

# A combination of ultrasonic debridement and Shenghong wet dressing in patients with chronic ulcers of the lower limbs

Journal of International Medical Research

2019, Vol. 47(10) 4656–4663

© The Author(s) 2019

Article reuse guidelines:

[sagepub.com/journals-permissions](http://sagepub.com/journals-permissions)

DOI: 10.1177/0300060519858033

[journals.sagepub.com/home/imr](http://journals.sagepub.com/home/imr)



Xie Xiaolan<sup>1</sup> , Guan Wujie<sup>2</sup>, Tang Xiaoyan<sup>2</sup>  
and Chang Wenlai<sup>3</sup>

## Abstract

**Objective:** This study aimed to examine the effects of ultrasonic debridement plus a wet dressing of Shenghong (SH) on chronic ulcer healing of the lower extremities in patients with diabetes.

**Methods:** Sixty cases of diabetes combined with chronic lower limb ulcers were randomly divided into control (n=30) and experimental (n=30) groups. The control group was treated with ultrasonic debridement plus recombinant human fibroblast growth factor (FGF) gel. The experimental group was treated with ultrasonic debridement plus SH wet dressing.

**Results:** The mean clinical efficacy in the experimental group was significantly higher than that in the control group (93.33% ± 6.32% versus 60.0% ± 5.87%). The mean ulcer area was significantly smaller and the mean ulcer healing rate was significantly shorter in the first 3 months, and the mean overall pain intensity score was significantly lower in the experimental group than in the control group. Moreover, the positive rates of bacterial culture on the 7<sup>th</sup> and 15<sup>th</sup> days were significantly lower in the experimental group than in the control group.

**Conclusion:** The use of ultrasonic debridement plus SH wet dressing for treating ulcers can significantly improve clinical efficacy and promote healing.

<sup>1</sup>Nursing Department, Guangdong Provincial Hospital of Integrated Traditional Chinese and Western Medicine Hospital, Nanhai, Guangdong, China

<sup>2</sup>Endocrine Department, Guangdong Provincial Hospital of Integrated Traditional Chinese and Western Medicine Hospital, Nanhai, Guangdong, China

<sup>3</sup>Department of Pharmacy, Shandong Provincial Third Hospital, Jinan, Shandong, China

### Corresponding author:

Chang Wenlai, Department of Pharmacy, Shandong Provincial Third Hospital, Jinan 250000, Shandong, China.  
Email: [chenjianhua86@163.com](mailto:chenjianhua86@163.com)



## Keywords

Ultrasonic debridement, Shenghong liquid, diabetes, chronic ulcer, lower limb, fibroblast growth factor, nursing

Date received: 20 November 2018; accepted: 28 May 2019

## Introduction

Chronic and recurring lower limb ulcers are common and frequently occurring diseases in clinics.<sup>1</sup> If a patient with these ulcers also has diabetes, healing of the ulcer will be delayed and may even cause serious consequences, such as amputation.<sup>2</sup> A 2008 epidemiological survey in China showed that the prevalence of lower limb ulcers in diabetes and prediabetes was 10% and 15%, respectively.<sup>1</sup> The amputation rate of patients with diabetes is approximately seven to 10 times that of patients without diabetes.<sup>3</sup>

In response to such a severe situation, medical scientists believe that treatment of diabetes in patients with chronic ulcers of the lower extremities should take into consideration factors that are not conducive to ulcer healing (e.g., high blood sugar, ulcer infections, necrotic tissue, and fibrosis) to improve the overall body condition and facilitate the healing of ulcers. Ultrasonic debridement can remove bacterial, fungal, and necrotic tissue through “cavitation” and hemostatic effects during jet flushing with low-frequency and high-energy ultrasound waves.<sup>4</sup> This technique is currently widely used in European and American countries for some chronic and intractable ulcers. Ultrasonic debridement is not only useful in controlling infection, but is also closely associated with the ultrasonic thermal and biological effects in promoting healing of ulcer surfaces. The thermal effect can increase skin temperature, improve blood supply, and help tissue repair. Demir et al.<sup>5</sup> showed that low-frequency ultrasound could promote the

release of growth factors indirectly, thereby promoting faster healing of ulcers.

