Alteration of the Tongue Manifestation Reflects Clinical Outcomes of Peptic Ulcer Disease

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Abstract

Objectives: This study investigated whether the tongue inspection technique in Traditional Chinese Medicine (TCM) can be used as a noninvasive auxiliary diagnostic tool to differentiate the subtypes of peptic ulcer disease (PUD) and as an indicator of therapeutic efficacy.

Subjects and methods: A total of 198 outpatients from the China Medical University Hospital were recruited. The control group comprised 50 healthy adults. The remaining 148 patients were diagnosed with gastric ulcer, duodenal ulcer, or *Helicobacter pylori* (Hp) infection using upper gastrointestinal (GI) endoscopy, biopsy, and *Campylobacter*-like organism test. Tongue appearance was evaluated by a physician experienced in clinical Chinese medicine. Images of the tongue were immediately recorded using a high-resolution digital camera system.

Results: The affected group of 148 patients received an 8-week course of ulcer therapy. Of these, 108 patients infected with Hp were subjected to triple therapy in the first week. Forty-nine of these 108 cases infected with Hp completed secondary examination of upper GI endoscopy and tongue inspection. Forty-one of 49 cases (83.7%) were fully cured of Hp infection. These results showed that the color of the tongue body did not change in the cured patients; however, tongue fur was markedly thinner with a color change to white ($p < 0.05$), while sublingual veins with engorgement ($p < 0.05$) and blood stasis ($p < 0.01$) improved after the ulcer healed and Hp was eradicated.

Conclusions: TCM tongue inspection can be potentially used as a noninvasive auxiliary diagnostic method and as an indicator for clinical outcomes for patients with PUD.

Introduction

TRADITIONAL CHINESE MEDICINE (TCM) uses four diagnostic methods to acquire integrated health status information from patients. Four diagnostic methods include inspection, auscultation and olfaction, inquiry, and palpation. Of these, the inspection of tongue manifestation plays a routine assessment and critical reference basis for TCM dialectics. Examination is based on the appearance changes of tongue fur, tongue body, and sublingual veins, whose exterior signs provide useful information to assist TCM doctors to understand the patients' physiologic status inside the body, such as the changes of *yang-qi*, the body's vital force and pathogenic conditions. Tongue fur is a layer of moss-like materials coated on the tongue surface, which was formed by *stomach-qi*

according to TCM theory. Accordingly, the manifestation of tongue fur is a critical index for diagnosis of GI problems. The *Wang Zhen Zun Jing*, a classic TCM literature, also states that tongue fur can be a visible index of the functional status of the gastrointestinal system. The typical appearance of the tongue fur is thin, white and moist in healthy adults. According to TCM, white fur may be indicative of a normal tongue or a Cold pattern or an exterior Cold pattern; yellow fur indicates an interior Heat or exterior Wind-Heat pattern; the gray fur means an interior pattern; the black fur was identified as serious health conditions.¹ Therefore, the color change of tongue fur could distinguish the Cold or Heat pattern of the diseases, and the thickness change of tongue fur could differentiate the severity of the diseases. In addition, the tongue body refers to the muscular tissue of the tongue, representing as light red

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(pink) color in healthy adults. TCM diagnostics states that the tongue body with a pale color means either dual vacuity of *qi* and blood (*qi-xue-ju-xu* pattern) or *yang-qi* vacuity (*yang-xu* pattern); a tongue body with a red color indicates repletion Heat (*shi-re* pattern); the purple color indicates repletion Heat, effulgent *yin* vacuity Fire (*yin-xu-huo-wang* pattern), or Heat entering construction-blood (*re-ru-ying xue* pattern). Inspection of the sublingual region is used to observe the stasis speckles, stasis macules, and vascular engorgement (or varix) in the sublingual veins (deep lingual veins), which may indicate the activity of the blood circulation and the phenomenon of *qi* stagnation and blood stasis. Blood stasis is a pathological condition of sluggishness or obstruction in the flow of blood, resulting from *qi* deficiency. The clinical symptoms of blood stasis in the sublingual veins presents as stasis speckles and stasis macules around the sublingual veins as well as excessive swelling (engorgement), meandering, dark purple coloring, or collateral vessels formation.

