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CLINICAL ARTICLE

Effective ablation therapy of adenomyosis with ultrasound-guided high-intensity focused ultrasound

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ABSTRACT

Objective: To evaluate the effects of ultrasound-guided high-intensity focused ultrasound (HIFU) on adenomyosis. *Methods:* In a retrospective analysis, data were reviewed from 202 patients with adenomyosis who underwent ultrasound-guided HIFU between November 2010 and June 2012 at Suining Central Hospital, Sichuan, China. Among these patients, 120 and 82 were classified as having focal adenomyosis and diffuse adenomyosis, respectively. All patients underwent pre-treatment and post-treatment magnetic resonance imaging by a standardized protocol to evaluate the treatment. All adverse effects were recorded. *Results:* All patients completed the ultrasound-guided HIFU treatment in 1 session. A non-perfused volume ratio of 71.6% ± 19.1% was achieved. Compared with baseline data, the average menorrhagia severity score and the average dysmenorrhea severity pain score decreased significantly after ultrasound-guided HIFU (both $P < 0.001$). The proportion of women with complete relief of dysmenorrhea at the 3-month follow-up was significantly higher among women with focal adenomyosis than among those with diffuse adenomyosis ($P = 0.02$). No other significant differences were observed between the 2 patient groups. *Conclusion:* Ultrasound-guided HIFU was found to be an effective technique for treating both focal and diffuse adenomyotic lesions to alleviate the symptoms of menorrhagia or dysmenorrhea.

1. Introduction

Adenomyosis is a common benign disease among women of reproductive age [1,2]. The prevalence of adenomyosis varies across race; it can range from 1% to 70% among women of reproductive age, and is frequently reported as 20%–30% [3–5].

Patients with adenomyosis often report menorrhagia and dysmenorrhea, and sometimes complain of pelvic pressure and frequent urination. In clinical practice, gynecologists can offer several treatment options to women with symptomatic adenomyosis. Among these options, hysterectomy is considered as the only definitive treatment for patients with adenomyosis. However, hysterectomy is only suitable for patients who are older than reproductive age and are not opposed to definitive surgical treatment. Conservative myomectomy is an option for patients who desire to preserve their uterus but, because of ill-defined boundaries between the endometrium and myometrium, complete removal of the focal adenomyotic lesions is problematic.

In an attempt to find a treatment option with minimal impact on a patient's lifestyle, lower cost, and less invasiveness, several groups have tested the clinical value of uterine artery embolization, intrauterine devices, gonadotropin-releasing hormone analogs, oral hormonal medication, non-hormonal medication, and ultrasound-guided high-intensity focused ultrasound (HIFU) for the treatment of adenomyosis [6–10].

Ultrasound-guided HIFU is a non-surgical technique. Over the past 10 years, this non-invasive therapeutic modality has been applied to treat malignant solid tumors in the liver, breast, pancreas, and bone [11–13]. Although many studies have shown that ultrasound-guided HIFU ablation is a safe and effective treatment for uterine fibroids [14–16], only a few have examined the application of ultrasound-guided HIFU for treating patients with adenomyosis [9,10,17].

The primary aim of the present study was to evaluate the therapeutic effect of ultrasound-guided HIFU on adenomyosis-associated clinical symptoms, as defined by the symptom severity score (SSS) and the uterine fibroids symptoms quality of life (UFS-QOL) questionnaire. A secondary aim was to compare the alleviation of symptoms of pain and heavy periods between patients with focal adenomyosis and patients with diffuse adenomyosis.

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2. Materials and methods

In a retrospective study, data were analyzed from women who underwent ultrasound-guided HIFU for adenomyosis between November 1, 2010, and June 30, 2012, at Suining Central Hospital of Sichuan, China. The ethics committees at Suining Central Hospital of Sichuan and Chongqing Medical University approved the study protocol. All patients gave written informed consent for ultrasound-guided HIFU and for the future use of data collected.

The diagnosis of adenomyosis was confirmed by magnetic resonance imaging (MRI). The selection criterion for the study was the presence of symptomatic adenomyosis with an endometrial–myometrial junctional zone thickness of more than 3 cm for diffuse adenomyosis or a lesion diameter larger than 3 cm for focal adenomyosis.

All patients were asked to take liquid food for 3 days. Mandatory enema was performed on the morning of the treatment day after a 12-hour fasting period. To avoid bowel injury during treatment, the bowel loops in the acoustic pathway were pushed away or compressed by placing a degassed water balloon on the abdominal wall of the patient.

A JC 200 HIFU system (Chongqing Haifu Technology, Chongqing, China) was used to perform ultrasound-guided HIFU. Equipped with a transducer of 20 cm in diameter, a focal length of 15 cm, and a frequency of 0.8 MHz, this system produced therapeutic focused ultrasound energy and was paired with an ultrasound imaging device (My-Lab70; Esaote, Genoa, Italy) as a real-time imaging unit to guide the HIFU procedure.

The HIFU ablation procedure was performed after conscious sedation of patients with a single- or multidose injection of fentanyl (range, 50-400 μg), and midazolam hydrochloride (range, 1–4 mg). During treatment, patients were requested to report any discomfort, and the vital signs of heart rate, respiration rate, and blood pressure were monitored. The HIFU ablation was terminated after an indistinct increase in the grayscale area in the adenomyotic lesion was observed (Fig. 1).