Fibroblast growth factor (FGF) promotes migration of endothelial cells and proliferation of fibroblasts, promotes formation of new blood vessels, and repairs damaged endothelial cells. Under the action of FGF, a large number of endothelial cells and fibroblasts create a granulation tissue, which provides necessary oxygen and nutrients for wound repair and promotes ulcer healing. At present, FGF is routinely used for treating diabetic ulcers.<sup>6</sup>

In recent years, under the guidance of the basic theory of traditional Chinese medicine (TCM), clinical application of TCM, including paste, lotion, fumigation, and wet dressing, has played a significant role in treating lower limb ulcers.<sup>3</sup> Owing to TCM’s potency and effects, we hypothesize that TCM is even more efficient if administered together with another treatment in patients with diabetes and chronic ulcers. Therefore, in this study we investigated whether ultrasonic debridement and Shenghong liquid ([SH] *Radix rehmanniae* 25 g, *Carthamus tinctorius* 25 g, *Coptis chinensis* 20 g, *Rheum officinale* 20 g, *Radix lithospermi* 20 g, *Fructus gardeniae* 20 g, licorice 15 g) promotes the combined healing of diabetes and chronic ulcers in the lower extremities.

## Materials and methods

### Basic information

Sixty patients with diabetes who were complicated by the presence of chronic lower

limb ulcers and hospitalized at the Endocrinology Department of our hospital from January 2017 to February 2018 were included in our study. Patients were included by following the 1999 World Health Organization's diagnostic criteria for diabetes,<sup>7</sup> the diagnostic criteria of syndromes for lower limb venous ulcers, and the diagnostic criteria for lower limb arterial ischemic ulcers.<sup>8</sup> There were 30 diabetic mixed ulcers, 18 diabetic lower limb venous ulcers, and 12 lower limb arterial ischemic ulcers. Gestational diabetes and diabetic conditions complicated by the occurrence of other major diseases were excluded. This project was reviewed and approved by the medical ethics committee of Guangdong Integrated Traditional Chinese and Western Medicine Hospital, and written informed consent was obtained from each participant. Patients were randomly divided into a control group (n = 30) and an experimental group (n = 30).

### **Treatments**

Ulcers, including ulcer size, depth, exudation, ulcer base, and infection, were evaluated by the same professional trained staff. Patients in both groups were administered the same drugs to control blood glucose levels and infection.

Patients in the control group received ultrasonic debridement plus external application of recombinant human basic FGF gel for ulcer treatment. A multifunctional ultrasonic debridement machine (model: MUI-IV-H/S; Tengyue, Chongqing, China) was configured and used. Functional configurations of the machine include digital temperature control, ultrasonic debridement, negative pressure suction, and high-pressure flushing. During treatment, the front end of the handle, containing the treatment end, was positioned to slightly touch the ulcer surface at a 45-degree angle, and the treatment head moved back and forth on the ulcer surface

with a spray of saline water. Each treatment was carried out once a day and lasted less than 20 minutes. After ultrasonic debridement, a recombinant FGF gel (Chinese Medicine S20040053; Nan Hai Lang Tai Pharmaceutical Co., Ltd., Guangdong, China; each dose was approximately 300 IU/cm<sup>2</sup>) was used to cover the ulcer surface once a day, followed by covering of the ulcer with sterile gauze and bandaging.

Patients in the experimental group were administered blood glucose control and infection drugs, and they also received ultrasonic debridement plus SH therapy. Briefly, after ultrasonic debridement treatment of the ulcer, a sterile gauze was soaked in a shaken raw red liquid that was prepared in a treatment bowl. The gauze was twisted into non-dripping water with tweezers, wet compressed on the fully exposed clean ulcer surface, and wrapped with a bandage.

### **Patients' care**

Patients in both groups received a low-salt and low-fat diabetes diet. They were also advised to keep ulcers clean, reduce activity, avoid standing for a long time, and wash feet with hot water every night. The patients also received psychological care to maintain a good state of mind.

