Application of Traditional Chinese Medicine Four-diagnostic auxiliary apparatus in evaluation of health status and clinical treatment

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Abstract

OBJECTIVE: To evaluate the application of Traditional Chinese Medicine (TCM) Four-diagnostic Auxiliary Apparatus in disease diagnosis.

METHODS: The liver cancer patients and healthy controls were recruited from Shanghai Integrated Chinese and Western Medicine Hospital and Beijing University of Traditional Chinese Medicine, respectively. Then, the included subjects were diagnosed by the Four-diagnostic auxiliary apparatus.

RESULTS: Thirty liver cancer patients and 30 paired healthy controls were enrolled in this study. Based on the apparatus, the pulse wave velocity was significantly higher in patients compared with controls ($P < 0.05$). The number of patients with purple tongue and ecchymosis were more than controls ($P < 0.05$). The number of patients (10%) with yellow tongue coating were higher than the controls (0%). Patients were inclined to be with water type and fire type constitution.

CONCLUSION: TCM Four-diagnostic auxiliary apparatus can be applied in clinical diagnosis of body constitution and health status of subjects. It promotes the accuracy and speed for disease diagnosis and TCM standardization.

Keywords: Liver neoplasms; Four diagnostic methods; Equipment and supplies; Medicine, Chinese traditional; Multi-information fusion

INTRODUCTION

The four diagnostic methods used in Traditional Chinese Medicine (TCM) are the major methods for disease diagnosis. The four diagnosis methods and symptom pattern identification were performed mainly based on Yin, Yang, Qi and blood condition. Individuals varied the causes of diseases, which is related with the constitution of subjects. The constitution identification of subjects is benefit to understand the body
characteristic, disease treatment and prevention. In recent times, the diagnosis of diseases mainly depends on the application of medical equipments that improved the diagnostic accuracy and speed.\textsuperscript{2,3} It is necessary to develop the high-tech equipment to diagnose the diseases by TCM.

Digitalization and quantization of four diagnostic methods provide simple, convenient, cheap, efficacious, appropriate health data monitoring, evaluation, and intervention method, which inherits TCM diagnostic methods and improves the progress of science and technology in TCM.\textsuperscript{4} TCM four-diagnostic auxiliary apparatus is the only apparatus that can automatically extracted the diagnostic information for TCM.\textsuperscript{5} It combined multi-information fusion technology, the data supported four diagnostic parameters, the equipment integration of the computer statistical analysis, with clinical experience of Chinese medicine experts, which makes the diagnostic information more stable and standard. Meanwhile, the apparatus shows advantages in disease diagnoses, symptom pattern identification and individualized therapy recommendations.\textsuperscript{6,7} In this study, we aimed to investigate the potential for the application of this apparatus in practice.

METHODS

Subjects
In this study, patients with liver cancer were recruited from Shanghai Integrated Chinese and Western Medicine Hospital. All the patients were diagnosed with primary liver cancer based on pathological examination, type B ultrasound, CT, MRI, Alpha-fetoprotein, and enzymatic examination. The patients who were accompanied by diseases that could affect tongue and pulse, such as hemangiomma, varicose veins of the lower extremities, tongue lesions, etc. were excluded. Cases were also excluded if they were accompanied with heart, lung, brain, kidney related diseases and other serious diseases or metabolic disorders, such as hypertension, diabetes, hyperlipidemia, hyperuricemia. Other exclusion criteria included pregnant or lactation women and cases with mental disorder.

In addition, the healthy controls without chronic diseases and acute diseases occurred within three months were recruited from the Beijing University of Traditional Chinese Medicine.