Peptic ulcer disease (PUD) is a common clinical disorder of the digestive system that includes two major subtypes: gastric ulcer (GU) and duodenal ulcer (DU). The DU incidence rate is 0.4–24 cases per 1000 persons per year. There are about 12% of males and 10% of females who suffer from PUD over their lifetimes in the United States.² PUD has a strong correlation with *Helicobacter pylori* (Hp) infection of the gastrointestinal (GI) tract.^{3,4} Ulcer relapse occurs infrequently after Hp eradication.^{5,6}

Upper GI endoscopy is a medical procedure that optically examines the GI tract, allowing inspection and visualization of the mucosal lesion surface, obtaining samples for biopsy, and intervention of ulcer bleeding by local electrocauterization. Although upper GI endoscopy is generally a safe and effective procedure, it still has potential complications or risks⁷ such as mucosal hemorrhage, mild soreness or discomfort during the invasive procedure, and increased risk of GI perforation with perforation-induced abdominal cavity infection. In addition, decreased venous return and/or hypoxia may occur if the stomach is overinflated with air. Furthermore, bradycardia may occur due to vasovagal stimulation during the procedure.

TCM tongue inspection was applied in the present study to investigate whether changes in tongue morphology and color could be used as a noninvasive auxiliary diagnostic method and as an indicator of PUD outcomes. This approach may present a great potential to decrease medical costs by reducing the reliance on upper GI endoscopy for PUD diagnosis.

Materials and Methods

Study subjects and selection criteria

Outpatients from the China Medical University Hospital (CMUH; Taichung, Taiwan) were recruited from the GI Department and the Department for the integration of Traditional Chinese and Western medicine. This study was approved by the institutional review board of CMUH. Candidates with the following conditions were excluded: diabetes mellitus, liver cirrhosis, uremia, systemic diseases, PUD hemorrhage, malignant diseases of the GI tract, and seriously stained tongue coating. All 198 qualified patients signed informed consent forms and then received PUD

diagnosis and Hp evaluation. Demographic information for the participants in the study group is provided in Table 1.

PUD diagnosis and Hp identification

Upper GI endoscopy was administered by a doctor of internal medicine to diagnose PUD in the participants with marked symptoms of GI tract disorder. Mucosal biopsies from patients with PUD were evaluated for the presence of Hp using a rapid urease test kit (CLOtest®; Kimberly-Clark, USA) and clinical histopathological analysis. The results of the urease test were interpreted as positive for Hp infection if the color changed from yellow to pink within 24 hours at room temperature.

Determination of tongue manifestation

Hp infection-related GI diseases were classified based on the symptoms of epigastric pain and “gastric stuffiness” (dyspepsia). The classification of tongue manifestation used in the present study was based on the *Wang Zhen Zun Jing* and clinical reports of PUD with Hp infection.^{8–10} Alterations in tongue fur, tongue body, and sublingual veins were evaluated. According to the progress (or severity) of the disease, tongue fur was rated using an 8-level scoring scheme, ranging from white-thin fur (+1 and +2), yellow-thin fur (+3 and +4), white-slimy fur (+5 and +6) to yellow-slimy fur (+7 and +8). Similarly, tongue body color was also rated using an 8-level scoring scheme, ranging from light red (+1 and +2), red (+3 and +4), dark red (+5 and +6), to purple (+7 and +8). Sublingual veins were scored on the basis of the presence or absence of engorgement (0, +1, +2, and +3) and blood stasis (0, +1, +2 and +3). Typical examples of the tongue manifestation are shown in Figure 1. Inspection of the tongue was accomplished by an experienced TCM doctor who was blinded with respect to the participant’s group as well as the reports of pathological examinations in order to judge the accuracy of the tongue manifestation in the present study.

After tongue inspection, tongue images were immediately recorded by a high-resolution digital camera system. Prior to taking the tongue image, participants were seated on a chair fitted with a chin rest to avoid the sway of the participant’s head while capturing the image. All image captures were performed by the same trained and experienced staff to

TABLE 1. PARTICIPANT DEMOGRAPHIC DATA

	Healthy (n=50)	PUD	
		Hp-positive (n=108)	Hp-negative (n=40)
Gender			
Male	20	78	23
Female	30	30	17
Average age	34.6	54.2	51.9
DU	—	59	16
GU	—	28	22
DU combined with GU	—	21	2

PUD, peptic ulcer disease; DU, duodenal ulcer; GU, gastric ulcer; Hp, *Helicobacter pylori*.