### **Evaluation of efficacy**

Clinical efficacy was assessed as follows: invalid – no significant change in the ulcer surface or the ulcer became worse, with a healing rate of the ulcer area < 40%; improved – the ulcer surface had shrunk, necrotic tissue was decreased, purulent secretion had disappeared, with possible appearance of some new granulation tissue, and the healing rate was between 40% and 80%; effective – the ulcer surface was greatly reduced, with more new granulation tissue than in the improved condition, and the ulcer healing rate was

between 80% and 100%; and cured – the ulcer healing rate was 100% and local symptoms had disappeared. The cure rate was calculated as follows:

Cure rate = (number of people cured/total number)  $\times$  100%.<sup>9</sup>

### **Reduction of the ulcer area**

A digital camera was used to capture the area of the ulcer. The reduction in the area of the ulcer was calculated as follows:

Reduction in ulcer area = (ulcer area before treatment – ulcer area after treatment)/ulcer area before treatment  $\times$  100%.<sup>9</sup>

Ulcer areas were measured at the end of each month in the first 3 months.

### **Ulcer healing time**

Healing of ulcers of the affected limbs was observed with the naked eye, and 3% hydrogen peroxide was applied to the healing surface to avoid producing foams. The recorded healing time (days) began upon treatment with the first debridement.

### **Assessment of pain**

An internationally accepted numeric rating pain scale was used to assess feeling pain in each patient after debridement, with a 0 to 10 scale representing different levels of pain. The intensity of pain was evaluated on the 1<sup>st</sup>, 7<sup>th</sup>, and 15<sup>th</sup> days, and the mean values were obtained. The higher the scores were, the higher the self-subjective pain was.

### **Bacterial cultures**

Ulcer secretions were harvested for bacterial culture on the 1<sup>st</sup>, 7<sup>th</sup>, and 15<sup>th</sup> days after treatment. The positive rate of culture = (positive number of bacterial cultures/total number of cases)  $\times$  100%.

### **Statistical methods**

SPSS 17.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for data analysis. Data are shown as number or mean  $\pm$  standard deviation. Comparison of clinical efficacy between the two groups, as well as the positive rate of bacterial culture, were analyzed using Pearson's chi-squared test. The mean ulcer area, rate of ulcer healing, healing time, and pain intensity score were analyzed using the *t*-test. A value of  $p < 0.05$  was statistically significant.

## **Results**

### **Comparison of clinical efficacy between the two groups**

The patients' characteristics are listed in Table 1. No patients were excluded during the study. Sex, age, disease duration, and Wagner grading were not significant between the two groups.

The cure rate in the experimental group was significantly higher than that in the control group (Figure 1, Table 2,  $p < 0.01$ ).

### **Comparison of ulcer areas and ulcer healing rates between the two groups**

There was no significant difference in the ulcer areas between the two groups at 0 months. After the 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> months of treatment, ulcer areas in the experimental group were significantly smaller than those in the control group (all  $p < 0.05$ ). Moreover, ulcer healing rates in the experimental group were significantly higher than those in the control group as early as after the 1<sup>st</sup> month of treatment (all  $p < 0.001$ , Table 3).

### **Comparison of the ulcer healing time and pain intensity between the two groups**

The mean time for ulcer healing in the experimental group was significantly

**Table 1.** Characteristics of the patients.

Characteristic	Experimental group (n = 30)	Control group (n = 30)
Male sex	16	17
Age (years)	66.13 ± 10.01	66.80 ± 10.63
Diabetes duration (years)	16.35 ± 8.28	17.02 ± 8.18
Diabetic mixed ulcers	15	15
Diabetic venous ulcer	9	9
Diabetic ischemic ulcer	6	6
Wagner grading		
I	4	6
II	22	20
III	4	4

Values are number or mean ± standard deviation.



**Figure 1.** Comparison of clinical efficacy between the control and experimental groups.

**Table 2.** Comparison of clinical efficacy between the two groups.

Group	Cases	Cure	Effective	Improved	Invalid	Cure rate (%)
Experimental group	30	28	2	0	0	93.33 ± 6.32
Control group	30	18	8	4	0	60.00 ± 5.87
$\chi^2$						9.3168
P						0.0023

Values are number or mean ± standard deviation.

shorter than that in the control group ( $p < 0.001$ ). The pain intensity score in the experimental group was significantly lower than that in the control group ( $p < 0.001$ , Table 4).

