Diabetes with Pyogenic Liver Abscess - A Perspective on Tongue Diagnosis in Traditional Chinese Medicine

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Abstract

Background: This novel study provides a time series analysis of tongue features extracted from a diabetic patient with pyogenic liver abscess (PLA), treated with the integration of western medicine and traditional Chinese medicine (TCM). The features, namely, tongue color, tongue fur thickness and fur color, identified from a series of tongue images taken every two days, exhibit significant transitions matching closely with the progression of disease. These tongue features could serve as effective, non-intrusive indices for different progression stages of diabetes with PLA.

Case presentation: A 76-year-old male diabetic patient was admitted for hyperglycemia hyperosmolar state. Intermittent fever and abdominal discomfort were noted. After performing abdominal computed tomography and laboratory studies, the results indicated pyogenic liver abscess, Klebsiella pneumoniae ssp pneumoniae related. As PLA progressed, the patient suffered spiking fever and right upper abdominal pain. Tongue examination revealed features with red tongue, white-yellow and thick fur. After receiving pig-tail catheter drainage, the fever subsided and the pus-like fluid was drained smoothly. During the course of this process, gradually dwindled tongue fur witnessed through periodic tongue examination coincides consistently with laboratory data, namely, body temperature, fasting plasma glucose and plasma glucose level, gathered.

Conclusion: This is the first time series analysis of applying tongue examination to the prognosis of a specific disease. Through a series of tongue images taken periodically, tongue color, tongue fur thickness and fur color are identified to closely linked to the progression of diabetes with PLA, as indicated by gathered through means of plasma glucose and abdominal sonographic follow-ups. Based on this promising finding, our future study will further extend the application of tongue diagnosis to evaluate the tongue characteristics of diabetic patients.

Keywords: traditional Chinese medicine (TCM), tongue examination, diabetes mellitus(DM), pyogenic liver abscess(PLA)
1. Introduction

As the world population increases rapidly, diabetes mellitus (DM) has become the major burden of adult public health. According to an epidemiological study of the global prevalence of diabetes\(^1\), there were 171 million people with diabetes worldwide in 2000. This figure is expected to keep increasing to 366 million by 2030. Among the risk factors relating to pyogenic liver abscess (PLA), e.g., diabetes, malignancy, renal disease and pneumonia, diabetes ranks first as the primary risk factor. PLA is associated with a poor prognosis for diabetic patients than other patients.\(^2\) PLA is a rare, life-threatening disease with an increasing rate of incidence.\(^3\) Previous studies indicated the prevalence of PLA increased among the population in eastern Asia, especially in Taiwan. PLA is regarded as an endemic disease in public health issues in Taiwan.\(^4\) These reports pointed out that diabetes is the main predisposing factor of liver abscess and \textit{Klebsiella pneumonia} the primary pathogen.\(^4\) For patients with \textit{Klebsiella pneumonia} liver abscess, an appropriate antimicrobial treatment combined with percutaneous drainage of liver abscesses is approved.\(^5\)

Tongue diagnosis plays an important role in TCM.\(^6\) The tongue is connected to the internal organs through meridians; thus the conditions of organs, qi, blood, and body fluids as well as the degree and progression of disease are all reflected on the tongue.\(^7\) Organ conditions, properties and variations of pathogens can be revealed through observation of tongue. For example, changes in the tongue proper primarily mirror organ status and the flow of qi and blood; variations in tongue fur can be employed to determine the impact of exogenous pathogenic factors and the flow of stomach qi. Tongue fur color and thickness were found to be associated with effective response in specific disease.\(^8\) Buccal alterations can be easily observed in diabetic patients with an inadequate glycemic control.\(^9\) In clinical practice, practitioners observe tongue characteristics, such as the color and shape, and the amount of saliva before deducing the primary ailment of a patient. However, observation diagnosis is often biased by subjective judgment, originating from personal knowledge, experience, thinking patterns, diagnostic skills, and color perception or interpretation. There are no precise or existing quantifiable standards. Different practitioners may pass varying judgments on the same tongue, while a practitioner may even reach different diagnoses on the identical tongue if examined at different time. Such inconsistency leads many people to be skeptical of TCM, which motivated us to develop the Automatic Tongue Diagnosis System (ATDS).\(^10\) ATDS has demonstrated high degree of diagnostic agreement far-surpassing human counterparts.\(^7\) It is expected that ATDS can assist TCM practitioners to establish reliable diagnoses by providing them with standardized automatic procedures as well as objective, reliable and quantified data. The aim of this study is to establish
representative indices on different progression stages of diabetic with PLA through periodic observation and analysis of tongue by ATDS.