FIG. 1. Typical examples of the tongue manifestation. (A) A light red tongue (+1) covered with white-thin fur (+1). (B) A red tongue (+3) covered with white-slimy fur (+5). (C) A dark red tongue (+5) covered with yellow-slimy fur (+8). (D) A light red tongue (+1) covered with yellow-thin fur (+4). (E) A tongue with sublingual engorgement (+2). (F) A tongue with blood stasis (+3). Arrows indicated the stasis speckles around the sublingual vein.

minimize the variability. The tongue images of participants were acquired in a darkroom to reduce lighting interference.

Hp eradication therapy

PUD participants with Hp infection were treated with a triple therapy (rabeprazole [20 mg], clarithromycin [500 mg] and amoxicillin [1000 mg]) twice a day for 1 week, and then the proton pump inhibitor rabeprazole (20 mg) alone was administered once a day for the remaining 7-week treatment period. After an 8-week treatment for PUD and a 4-week rest period, patients received a follow-up endoscopic examination of the upper GI tract and tongue inspection.

Statistical analysis

All data were analyzed using SPSS statistics software. The χ^2 test was performed to determine the association between the tongue manifestation and clinical categories, such as Hp infection or PUD subtypes. Data comparisons were accomplished with paired Student's *t*-tests to evaluate differences in tongue manifestation following Hp therapy. A value of $p < 0.05$ was considered statistically significant.

Results

Participant demographics

A total of 198 outpatients participated in the present study (Table 1). Of these, 148 patients were diagnosed with PUD, while the remaining 50 healthy subjects were in the control group. Male incidence of PUD was twice that of female incidence. Additionally, more than half of Hp-positive patients suffered from DU, but most Hp-negatives among the PUD patients came from the GU subgroup. Among the participants with PUD, 72.9% of the subjects (108 cases) were identified with Hp infection by rapid urase test and biopsy-proven diagnosis. These Hp-positive patients received 1-week Hp eradication and thereafter 7-week ulcer therapy. After PUD therapy and further rest for 4 weeks, only 49 of

108 subjects agreed to receive follow-up upper GI endoscopy and tongue inspection. Within the group who completed all aspects of the study, 41 of 49 subjects (83.7%) had been cured of Hp infection by endoscopic biopsy of rapid urease test.

Difference of tongue manifestation between the healthy subjects and PUD subjects

In the healthy group, the tongue was described as light red in color (80.0%) with white-thin fur (96.0%) and a low percentage of engorgement (26.0%) and blood stasis (16.0%) in the sublingual veins (Table 2). In contrast to the healthy group, the PUD subject tongues were described as a dark red color (45.3%) with yellow-slimy fur (38.5%) and the presence of engorgement (72.3%) and blood stasis (40.5%) in sublingual veins. According to the analyzed results, PUD patients had significant alterations in the tongue body, tongue fur,

TABLE 2. DIFFERENCE OF TONGUE MANIFESTATION BETWEEN HEALTHY AND PEPTIC ULCER DISEASE (PUD) GROUPS

Tongue manifestation	Healthy (n=50)	PUD (n=148)	χ^2 value	p-Value
Tongue body			26.74	<0.0001
Light red	40	59		
Red	6	22		
Dark red	4	67		
Purple	0	0		
Tongue fur			71.18	<0.0001
White-thin	48	41		
Yellow-thin	0	41		
White-slimy	3	9		
Yellow-slimy	0	57		
Sublingual veins				
Engorgement	13	107	31.64	<0.0001
Blood stasis	8	60	8.92	0.003

and sublingual veins as compared to those in the healthy group ($p < 0.01$).

Effect of Hp infection on tongue manifestation

The PUD participants were divided into two groups, Hp-positive and Hp-negative, to investigate whether Hp infection would result in different tongue manifestations between these two groups. The data suggested that Hp infection did not influence the major tongue manifestations between these two groups, which were both dark red in the tongue body with yellow-slimy fur, and engorgement and blood stasis in sublingual veins (Table 3).

Relationship of PUD subtypes and tongue fur

The tongue furs of PUD patients were inspected to determine whether the patients with different PUD subtypes would have differences in tongue fur. The majority of DU patients were manifested with yellow tongue fur (72%; yellow-thin and yellow-slimy), while the patients with GU alone or with both GU and DU possessed white-thin fur (40%–60%) (Table 4). No significant differences in manifestation of tongue fur were noticed between PUD subtypes. There was no difference between the PUD subtypes and appearance of the tongue body and sublingual veins (data not shown).