**Comparison of bacterial cultures between the two groups**

On the 1<sup>st</sup> day of treatment, there was no significant difference in the positive rate of

**Table 3.** Comparison of the ulcer area and healing rate between the two groups (n = 30).

Time (months)	Ulcer area (cm <sup>2</sup> )				Ulcer healing rate (%)			
	Control group (%)	Experimental group (%)	t	p	Control group (%)	Experimental group (%)	t	p
0	15.72 ± 3.11	15.90 ± 3.27	0.219	0.828	0	0		
1	14.20 ± 2.46	12.53 ± 2.85	2.429	0.018	8.00 ± 1.00	23.00 ± 3.00	25.981	<0.001
2	12.64 ± 3.03	7.15 ± 1.16	9.268	<0.001	24.00 ± 3.00	55.00 ± 6.00	25.311	<0.001
3	8.36 ± 2.07	2.75 ± 1.08	13.161	<0.001	52.00 ± 10.00	98.00 ± 11.00	22.811	<0.001

Values are mean ± standard deviation.

**Table 4.** Comparison of the healing time and pain intensity scores between the two groups.

Group	Cases	Healing time (days)	Pain intensity score
Experimental group	30	38.20 ± 14.35	1.97 ± 1.05
Control group	30	57.31 ± 11.23	3.85 ± 0.89
t		5.7442	7.481
p		< 0.001	< 0.001

Values are number or mean ± standard deviation.

**Table 5.** Comparison of the positive bacterial culture rate between the two groups.

Group	Cases, n	Day 1, n (%)	Day 7, n (%)	Day 15, n (%)
Experimental group	30	15 (50.00)	2 (6.67)	0 (0.00)
Control group	30	14 (46.67)	11 (36.67)	6 (20.00)
χ <sup>2</sup>		0.0667	7.9542	6.6667
p		0.7961	0.0048	0.0098

bacterial culture (e.g., *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterococcus* species, and *Escherichia coli*) between the two groups. However, on the 7<sup>th</sup> and 15<sup>th</sup> days of treatment, the positive rates of bacterial culture in the experimental group were significantly lower than those in the control group (both p < 0.01, Table 5).

**Discussion**

Lower limb chronic ulcers are clinically common and frequently occurring diseases. These ulcers are characterized mainly by local skin tissue damage, infection, and

even necrosis, and are often present in areas of dense connective and poor blood flow tissues, such as the foot, ankle, and heel. If there is no correct treatment at the early stage, ulcers can easily cause formation of a local scar, lead to relapse, and may even appear cancerous or require amputation. The presence of diabetes severely affects therapeutic effects and delays healing of an ulcer. Because the body’s blood sugar rises in diabetes, the glycogen content of the skin tissue also increases. This results in mass growth and reproduction of microorganisms, thereby reducing leukocyte phagocytosis. As a result, the patient’s

immune system is greatly limited, making it prone to infection.<sup>10</sup>

Ultrasound debridement is widely used in some chronic and intractable ulcers. Compared with traditional debridement techniques, ultrasound debridement is not only effective in controlling infections, but also closely related to heat effects and biological effects in improving ulcer. The heat effect can increase skin temperature on the surface of the ulcer, improve blood supply, and promote tissue repair.<sup>5</sup> Diabetic wound healing process can be accelerated by using FGF.<sup>6</sup> In the present study, we found that the mean reduction in ulcer area, healing rate, healing time, and mitigation of feeling pain in the experimental group were significantly better than those in the control group. These findings indicate that application of low-frequency ultrasonic debridement and SH for treating patients with diabetes and chronic lower extremity ulcers can significantly improve clinical efficacy.

The better efficacy of SH may be attributed to the different roles of its various components in ulcer healing. The main components of SH are *Radix rehmanniae*, *Carthamus tinctorius*, *Coptis chinensis*, *Rheum officinale*, *Radix lithospermi*, *Fructus gardeniae*, and licorice. *Radix rehmanniae* contains vitamin A, a variety of sugars, and amino acids that can promote tissue repair effectively.<sup>11</sup> *Carthamus tinctorius*, which is used to treat patients with diabetes complicated by peripheral atherosclerosis obliterans, can rapidly remove oxygen-free radicals and effectively improve local blood supply.<sup>12,13</sup> *Coptis chinensis* and *Rheum officinale* are traditional Chinese medications with various pharmacological properties, including anti-inflammatory, antibacterial, and detoxification effects. These features result in lowering of blood glucose levels and improving type 2 diabetes mellitus.<sup>14</sup> *Radix lithospermi* has antioxidative and anti-inflammatory effects against diabetes.<sup>15</sup> *Fructus gardeniae* exerts a hypoglycemic

peroxisome proliferator-activated receptor  $\gamma$ -activating effect and improves insulin resistance.<sup>16</sup> Licorice promotes the production of muscle.<sup>17</sup> All of these Chinese herbal medicines are effective in intervention of blood sugar and injury repair, although their mechanisms need to be further studied.

