultrasound (HIFU) has been used in recent years for the non-invasive treatment of uterine fibroids and shown to be a uterus preserving, safe and effective treatment alternative [1]. Currently, contrast enhanced (Gd-DTPA) T1-weighted imaging (CE-T1WI) has been widely used in assessing the ablated area of uterine fibroids immediately after HIFU ablation [2]. The necrotic tissue appears no perfusion on CE-T1W images, which is called non-perfused volume (NPV). However, the major disadvantage of CE-T1WI lies in the potential risk of Gd-contrast agents' injection. It has restriction on patients with history of allergy and nephrotic dysfunction. In addition, if injected just before or during the HIFU treatment, the entrapment of contrast agent in the ablated tissues might result in long-term retention of Gd in the body, Therefore, an alternative method that does not require a gadolinium based MR contrast agent would therefore be preferred to determine how much percent of uterine fibroid volume ablated and/or which part ablated and/or not ablated during and immediately after HIFU treatment. Diffusion-weighted imaging (DWI) [3] for providing observation of effective ablated and non-ablated area has been under investigation in recent publications. It has been reported that a decrease in apparent diffusion coefficient (ADC) value at lower b-value may suggest low-degree enhancement inside fibroids. However, the quality of DW images may be affected by a variety of artifacts related to physiologic motion and susceptibility effects. In this study, we present another non-invasive method, called fast field echo (FFE) T2*-weighted imaging (T2*WI), for assessing NPV of fibroids response to HIFU therapy as an alternative to CE-T1WI.

Materials and Method: Institutional review board approval and informed consents were obtained before the study. Seven patients with 9 fibroids were treated by HIFU ablation on a clinical MR-guided HIFU system (Sonalleve; Philips Medical Systems, Vantaa, Finland). All MR images were acquired with Philips 3.0 T MR scanner (Achieva TX; Philips Medical Systems, Best, the Netherlands). T2*W images were acquired before intravenous injection of Gd-DTPA, and CE-T1WI was conducted 3 minutes after injection of Gd-DTPA. The geometric parameters of both the two protocols were the same in all patients: the scanning location of both the two protocols were the same in each patient with the same FOV, number of slices, slice thickness, gap and matrix. T2*W images and CE-T1W images were compared slice by slice at the same location in each patient for assessment. Meanwhile, areas of NPV on each slice of both T2*W and CE-T1W images for all the patients were calculated manually for statistical analysis.

Results: On T2*W images of the 7 patients, all the NPVs inside uterine fibroids could be visualized with clear margins, and the details around the margin were almost exactly the same with those on CE-T1W images. Meanwhile, paired-t-test analysis of NPV areas measurement between T2*W images and CE-T1W images showed no significant differences between them ($t=1.295$, $P=0.203 > 0.05$).

Conclusion: As an alternative to CE-T1WI, T2*WI is a very promising method in assessing NPV inside uterine fibroids response to HIFU ablation both in real-time and follow-ups.

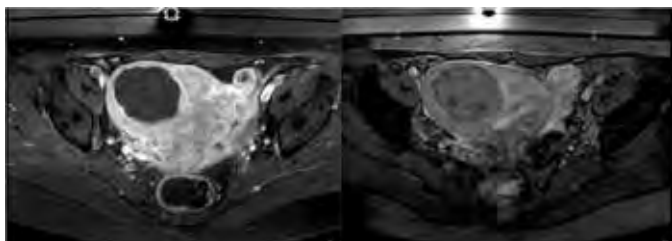


Fig.1 MR Images of the fibroid immediately after HIFU ablation. A 45-year-old woman with one subserosal fibroid on the right side of uterus. Left: CE-T1W image. Right: T2*W image at the same location.

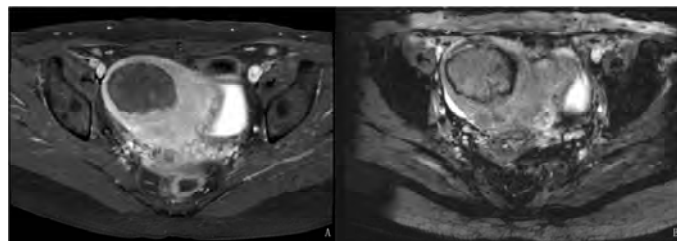


Fig.2 MR Images of the fibroid at 1-month follow-up. The same patient with Fig. 1 at 1-month follow up after HIFU ablation. Left: CE-T1W image. Right: T2*W image at the same location.

References: [1] Lenard ZM, McDannold NJ, Fennessy FM, Stewart EA, Jolesz FA, Hynynen K, et al. Uterine leiomyomas: MR imaging-guided focused ultrasound surgery—imaging predictors of success. *Radiology* 2008; 249: 187–194. [2] Kim YS, Lim HK, Kim JH, Rhim H, Park BK, Keserci B, et al. Dynamic Contrast-Enhanced Magnetic Resonance Imaging Predicts Immediate Therapeutic Response of Magnetic Resonance-Guided High-Intensity Focused Ultrasound Ablation of Symptomatic Uterine Fibroids. *Invest Radiol* 2011; 46(10): 639–647. [3] Jacobs MA, Herskovits EH, Kim HS. Uterine fibroids: diffusion-weighted MR imaging for monitoring therapy with focused ultrasound surgery—preliminary study. *Radiology* 2005; 236(1): 196–203.