Relationship of Hp therapy and alteration of tongue manifestation

A total of 41 subjects with successful Hp eradication were examined to evaluate the changes of tongue manifestation after Hp therapy (Table 5). The results showed that Hp therapy significantly reduced the average score for tongue fur (4.51 ± 2.73 versus 3.66 ± 2.63 ; $p < 0.05$) and markedly improved the status in sublingual vein engorgement (1.51 ± 0.93 versus 1.17 ± 0.67 ; $p < 0.05$) and blood stasis (1.14 ± 0.94 versus 0.41 ± 0.59 ; $p < 0.01$). Typical tongue manifestations of the PUD group before and after Hp therapy are shown in Figure 2.

TABLE 3. CORRELATION BETWEEN TONGUE MANIFESTATION AND *HELICOBACTER PYLORI* (Hp) INFECTION IN SUBJECTS WITH PEPTIC ULCER DISEASE

Tongue manifestation	Hp-positive (n=108)	Hp-negative (n=40)	χ^2 value	p-Value
Tongue body			2.63	0.27
Light red	43	16		
Red	19	3		
Dark red	46	21		
Purple	0	0		
Tongue fur			0.94	0.81
White-thin	32	9		
Yellow-thin	30	11		
White-slimy	6	3		
Yellow-slimy	40	17		
Sublingual veins				
Engorgement	79	28	0.03	0.86
Blood stasis	44	16	0.00	1.00

TABLE 4. CORRELATION BETWEEN TONGUE FUR AND PEPTIC ULCER DISEASE SUBTYPES

Tongue manifestation	DU (n=75)	GU (n=50)	DU + GU (n=23)	p-Value
Tongue fur				0.24
White-thin	26	11	4	
Yellow-thin	21	16	4	
White-slimy	5	3	1	
Yellow-slimy	23	20	14	

GU, gastric ulcer; DU, duodenal ulcer.

Relationship of Hp therapy and alteration of tongue manifestation in the GU patients

Among 41 of 49 subjects with successful Hp eradication, there were 27 of 31, 6 of 8, and 8 of 10 patients with DU, GU, and mixed subtype, respectively. A total of 6 GU patients with successful Hp eradication were further examined to evaluate changes in tongue manifestation (Table 6). The results indicated that the average scores of tongue manifestation demonstrated a decreasing trend after therapy, and the status of blood stasis in sublingual veins was significantly improved (1.67 ± 0.82 versus 0.33 ± 0.52 ; $p < 0.01$). In the present study, the cure rate of GU patients is about 75.00% (6 of 8 GU subjects).

Relationship of Hp therapy and alteration of tongue manifestation in the DU patients

A total of 27 DU subjects with successful Hp eradication were inspected again to estimate the alteration of tongue manifestation after Hp therapy (Table 7). The data suggest that the average score of tongue manifestation after therapy was significantly reduced in tongue fur (4.37 ± 2.63 versus 3.37 ± 2.50 ; $p < 0.05$) with significantly decreased sublingual engorgement (1.56 ± 1.05 versus 1.07 ± 0.62 ; $p < 0.05$) and blood stasis (1.00 ± 0.88 versus 0.41 ± 0.64 ; $p < 0.01$). The cure rate of DU patients is about 87.09% (27 of 31 DU subjects) in the present study.

Discussion

Numerous studies indicated that tongue manifestations for healthy adults are a light red color in the tongue body with white-thin fur.^{11,12} Significantly different patterns of tongue fur are typically found in patients with upper GI diseases.¹³ In the present study, upper GI endoscopy was

TABLE 5. COMPARISON OF TONGUE MANIFESTATION AFTER *HELICOBACTER PYLORI* (Hp) THERAPY

Tongue manifestation	Hp therapy (n=41)		p-Value
	Before	After	
Tongue body	2.80 ± 2.00	2.46 ± 1.48	0.0750
Tongue fur	4.51 ± 2.73	3.66 ± 2.63	0.0145
Sublingual veins (engorgement)	1.51 ± 0.93	1.17 ± 0.67	0.0463
Sublingual veins (blood stasis)	1.14 ± 0.94	0.41 ± 0.59	<0.0001