Experimental method
The Traditional Chinese Medicine (TCM) Four-diagnostic auxiliary apparatus (BD-SZ, Registration number YZB/Jin 0019-2014), was developed by the team of Beijing University of Chinese Medicine. The apparatus can automatically extract the diagnostic information of traditional Chinese indexes such as looking, listening, asking and feeling the pulse, accompanied with dynamic electrocardiogram (ECG), oxygen, pulse wave velocity (PWV), vascular compliance and other available diagnostic information.\textsuperscript{8,9}

Before the test, the TCM Four-diagnostic auxiliary apparatus instrument was checked and debugged to make it reach the most stable state. All the subjects were allowed to calm for 5-10 min to exclude external disturbances and informed about the detailed test procedures and matters needing attention. First, the basic information of the subjects were collected, and the ECG limb leads were connected with the corresponding limbs. Pulse pressure probe was put to test the subject’s radial artery pulse pulsation. Then the pulse chart, ECG and photoelectric volume chart were collected by computer via putting the photoelectric finger volume clip on the subject’s right middle finger. In the tongue diagnosis mode, subjects were informed to put the tongue out of the mouth, and images of tongue were acquired by adjusting the camera. The clear and complete picture of tongue were collected for further analysis. Subsequently, in the listening module, subjects listened and repeated following hints and the digital audio data were stored. After collecting the the basic information, and the results of pulse diagnosis, tongue diagnosis, the asking mode was performed. The symptoms self stated by subjected were input into the asking mode by computer. Then the diagnostic report was automatically generated combined with all the information of diagnostic modes.

Statistical analysis
All the data were analyzed by SPSS 20.0 (IBM Corp., Released 2011. IBM SPSS Statistics for Windows, Version 20.0., Armonk, NY, USA). Data were expressed as mean ± standard deviation (\( \bar{x} \pm s \)) or number (percentage). The difference between patient group and controls were analyzed by paired \( t \) test or \( \chi^2 \) testing. \( P < 0.05 \) was defined as statistically significance.

RESULTS

Totally 30 cases (28 males and 2 females, age range: 36-80 years) with liver cancer were enrolled in this study and 30 age and gender paired healthy controls were included. Compared with the patient group, PWV was significantly higher than that of the control group and the pulse pressure and pulse rate were significantly lower \((P < 0.05)\). No difference was observed in the pulse parameters, pulse power and pulse rate between two groups \((P > 0.05)\) (Table 1).

As shown in Table 2, the number of patients who were present with purple tongue and ecchymosis were significantly higher than healthy controls \((P < 0.05)\). The healthy controls trended to show pale white (3.3% vs 0.0%) and light red tongue (73.3% vs 36.7%). More patients (10.0%) were present with yellow tongue coating compared with controls (0.0%). Compared with control group, the proportion of patients with water
type constitution and soil type constitution was higher in the experimental group. Compared with patient group, the proportion of subjects with water type constitution and fire type constitution was higher in the control group (Table 3).

The TCM Four-diagnostic auxiliary apparatus automatically analyzed the data of the diagnostic module and exported the diagnostic results and intervention managements. Based on the TCM, the patients with liver cancer were diagnosed as six types of diseases, such as (a) Qi stagnation and blood stasis, treatment with modified Zhuyu decoction with Six Gentlemen decoction; (b) food turbidity block, treatment with Six Milled Ingredients decoction; (c) Qi stagnation and blood blockade type, treatment with Shixiao powder with Jinlingzi powder addition and subtraction; (d) deficiency of vital energy and stagnation of blood, treatment with Bazhen decoction and Huaji pills addition and subtraction; (e) liver Qi stagnation type, treatment with Yueju pills addition and subtraction; (f) liver Yin deficiency type, treatment with Bugan decoction. A larger number of subjects in control group were present with sub-health, thus exercises were recommended.