All patients were asked to undergo contrast-enhanced MRI before and 1 day after the HIFU treatment. Diffused thickening of the endometrial–myometrial junctional zone on the T2-weighted image was considered as diffuse adenomyosis. Focal adenomyosis was observed as a localized region on the T2-weighted image. This image was used to measure the adenomyotic lesion volume, and the contrast-enhanced T1-weighted image was used to measure the non-perfused volume (NPV) in the treated adenomyotic lesion (Figs. 2 and 3). The volume with no enhancement on the contrast-enhanced T1-weighted image of the post-treatment MRI was recognized as the lesion coagulation volume, which was defined as NPV (Figs. 2C and 3C). HifuMars (Chongqing Haifu) software program was used to contour the uteri, adenomyotic lesion, and the area with no enhancement in the treated lesion slice by slice. The same program was then used to calculate the uterine volume, the adenomyotic lesion volume, and the NPV.

In accordance with institutional guideline for follow-up observations, a nurse was requested to call the patients daily during the first 3 days, and the patients were requested to come back 1, 3, 6, and 12 months after ultrasound-guided HIFU to check for adverse effects, symptoms, and MRI evaluation. Both menorrhagia and dysmenorrhea were evaluated via the SSS and the UFS-QOL questionnaire using a 5-point categoric scale (1, not affected; 2, a little affected; 3, somewhat affected; 4, greatly affected; 5, very greatly affected) [18].

The degree of dysmenorrhea alleviation after ultrasound-guided HIFU was assessed as follows: complete relief, dysmenorrhea completely disappeared; partial relief, dysmenorrhea was not resolved completely, but the pain score decreased by 2 points or more; minor relief, dysmenorrhea was present, but the pain score decreased by 1 point; ineffective, no change in pain score; exacerbated, the pain score increased after treatment.

Data were reported as the mean ± SD score. Data analysis was carried using SPSS version 18 (IBM, Armonk, NY, USA). A 1-sample *t* test was used to compare the menorrhagia and dysmenorrhea scores between the baseline and different follow-up times after ultrasound-guided HIFU. A 1-sample *t* test was also used for comparisons of adenomyotic lesion volume and NPV ratio between focal adenomyosis and diffuse adenomyosis. The changes in frequency of menorrhagia and dysmenorrhea after ultrasound-guided HIFU treatment (focal versus diffuse adenomyosis) were compared via χ^2 test. A significant difference was defined as a *P* value of less than 0.05.

3. Results

During the study period, 202 patients with adenomyosis were treated by ultrasound-guided HIFU. The mean ± SD age of the patients at treatment was 41.7 ± 4.9 years (range 26–54 years) (Table 1). A point scan with 300–400 W of power was used for HIFU treatment. Each patient tolerated and completed the procedure. The median room time was 102 minutes, and the mean time for sonication was 20 minutes 11 seconds.

The adenomyotic lesion was clearly displayed on the T2-weighted image of MRI. The NPV, which is induced by ultrasound-guided HIFU ablation, was clearly observed on the contrast-enhanced T1-weighted image of

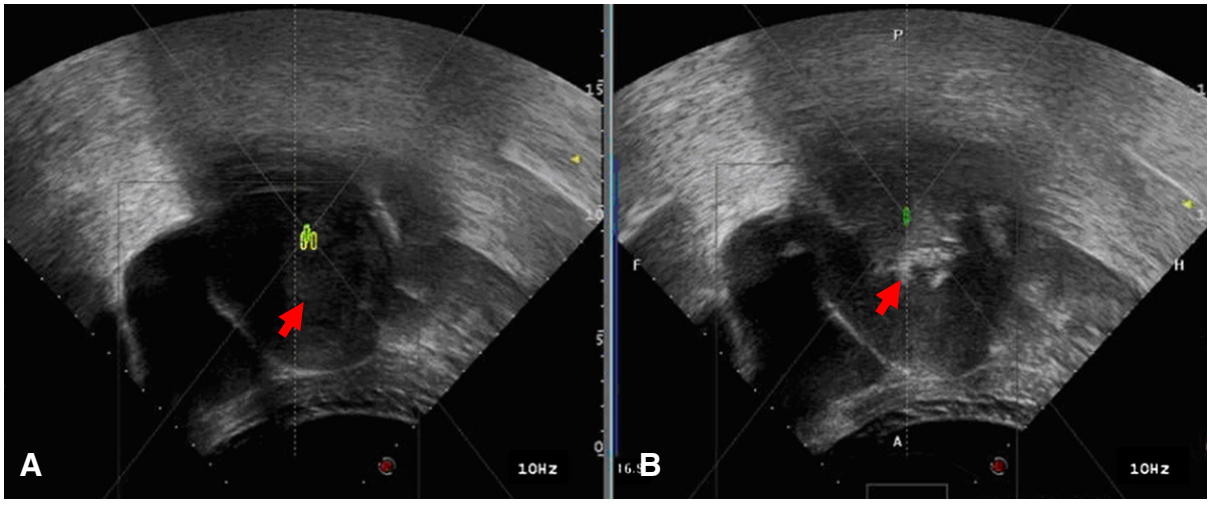

Fig. 1. Real-time ultrasound images from a 44-year-old woman with focal adenomyosis. (A) Pre-treatment ultrasound image shows a focal adenomyotic lesion at the posterior wall of the uterus (arrow). (B) Intra-procedure ultrasound image shows massive grayscale changes in the adenomyotic lesion (arrow).