FIG. 2. Representative changes of the tongue manifestation in patients with peptic ulcer disease. (A) Before *Helicobacter pylori* (Hp) therapy, the patient possessed a light red tongue (+2) with yellow-slimy fur (+7), engorged sublingual veins (+2), and blood stasis (+1). (B) After successful Hp eradication, this patient was found to have a light red tongue (+1) with white-thin fur (+2) and engorged sublingual veins (+1).

used to verify the pathological status of GI tract while the appearance of the tongue was inspected to obtain evidence of possible relationships between tongue manifestations and clinical outcomes. The results indicated that tongue manifestations for PUD patients who received successful Hp therapy were markedly restored, starting from a dark red tongue body with yellow-slimy fur and sublingual engorgement and blood stasis, and then progressing to the manifestations of tongue in the healthy group (light red tongue body with white-thin fur but without engorgement and blood stasis in sublingual veins). Based on these results, TCM tongue inspection has the potential to become a reliable noninvasive auxiliary diagnostic method for indicating successful clinical outcomes for PUD.

Numerous clinical reports mentioned that TCM tongue inspection could reveal the pathological status of the GI

TABLE 7. COMPARISON OF TONGUE MANIFESTATION AFTER *HELICOBACTER PYLORI* (Hp) THERAPY IN THE SUBJECTS WITH DUODENAL ULCER ALONE

Tongue manifestation	Hp therapy (n = 27)		p-Value
	Before	After	
Tongue body	2.89 ± 2.17	2.52 ± 1.58	0.1698
Tongue fur	4.37 ± 2.63	3.37 ± 2.50	0.0250
Sublingual veins (engorgement)	1.56 ± 1.05	1.07 ± 0.62	0.0250
Sublingual veins (blood stasis)	1.00 ± 0.88	0.41 ± 0.64	0.0003

tract.¹⁴⁻¹⁷ The typical manifestation of the tongue in superficial gastritis was a normal color (light red) in the tongue body with yellow-slimy fur. For atrophic gastritis, the appearance of tongue fur was described as white or yellow-thin with little saliva. In contrast, tongue manifestations for hypertrophic gastritis presented as a red-colored tongue body with slimy fur. For DU patients, a light red color in the tongue body with white-thin fur was found, while GU patients were found to have a red tongue with yellow-slimy fur. Finally, a fissured tongue with slimy or peeling fur is often found in patients with stomach cancer.¹⁴ Several clinical observations suggested that typical manifestations of the tongue would be altered following Hp infection or during three different stages of PUD disease.¹⁸⁻²⁴ During the active stage of PUD, the tongue was described as red in color with slimy fur. During the healing stage of PUD, the tongue was described as white or light red color with white-thin, yellow-thin, or white-slimy fur. Patients with white-slimy or yellow fur tend to have a higher rate of Hp infection as compared to those with white-thin fur. Red or purple color tongue indicated patients with increased susceptibility to Hp infection as compared with those with a tongue body of light white or light red color. In patients with chronic atrophic gastritis, Chen and Wang mentioned that the TCM vacuity pattern is associated with a higher prevalence rate of Hp infection as compared to those with the TCM repletion pattern.²⁵ There were five TCM patterns indicating a degree of susceptibility to Hp infection, ranging from high to low prevalence: Damp-Heat in the spleen and stomach (*pi-wei-shi-re* syndrome; 87.5%), static blood in the stomach collaterals (*wei-luo-yu-xue* pattern; 83.3%), disharmony between the liver and stomach (*gan-wei-bu-he* pattern; 76.9%), hypofunction of the spleen and stomach (*pi-wei-xu-ruo* pattern; 50.0%), and insufficiency of the stomach-yin (*wei-yin-bu-zu* pattern; 44.4%).²⁵ Based on observations from the cited studies, one of the basic tenets of TCM theory is confirmed—"The tongue is the mirror of the gastrointestinal system."