**DISCUSSION**

Compared with the traditional pulse-taking, the digital pulse-taking combined TCM theory with the modern scientific theory. Digital pulse-taking detects the parameters of pulse pressure, pulse rate, coefficient of variation, pulse power, fluency, string tightness, PWV, which collected more diagnostic information.\textsuperscript{11,12} Our

### Table 1: Comparison of pulse parameters between experimental group and control group ( ± s)

<table>
<thead>
<tr>
<th>Group</th>
<th>Pulse pressure (Pa)</th>
<th>Pulse power</th>
<th>Pulse rate (n/min)</th>
<th>String tightness</th>
<th>PWV (m/s)</th>
<th>Pulse rhythm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>2120.00±731.00</td>
<td>1759.00±394.00</td>
<td>73.0±12.68</td>
<td>132.0±64.55</td>
<td>7.1±1.80</td>
<td>0.04±0.04</td>
</tr>
<tr>
<td>Control</td>
<td>2720.00±666.00</td>
<td>1744.00±549.00</td>
<td>78.4±10.62</td>
<td>102.9±43.49</td>
<td>5.0±0.84</td>
<td>0.05±0.04</td>
</tr>
</tbody>
</table>

Notes: control group included in the health volunteers; experimental group included in the patients with liver cancer. Compared with the control group and the experimental group, PWV was significantly higher than that of the control group and the pulse pressure, pulse rate and String tightness were significantly lower ($P < 0.05$). No difference was observed in the pulse parameters, pulse power and pulse rate between two groups ($P > 0.05$).

### Table 2: Comparison of tongue diagnosis information between experimental group and control group (n [%])

<table>
<thead>
<tr>
<th>Group</th>
<th>Experimental group (n = 30)</th>
<th>Control group (n = 30)</th>
<th>$\chi^2$ value</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongue substance</td>
<td>Pale white (0 (0.0))</td>
<td>1 (3.3)</td>
<td>-</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Light red (11 (36.7))</td>
<td>22 (73.3)</td>
<td>8.148</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td>Red (17 (56.7))</td>
<td>7 (23.3)</td>
<td>6.944</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>Deep red (1 (3.3))</td>
<td>0 (0.0)</td>
<td>-</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Purple (1 (3.3))</td>
<td>0 (0.0)</td>
<td>-</td>
<td>1.000</td>
</tr>
<tr>
<td>Tongue coating color</td>
<td>White (27 (90.0))</td>
<td>30 (100.0)</td>
<td>1.404</td>
<td>0.236</td>
</tr>
<tr>
<td></td>
<td>Yellow (3 (10.0))</td>
<td>0 (0.0)</td>
<td>-</td>
<td>1.000</td>
</tr>
<tr>
<td>Tongue fur</td>
<td>Thin (16 (53.3))</td>
<td>18 (60.0)</td>
<td>0.271</td>
<td>0.602</td>
</tr>
<tr>
<td></td>
<td>Thick (14 (46.7))</td>
<td>12 (40.0)</td>
<td>-</td>
<td>1.000</td>
</tr>
<tr>
<td>Ecchymosis</td>
<td>7 (23.3)</td>
<td>0 (0.0)</td>
<td>5.822</td>
<td>0.016</td>
</tr>
</tbody>
</table>

Notes: control group included in the health volunteers; experimental group included in the patients with liver cancer. The number of patients who were present with purple tongue and ecchymosis were significantly higher than healthy controls ($P < 0.05$).

### Table 3: Comparison of auscultation and smelling information between experimental group and control group (n [%])

<table>
<thead>
<tr>
<th>Item</th>
<th>Experimental group (n = 30)</th>
<th>Control group (n = 30)</th>
<th>$\chi^2$ value</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>4 (13.3)</td>
<td>3 (10.0)</td>
<td>&lt;0.001</td>
<td>1.000</td>
</tr>
<tr>
<td>Fire</td>
<td>3 (10.0)</td>
<td>6 (20.0)</td>
<td>0.523</td>
<td>0.470</td>
</tr>
<tr>
<td>Earth</td>
<td>6 (20.0)</td>
<td>3 (10.0)</td>
<td>0.523</td>
<td>0.470</td>
</tr>
<tr>
<td>Metal</td>
<td>5 (16.7)</td>
<td>5 (16.7)</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Water</td>
<td>12 (40.0)</td>
<td>13 (43.3)</td>
<td>0.069</td>
<td>0.793</td>
</tr>
</tbody>
</table>