To the best of our knowledge, there is no references surveyed applying temporal analysis to a series of tongue images to observe transitions in tongue characteristics. The subject, infected with poorly controlled DM, further complicated by PLA, was treated with the integration of western medicine and TCM throughout the progression of the disease without further complication such as endophthalmitis or meningitis.

2. Case presentation
2.1 Hospital course
This 76-year-old male patient, with the past history of diabetes mellitus and hypertension, was admitted due to shortness of breathing and general weakness persistent for one day. Dyspnea, thirst sensation and poor appetite were also mentioned. Laboratory data showed hyperglycemia (random plasma glucose level: 689 mg/dL) and urine examination indicated no ketone body, ref. Table 1. Arterial blood gas showed hypoxemia but no acidosis. The patient was admitted for further care under the impression of Type 2 DM with hyperglycemia hyperosmolar state.

During hospital course, the hyperglycemic status was not well-controlled by insulin injection pump. Intermittent fever and abdominal discomfort were noted. Abdominal CT was performed, which revealed liver abscess (Figure 1), and blood culture showed Klebsiella pneumoniae. The patient was diagnosed as pyogenic liver abscess, Klebsiella pneumoniae ssp pneumoniae related, accompanied with hyperglycemia. Whole body Ga-67 scan was arranged to rule out endophthalmitis or meningitis, and the result revealed infectious process at segments VI and VII of liver. Standard treatment included percutaneous aspiration or catheter drainage and combination antimicrobial therapy for 2-4 weeks. He later received transcutaneous needle aspiration and antibiotic therapy. Abdominal ultrasound was prescribed to evaluate the size of liver abscess and fine needle aspiration was performed in the case of liquefied abscess. After a spiking fever up to 39 degrees and persistent abdominal pain, the pig-tail catheter drainage was subsequently performed and antibiotics changed to Anegyn 500 mg every 6 hours on D9. After treatment, catheter drainage was smooth and fever subsided. His condition improved gradually and liver abscess reduced after drainage. After several rounds of abdominal sonographic follow-ups, drainage catheter was removed on D19 because the size of PLA dwindled and abscess drainage was less than 5 ml for successive 3 days. The blood sugar level stabilized and insulin pump shifted to oral anti-diabetic drugs. In consideration of no more complication occurred, the
patient was later discharged.

2.2 Integration of western medicine and tongue diagnosis

During hospital course, physical examination, namely, body temperature, pulse rate and respiration rate, were checked every 8 hours. Other items, e.g., fasting plasma glucose and plasma glucose (A.C.), were recorded every day. At the same time, tongue diagnosis through ATDS was performed every 2 days and herbal medicine was prescribed based on the result of examination. For every tongue image taken, distinguishing characteristics employed in tongue diagnosis were extracted automatically by ATDS, such as tongue color, tongue fissure, fur color, fur thickness, ecchymosis, tooth mark, red dot, saliva, and tongue shape, to further generate detailed information regarding length, area, moisture, and number of fissures, marks, and dots, as shown in Figure 2. Based on the suggestions of TCM doctors participating in this investigation, ATDS selects 9 primary tongue features, including tongue color (slightly white, slightly red, red, pink red, dark red, dark purple), fur color (white, white-yellow, yellow, dye), fur thickness (none, thin, thick), saliva (none, little, normal, excessive), tongue shape (thin and small, moderate, fat and large), tongue fissure, red dot, ecchymosis, and tooth marks (the last four are divided into categories of none, mild, moderate, and severe), for the time series analysis.

3. Clinical findings

3.1 Transitions of body temperature and plasma glucose

The most common clinical manifestations in patients with PLA are fever, chills, and abdominal pain. Although the patient received antimicrobial therapy, yet intermittent fever and abdominal pain persisted. As PLA progressed, he suffered spiking fever and right upper abdominal pain on D9. After receiving pig-tail catheter drainage, the fever subsided and the pus-like fluid was drained smoothly on D12. Gradually, a afebrile condition was reached after D12, as shown in Figure 3.