In conclusion, application of ultrasonic debridement combined with SH dressing in diabetic patients with chronic lower limb ulcers can significantly improve the clinical efficacy and promote healing of ulcers.


### Declaration of conflicting interest

The authors declare that there is no conflict of interest.

### Funding

This study was supported by the Foshan Science and Technology Bureau (Project No.: 2017 AB 000812).

### ORCID iD

Xie Xiaolan  <https://orcid.org/0000-0002-2387-6262>

### References

1. Kirsner RS and Vivas AC. Lower-extremity ulcers: diagnosis and management. *Br J Dermatol* 2015; 173: 379–390.
2. Jornayvaz FR. News in diabetology 2016. *Rev Med Suisse* 2017; 13: 41–44.
3. Martins-Mendes D, Monteiro-Soares M, Boyko EJ, et al. The independent contribution of diabetic foot ulcer on lower extremity amputation and mortality risk. *J Diabetes Complications* 2014; 28: 632–638.
4. Ennis WJ, Foremann P, Mozen N, et al. Ultrasound therapy for recalcitrant diabetic foot ulcers: results of a randomized, double-blind, controlled, multicenter study. *Ostomy Wound Manage* 2005; 51: 24–39.
5. Demir H, Yaray S, Kirnap M, et al. Comparison of the effects of laser and ultrasound treatments on experimental wound healing in rats. *J Rehabil Res Dev* 2004; 41: 721–728.

6. Zubair M and Ahmad J. Role of growth factors and cytokines in diabetic foot ulcer healing: a detailed review. *Rev Endocr Metab Disord* 2019; 20: 207–217. doi: 10.1007/s11154-019-09492-1.
7. Tominaga M. Diagnostic criteria for diabetes mellitus. *Rinsho Byori* 1999; 47: 901–908.
8. Dai S, Xue J and Yue P. *Diagnosis and treatment criteria and prescription selection of TCM diseases*. Beijing: People's Health Publishing House, 2003, pp.319–324.
9. Santamaria N, Ogce F and Gorelik A. Healing rate calculation in the diabetic foot ulcer: comparing different methods. *Wound Repair Regen* 2012; 20: 786–789.
10. Pitocco D, Spanu T, Di Leo M, et al. Diabetic foot infections: a comprehensive overview. *Eur Rev Med Pharmacol Sci* 2019; 23: 26–37.
11. Liu C, Ma R, Wang L, et al. *Rehmanniae Radix* in osteoporosis: a review of traditional Chinese medicinal uses, phytochemistry, pharmacokinetics and pharmacology. *J Ethnopharmacol* 2017; 198: 351–362.
12. Han SY, Li HX, Bai CC, et al. Component analysis and free radical-scavenging potential of *Panax notoginseng* and *Carthamus tinctorius* extracts. *Chem Biodivers* 2010; 7: 383–391.
13. Choi EM, Kim GH and Lee YS. *Carthamus tinctorius* flower extract prevents H<sub>2</sub>O<sub>2</sub>-induced dysfunction and oxidative damage in osteoblastic MC3T3-E1 cells. *Phytother Res* 2010; 24: 1037–1041.
14. Cheng FR, Cui HX, Fang JL, et al. Ameliorative effect and mechanism of the purified anthraquinone-glycoside preparation from *rheum palmatum* L. on Type 2 diabetes mellitus. *Molecules* 2019; 24: pii: E1454. doi: 10.3390/molecules24081454.
15. Jin CJ, Yu SH, Wang XM, et al. The effect of lithospermic acid, an antioxidant, on development of diabetic retinopathy in spontaneously obese diabetic rats. *PLoS One* 2014; 9: e98232.
16. Chen YI, Cheng YW, Tzeng CY, et al. Peroxisome proliferator-activated receptor activating hypoglycemic effect of *Gardenia jasminoides* Ellis aqueous extract and improvement of insulin sensitivity in steroid induced insulin resistant rats. *BMC Complement Altern Med* 2014; 14: 30.
17. Yoshioka Y, Yamashita Y, Kishida H, et al. Licorice flavonoid oil enhances muscle mass in KK-Ay mice. *Life Sci* 2018; 205: 91–96.