

● *Original Contribution*

HIGH-INTENSITY FOCUSED ULTRASOUND LEADS TO HISTOPATHOLOGIC CHANGES OF THE INFERIOR TURBINATE MUCOSA WITH ALLERGIC INFLAMMATION

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(Received 16 January 2014; revised 21 April 2014; in final form 19 May 2014)

Abstract—This study was aimed at understanding the histopathologic changes that occur in the nasal mucosa of patients with perennial allergic rhinitis after high-intensity focused ultrasound (HIFU) treatment. Biopsy specimens of the inferior turbinate mucosa were taken from 11 PAR patients before, immediately after and 1 y after HIFU treatment. Morphometric analysis revealed that the density of eosinophils and other inflammatory cells increased immediately after treatment and then were decreased significantly 1 y post-treatment. Submucosal glands were swollen and venous sinusoids were dilated, but there was no statistically significant change in their density, immediately after treatment. However, both glands and venous sinusoids significantly decreased in number 1 y after HIFU treatment. The ciliated epithelium or basement membrane of the nasal mucosa was well preserved at all stages. In conclusion, HIFU is a tolerable and effective treatment to reduce inflammation of the inferior turbinate mucosa in patients with perennial allergic rhinitis. (E-mail: hongquanwei@163.com (Hongquan Wei); langmf@hotmail.com (Ming-Fei Lang); sunjing010@yahoo.com (Jing Sun)) © 2014 World Federation for Ultrasound in Medicine & Biology.

Key Words: High-intensity focused ultrasound, Perennial allergic rhinitis, Allergic inflammation, Nasal mucosa.

INTRODUCTION

High-intensity focused ultrasound (HIFU) has been increasingly accepted as a treatment for benign or malignant solid tumors in the past decade (Khokhlova and Hwang 2011; Klingler et al. 2008; Li et al. 2010; Napoli et al. 2013; Park et al. 2013; Wang et al. 2012; Wijlemans et al. 2012). From a technical point of view, HIFU is feasible and tolerable for non-invasive ablation of deeply located tissue targets. The target tissue is heated to temperatures above the threshold of protein denaturation within seconds without damaging superficial layers (Al-Bataineh et al. 2012). The HIFU technique was first

proposed more than 70 y ago (Lynn et al. 1942). The first commercial HIFU device became available in Japan in 1999. Devices for HIFU and its limited clinical applications were subsequently approved in Europe (2001) and in the United States (2004).

Allergic rhinitis (AR) is a non-infectious inflammation of the airway mediated by immunoglobulin E. Avoidance of the allergens, treatment with medications and specific immunotherapy are recommended to alleviate AR symptoms of most patients (Bousquet et al. 2008). However, some patients still suffer from persistent symptoms. For these refractory cases, surgical options may be considered (Lin et al. 2010; Tan et al. 2012; Unsal Tuna et al. 2008). Most of these surgical treatments are invasive procedures including turbinectomy, electrocautery, cryosurgery, chemosurgery with trichloroacetic acid and microwave and laser surgery (Tsai et al. 2009). Radiofrequency (Lin et al. 2010) is a comparably less invasive treatment. Since 2006, HIFU has been used to treat AR in China and has been proved to be a tolerable and effective option (Cheng et al. 2013; Wei et al. 2013). Here we report a histopathologic study of the

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Table 1. Patients' satisfaction 1 y after HIFU treatment

Rating	Number (%) of patients
Excellent ($9 \leq$ VAS score ≤ 10)	4 (36.4%)
Very good ($7 \leq$ VAS score < 9)	2 (18.2%)
Good ($5 \leq$ VAS score < 7)	3 (27.3%)
Poor ($3 \leq$ VAS score < 5)	1 (9.1%)
Very poor ($0 \leq$ VAS score < 3)	1 (9.1%)

VAS = visual analogue scale.

inferior turbinates of 11 patients with perennial AR (PAR) who received HIFU treatment.