Plasma glucose level was examined for 4 times a day. A higher level of plasma glucose (567mg/dl) was observed on D9 as PLA progressed. The corresponding hyperglycemic status was not well-controlled by insulin injection pump and antibiotics before pig-tail catheter drainage was performed. As the infectious condition steadily improved, the plasma glucose gradually stabilized at a lower level after D12, ref. Figure 4.

3.2 Transitions of sonography of pyogenic liver abscess
Abdominal sonography showed size of main liver abscess about 8.87 cm * 8.64 cm in the liver S7-8 on D3. Percutaneous aspiration and combination antimicrobial therapy were performed subsequently. As PLA progressed and matured, the patient’s condition improved gradually and the abscess size reduced slightly to 8.74 * 8.64 cm on D11 after receiving catheter drainage. Eventually, drainage catheter was removed on D19 because the size of PLA decreased and abscess drainage less than 5 ml for successive three days. The liver abscess size about 4.71 * 4.18 cm was observed on D23, as shown in Figure 5.

3.3 Transitions of tongue characteristics

A series of tongue images were taken every two days. All images were analyzed by ATDS and relevant features, namely, tongue color, tongue fissure, fur color, fur thickness, ecchymosis, tooth mark, red dot, saliva and tongue shape, were extracted. The tongue images taken on D1, D10, D19, and D23 are shown in Figure 6. The corresponding tongue features extracted are also included.

On D1~D8, the tongue examination showed pink red tongue, yellow tongue fur, thick fur distributed over the tongue root. As PLA progressed, the patient suffered spiking fever and right upper abdominal pain on D9. This was immediately reflected on tongue color changing to red on D10. According to TCM theory, red tongue was closely linked to the heat pattern, as evidenced by the corresponding spiking fever. After receiving pig-tail catheter drainage, the fever subsided and the pus-like fluid was drained smoothly on D12. Tongue color returned to normal pink-red on D15.

Additionally, obvious changes in fur color and thickness were observed. Fur color changed sequentially from yellow to white-yellow on D10, and then to white on D15. However, fur thickness didn’t have a dramatic change during D1 to D19. Thick fur was related to the phlegm-dampness pattern. Tongue fur was distributed all over tongue surface on D10~D15. Fur distribution and root fur correspond to the pathogen distributed on triple energizers (upper, middle, or lower energizers). The tongue fur gradually reduced as the patient’s symptoms improved. Based on the tongue features observed, Huopu-xialing decoction was prescribed to reduce the dampness-heat assailing the exterior. Thick fur was gradually reduced until D21. The changes in tongue and fur characteristics, as observed through a series of tongue examination, are summarized in Table 2.

4. Discussion

To the best of our knowledge, this is the first study of applying tongue examination, through the progression of the disease, to observe diabetic patient
with PLA treated with the integration of western medicine and TCM. The core of
diagnosis in Chinese Medicine is “pattern identification/syndrome differentiation
and treatment” with inspection, listening and smelling examination, inquiry, and
palpation as the bases. Inspection tops the four diagnoses, and tongue diagnosis
is a crucial part during observation. Observation of the tongue, also known as
tongue diagnosis, is an important procedure in diagnosis by inspection. The
tongue appearance is a crucial indicator in the diagnosis of the physiological and
pathological changes of internal organs in the body.12

Studies have shown that tongue diagnosis plays an important role in clinical
prognosis and treatment.8,13,14 The tongue is connected to the internal organs
through meridians; thus the conditions of organs, qi, blood, and body fluids as well
as the degree and progression of disease are all reflected on the tongue. Organ
conditions, properties, and variations of pathogens can be revealed through
observation of tongue. Tongue inspection refers to the shape, color, and fur color,
fur thickness, and other characteristics.15 For instance, red tongue is closely
related to the fire-heat pattern and the yin deficiency pattern, while a faint white
tongue is connected with the phlegm-dampness pattern. Thin fur is associated
with the Wind and fire-heat pattern, and thick fur is usually linked to the
phlegm-dampness and blood stasis patterns.12