In the present study, the tongue manifestation of 148 participants with PUD, whether with or without Hp infection, was generally described as dark red color for the tongue body with yellow-slimy fur and sublingual veins with engorgement and blood stasis (Table 2). Although PUD subtypes of patients did not significantly affect the manifestation in tongue fur, the trends for tongue manifestation were generally a yellow fur and white-thin fur in the patients who had GU and DU, respectively (Table 4). Based on the observations from the tongue manifestation of the PUD

TABLE 6. COMPARISON OF TONGUE MANIFESTATION AFTER *HELICOBACTER PYLORI* (Hp) THERAPY IN SUBJECTS WITH GASTRIC ULCER ALONE

Tongue manifestation	Hp therapy (n = 6)		p-Value
	Before	After	
Tongue body	3.17 ± 2.23	3.00 ± 1.67	0.6952
Tongue fur	3.50 ± 2.88	4.50 ± 2.51	0.4366
Sublingual veins (engorgement)	1.17 ± 0.75	1.33 ± 0.82	0.6952
Sublingual veins (blood stasis)	1.67 ± 0.82	0.33 ± 0.52	0.0250

patients in the present study and the patterns classification in TCM, it was thought that GU patients might mostly belong to the Stagnant Heat of liver and stomach syndrome (*gan-wei-yu-re* pattern) as well as the Damp-Heat obstructing in the interior syndrome (*shi-re-zhong-zu* pattern); DU patients might mainly be classified as the liver-qi invading the stomach syndrome (*gan-qi-fan-wei* pattern) and deficiency in the spleen and stomach with Cold manifestations syndrome (*pi-wei-xu-han* pattern).

Forty-nine patients received final examination of the upper GI endoscopy, biopsy assay, and tongue inspection. Of these, 41 cases of PUD subjects had Hp successfully eradicated. There was not a significant change in the tongue body color before or after the triple therapy for Hp eradication. Manifestations in the tongue fur and sublingual veins were markedly restored to the appearance of healthy adult tongues (Table 5). Although the examination of upper GI endoscopy and biopsy assay demonstrated that these patients had fully recovered from PUD, the findings indicated that the manifestations of tongue fur and sublingual veins were markedly restored in DU patients after Hp therapy but not in those of GU patients (Table 6 and Table 7, respectively). From the TCM perspective, this may possibly indicate that organic and functional disorders of the stomach have not been fully cured in these GU patients. Thus, complete healing for GU may be more difficult than healing for DU. The authors' clinical observations also suggested that the DU patients receiving the standard therapy had a higher cure rate (87.09%) than those with GU (75.00%).²⁶

It should also be noted that the development of most diseases is a complex progression, and these PUD patients might have a number of other diseases that could also affect tongue manifestations. Such cases would therefore result in mismatches between tongue manifestations and actual disease status. In the present study, the recruited participants have been carefully selected without specific pathological conditions as described above; thus, possible interference from other diseases was minimized. Tongue diagnosis is not used alone in TCM diagnosis and should be used in conjunction with other TCM diagnostic methods to obtain the comprehensive and integrated health information of the patients.

There were 8 PUD patients in this study in whom Hp failed to be eradicated. Of these, biopsy examination demonstrated latent presence of Hp, although the ulcer lesions of these patients have healed as confirmed by endoscopic examination. In contrast to the tongue fur changes observed in the cured patients, changes in tongue body or sublingual veins were not observed. This implied that the presence of Hp would still result in the diagnosis of a TCM functional disorder even if the underlying organic GI disorder (ulcer lesion) in PUD patients has been cured. Moreover, the current results indicated that the tongue manifestation in the tongue fur and sublingual veins significantly altered after successful Hp therapy (Table 5). Interestingly, although there was no significant correlation between the tongue manifestation and Hp infection in the PUD patients before Hp therapy (Table 3), a deteriorating alteration (3.38 ± 2.92 versus 6.00 ± 1.69 ; $p < 0.067$) on the tongue fur of the PUD patients can also appear (8 of 49 subjects) with failed Hp eradication (data not shown). This finding implied that the

tongue inspection might have potential as an auxiliary tool to gauge whether HP eradication has occurred.

Conclusions

This study demonstrated that TCM tongue inspection detects changes in the GI tract of PUD patients (the Cold, Heat, and *qi*-blood of TCM patterns). The correlation between the alteration of tongue manifestation and clinical outcomes of PUD patients was verified by upper GI endoscopy and biopsy assay. Thus, TCM tongue inspection has clinical potential to be used as a noninvasive auxiliary diagnostic aid to indicate successful clinical outcomes for patients treated for PUD.

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Disclosure Statement

No competing financial interests exist.

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