METHODS

Patient information

The 11 patients enrolled in this study met the diagnosis of moderate to severe PAR as described in Allergic Rhinitis and Its Impact on Asthma guidelines in 2008 (Bousquet et al. 2008). Of these, 7 were male and 4 were female. The average age was 34 y (range: 13–61 y). Their PAR history ranged from 2 to 21 y (average duration: 8.32 y). All of the patients were not satisfied with the conventional medication and immunotherapy treatments. Patients who had undergone immunotherapy within 3 mo or other clinical treatments within 1 mo; patients who had taken a long-acting corticosteroid within 1 mo or an antihistamine, corticosteroid, anticholinergic, β -receptor agonist or sedative within 2 wk; and patients who had previously undergone surgery of the nose were excluded from the study. The study protocol was

approved by the institutional review board of the First Hospital of China Medical University. Signed informed consents were obtained from all patients.

Operative procedures

All patients were positioned supine. General anesthesia was applied using a routine procedure. An ultrasound therapeutic device (Seapopinna Model CZB, Chongqing HIFU Technology, Chongqing, China) for rhinitis was used (power parameter: gear III). The emitter window of the ultrasound device was placed against the anterior and superior lateral wall of the nasal cavity around the agger nasi, the inferior turbinate and the corresponding nasal septum, and then scanned from front to back and top to bottom. The scan speed was 2 mm/s on the lateral wall and 4 mm/s on the nasal septum. The unilateral treatment time was 300 s on the lateral wall and 150 s on the nasal septum. The total treatment time was 900 s for both sides. Nasal packing or any other additional medications were not required after treatment.

Evaluation of patient satisfaction

A survey using a visual analogue scale (VAS) (from 0 to 10) was conducted 1 y after HIFU treatment to assess patient satisfaction. Based on the VAS, patient satisfaction was further categorized as excellent (9–10), very good (<9), good (<7), poor (<5) and very poor (<3).

Biopsy and morphometric analysis

Under topical anesthesia with 2% dicaine, biopsy specimens were obtained from the front end of the

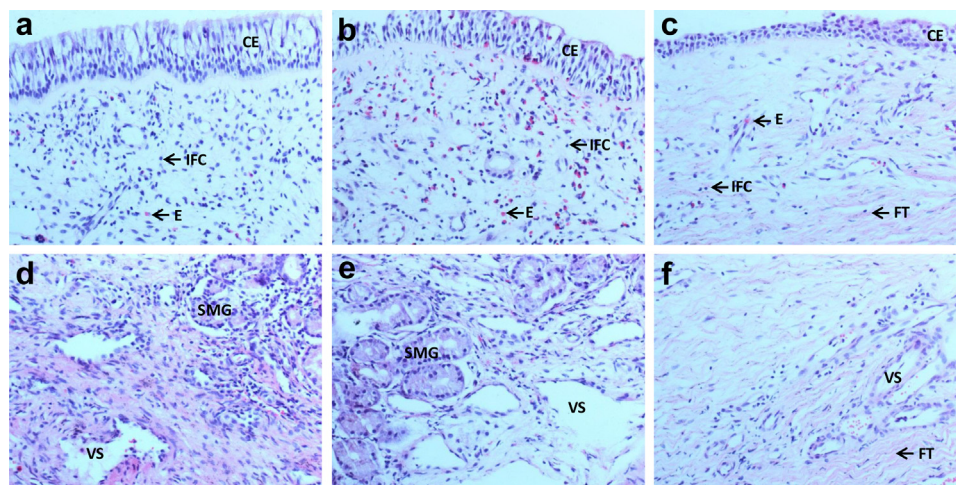


Fig. 1. Hematoxylin and eosin staining of the inferior turbinate mucosa of patients with allergic rhinitis, before, immediately after and 1 y after high-intensity focused ultrasound (HIFU) treatment. Inflammatory cells, submucosal glands and venous sinusoids of the patients' inferior turbinate mucosa before HIFU treatment (a, d). Immediately after HIFU treatment, eosinophils and other inflammatory cells were increased in number, and submucosal glands and venous sinusoids were swollen or dilated (b, e). Compared with the results before and immediately after HIFU treatment, at 1 y after treatment, eosinophils, other inflammatory cells, submucosal glands and dilated venous sinusoids were reduced in number; whereas more fibrous tissue was present (c, f). CE = ciliated epithelium, E = eosinophils, FT = fibrous tissues, IFC = other inflammatory cells, SMG = submucosal glands, VS = venous sinusoids. $\times 200$.

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