Notes: control group included in the health volunteers; experimental group included in the patients with liver cancer. Compared with control group, the proportion of patients with water type constitution and soil type constitution was higher in the experimental group. Compared with patient group, the proportion of subjects with water type constitution and fire type constitution was higher in the control group.
data showed that the string tightness of the patients was higher than that of the controls, which was consistent with the TCM theory of the pulse in patients with liver related diseases. Modern hemodynamic studies have shown that the main mechanism of chordal pulse formation is the tumor development that results in the changes of liver and portal system hemodynamics and increases the peripheral resistance.13.14 In the present study, compared with control group, PWV increased and the coefficient of variation was decreased in patient group. Despite of age and other factors, PWV is the indicator of systematic arterial compliance, heart rate variability can indirectly reflect the function of the autonomic nervous system of the heart. Therefore, PWV and coefficient of variation can be used for indicating the cardiovascular disease of liver cancer. TCM Four-diagnostic auxiliary apparatus showed that liver cancer patients were present with deep red tongue, which was in line with TCM theory that “Liver blood stasis results in green tongue, stagnation of blood stasis for a long time leads to the purple tongue”. TCM emphasizes the “individual-oriented”, and close relationship between constitution and etiology, pathogenesis and diagnostics. Based on digital auscultation and smelling information, TCM Four-diagnostic auxiliary apparatus distinguished the constitution of subjects, which improved the diagnostic accuracy and therapy recommendation. Liver cancer originates from liver lesion, which is closely related with the the health state of other viscera such as gallbladder, spleen, stomach, kidney. Populations can be classified into three TCM constitutional types including coexistence of blood stasis and Qi deficiency; Qi stagnation, wetness, wet heat stroke of the solid syndromes; blood deficiency, Yin and Yang deficiency and folder of the virtual syndromes. For TCM, the therapeutic principle of liver cancer is invigorating the spleen, regulating Qi, accompanying by the elimination. The commonly used methods in the treatment of liver cancer include reinforcing Qi and nourishing blood method, resolving hard lump method, method of promoting blood circulation and removing blood-stasis, warming kidney and invigorating spleen method, etc. In this study, the apparatus divides the patients into six syndromes, and provided the intervention plan for each syndrome type. The curative effect of TCM mainly depends on the clinical dialectical thinking ability of TCM practitioners. The digital and quantitative technology is lacking in the clinical application of TCM. Four-diagnostic auxiliary apparatus combines Multi-information fusion key technology and data supported four diagnostic parameters based on TCM, which provides more diagnostic information and improved the accuracy of diagnosis and therapy. It also provide an open platform for the diagnosis and treatment of TCM, and provide more possible diagnostic references. Physicians can choose the most appropriate diagnostic results and prescription according to their own experience, which ensured the integrity and the coexistence of comprehensive diagnosis of physician and individual experience of the differences. It promote to achieve a combination of subjective and objective syndrome and obtain accurate diagnosis and treatment of four diagnostic results. It is conducive to improve the service capacity of TCM medical institutions.15

At present, the technical talents of health care system of TCM are limited. The applications of multi-information fusion key technology, data support of the four diagnostic data sets and equipment in the grassroots health service center, can improve the level of Chinese medicine medical staff and the level of Chinese medicine service level. It can promote and popularize the advantages of TCM, to meet people’s demand and promote the development of TCM, and promote the comprehensive development of grass-roots health care system in China.

In conclusion, TCM Four-diagnostic auxiliary apparatus can be used in the clinical diagnosis of various diseases. It collects more diagnostic information to distinguish the constitution of individuals and provide the personalized therapy. It improves the accuracy and speed of the disease diagnosis. The apparatus can improve the application of TCM theories and promoted modernization of TCM.

REFERENCES