For this diabetic patient with PLA, the transitions of tongue coating, location,
and coating color, thickness closely match the progression of the disease. These
tongue features can be utilized to predict the prognosis of diabetes with PLA. The
tongue fur thickness is further divided into none fur, thin fur, and thick fur. None
fur is literally the absence of tongue coating, and the criterion to differentiate
between thin and thick fur hinges on whether the tongue quality lying below is
visible.16 Moreover, there was no common agreement regarding the classification
of tongue fur thickness in the past. To circumvent this deficiency, a quantitative
definition of thick fur is given in this study. Thick fur is defined as the tongue fur
making the underlying tongue quality invisible and occupying more than two
thirds of the total tongue area.16 We found the tongue fur changed dramatically as
disease progressed, such as thick fur in the posterior surface at hyperglycemia,
thon fur covering the whole surface at spiking fever, and thin fur after recovery.
According to the TCM theory, tongue fur indicates the state of the Yang organs,
especially the digestive system.17 Our finding indicates that the tongue diagnosis
could potentially serve as an indexing means for disease prognosis, such as
rheumatoid arthritis8 and diabetes. More future research efforts will focus on this
efficient, non-intrusive and important direction.

Inevitably, traditional tongue diagnosis does have its limitations attributable to
both practitioner’s skill and environmental setting. Not only the clinical skill involved in tongue diagnosis depends highly on the clinician’s experience and knowledge, but also the environmental factors influence significantly on the diagnostic results. According to the study on the agreement on tongue diagnosis, poor intra-observer agreement is still manifested even if the TCM doctors were well trained.\(^7\) Therefore, it is necessary to establish an objective diagnostic standard for tongue diagnosis.\(^{18}\) We regularly collected and displayed standard photographs to teach the TCM doctors to improve both the intra- and inter-agreement of tongue diagnosis. The standard operating procedure of tongue diagnosis is proposed and detailed guidelines are followed to enhance the diagnostic agreement among TCM clinicians, as shown in Figure 7. As a result, the study suggests that tongue diagnosis is potentially useful for identifying diabetic patients both for TCM and conventional medicine interventions.

**Conclusion**

This is the first time-series analysis of applying tongue examination to observe disease prognosis. The features, namely, tongue color, tongue fur thickness and fur color, extracted from a series of tongue images taken every two days, exhibit significant changes that match closely with the progression of disease. These features could serve as indices for different stages of diabetes with PLA. Future endeavors will focus on the application of tongue diagnosis to evaluate the tongue characteristics of diabetic patients.
References:


Table 1: Laboratory Data on consultation day (2012.02.06, D1)

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<tr>
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Table 2: Tongue shape, tongue color, fur color, fur thickness, fur distribution and fur root, extracted from a series of tongue images taken every two days, are listed. This data serves as the basis to evaluate the changes in tongue as the progression of disease.

<table>
<thead>
<tr>
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<td>D23</td>
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</table>
Figure 1. (2012.02.01) Abdominal computed tomographic scan showing two mass lesions in the R’t liver, about 6.5 * 6.1 cm in the liver S7-8.
Figure 2. Nine primary tongue features automatically extracted by ATDS.
Figure 3. The fluctuations of body temperature. As PLA progressed, the patient suffered spiking fever and right upper abdominal pain on D9. After receiving pig-tail catheter drainage, the fever subsided and the pus-like fluid was drained smoothly on D12.
Figure 4. The changes in Plasma glucose level. The patient’s hyperglycemic status was not well-controlled under infectious condition. After receiving pig-tail catheter drainage on D9 with plasma glucose was 567 mg/dl, his plasma glucose gradually stabilized after D12.
Figure 5. Abdominal Sonography showed (a)D3. Size about 8.87cm * 8.64 cm in the liver S7-8 (b)D11. Size dwindled slightly to about 8.74* 8.64 cm (c)D16. Size decreased down to 4.75* 4.8 cm (d)D23. Size reduced to 4.71*4.18 cm.
Figure 6: Tongue image series (a)D1. Pink-red tongue color, yellow thick fur, (b)D10. Red tongue color and white-yellow, thick fur, (c)D19. Pink-red tongue color and obviously reduced tongue fur, mainly distributed on the posterior segment, (d)D23. Normal pink-red tongue color, white and thin fur, corresponding to tongue features of a healthy person, and (e) The corresponding tongue features extracted.
Figure 7: The standard processing flow of tongue diagnosis