Pulse Analysis of Patients with Severe Liver Problems

Studying Pulse Spectrums to Determine the Effects on Other Organs

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Blood tests and ultrasound scanning are standard techniques for the diagnosis of liver problems. However, there is no easy assessment of how liver problems affect other parts of the body [1], such as the spleen, stomach, lung, and gallbladder. Traditional Chinese medicine makes use of pulse analysis to diagnose such conditions. In this article, we study the pulse spectrum of patients with liver problems, with the goal of using this technique to analyze related conditions.

Overview

In previous studies, our results of pulse analysis have shown that the liver, lung, gallbladder, and spleen meridians were closely related to possible liver problems [2, 3]. In those studies, the subjects were essentially healthy or with only minor discomfort related to possible liver problems.

In this study, pulse diagnosis was carried out on 24 patients diagnosed with liver cirrhosis and 85 patients with possible liver problems. Correlation with conventional liver tests, which include SGOT, SGPT, T-Bil, ZTT, Alp, r-GT. ChO, AlB, AlB/Glo and ultrasound scanning were analyzed. We found that all the cirrhosis patients possessed the same criterion $C_3 \leqq -$ in intensity and $C_3 \leqq -$ in phase. (C_n is the nth Fourier component of the pulse pressure wave normalized by C_o, the DC term of the wave.) For intensity, every 10% above normal was given one "+", every 10% below normal was given one "–". For phase, every 10% delay in the traveling speed was given one "–". Only the "+", "N" (N = normal), and "–" states were considered, while quantities of "+" "–" were neglected. In pulse analysis, there are 3^{11} (from amplitude) x 3^{11} (from phase) = 177,147 x 177,147 possible states (3 qualitative states and 11 meridians).

The subjects in this study were from two particularly selected groups. The first group contained subjects with liver cirrhosis where most patients had minor or even severe ascites and splenomegaly. The other group contained patients with possible, though undiagnosed, liver problems.

In traditional Chinese medicine, the spleen meridian is very important as a liver cirrhosis marker. This relationship corresponds to the spleen being closely related to the liver in physiology and pathology [4, 5]. The spleen meridian is also related to blood composition [6, 7]. These understandings are consistent with the teachings of traditional Chinese medicine, such as Huang-Ti-Nei-Ching [6], Chin-Kuei-Yao-Lueh [7], which recognize that liver problems may also effect the spleen.

Material and Methods

The first group of 24 patients (11 males and 13 females, between 42 and 78 years of age (average age of 58.60 ± 10.03)) were diagnosed as having liver cirrhosis by ultrasound scanning, blood tests, and physical examination. The second group of 85 patients, (56 males and 29 females, between 16 and 65 years of age (average 41.5±12.0 years)) had come to the hospital for treatment of possible liver problems. Comparison between the two groups of tests was carried out by the following studies (all tests were done in Ho-Ping Municipal Hospital).

Blood Tests and Ultrasound Scanning

The blood tests included SGOT (serum glutamic oxaloacetic transaminase), SGPT (serum glutamic pyruvaic transaminase), D-Bil (direct bilirubin), T-Bil (total bilirubin), Alp (alkaline phosphates), r-GT (r-glutamyl, transpeptidase), ZTT (zinc sulfate turbidity), CHO (cholesterol), Alb (albumin), and Alb/Glo (albumin/globulin). In this study, the following were considered abnormal (normal ranges are in the parentheses):

SGPT > 35 IU/L (6 ~ 35 IU/L)
SGPT > 30 IU/L (0 ~ 30 IU/L)
D-Bil > 0.4 mg/dL (0.1 ~ 0.4 mg/dL)
T-Bil > 1.0 mg/dL (0.1 ~ 1.0 mg/dL)
Alp > 220 IU/L (75 ~ 220 IU/L)
r-GT > 45 IU/L (5 ~ 45 IU/L)
ZTT > 12 Kv – μ (3 ~ 12 Kv – μ)
CHO > 250 mg/dL or 120 mg/dL (120 ~ 250 mg/dL)
Alb < 3.5 gm/dL (3.5 ~ 5.0 gm/dL)
Alb/Glo < 1.0 (1.0 ~ 1.5)

Any test result or ultrasound scan found to be outside of the normal range was considered to be abnormal [3].

Pulse Test

The pulse was taken and analyzed during the patient's first visit to avoid the effects of hunger [8]. (It is routine to ask patients to fast prior to drawing blood for a test.) We selected those patients who told us that they did not take any medicine within last three days.

The pulse analyzer was set up as in our previous experiments [2, 3, 8]. The radial artery pressure pulses of both hands were recorded with a pressure transducer (PSL-200GL, Kyowa Electronic Instrument Co.. Ltd.. Japan) fixed on the skin with tape and an adjustable belt with a small button to give suitable pressure on the transducer. The criterion of a good measurement was to seek the largest pulse amplitude. The subjects were first asked to rest for 20 minutes prior to four consec-

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utive pulse measurement being taken. The output of the pressure transducer was stored in an IBM PC after A/D conversion at a sampling rate of 430/sec. The pulse spectrum was analyzed by the Fourier transform using the period equal to 1 pulse, as described earlier [9]. This analysis gave spectrum readings up to the 10th harmonic. The intensity of harmonics above the 11th was very small and thus not recorded. Intensity and phase were compared to a male standard (average of 100 male college students, age 18 to 20) and a female standard (average of 100 female college students, age 17 to 19). Normal was defined as those who had no known health problems.

The criterion for abnormal measurements followed the criterion used in our previous reports [3], but we added a new criterion: $C_3 \leqq 2-$ in intensity and $C_3 \leqq 2-$ in phase. We thereby had six criteria for abnormal liver function:

1. $C_1 \geqq 3$ and $C_1+C_4 \geqq 4$ or $C_1+C_6 \geqq 4$ (in intensity)
2. $C_1 \leqq 3-$ (in intensity)
3. $C_6 \geqq 3$ and $C1+C_6 \geqq 4$ (in intensity)
4. $C_6 \leqq 2-$ in intensity and $C_6 \leqq 2-$ in phase
5. $C_1 \geqq 2$ and $C_3 \geqq 2-$ in intensity or $C_3 \leqq 2-$ in phase
6. $C_3 \leqq 2-$ in intensity and $C_3 \leqq 2-$ in phase

A phase angle delay of 10% (i.e., the traveling speed of this harmonic was slowed by 10%) gave one "–". In general, this change was mainly due to a structural change in the meridian or its related organ [9-11].

For the intensity, the definition was the same as we used before. For C_1 (liver), every 5% above normal gave one "+" and every 5% below normal gave one "–". For C_3 (spleen), C_4 (lung), and C_6 (gall bladder), every 10% above normal gave one "+" and every 10% below normal gave one "–".

The observed values are presented in tables 1 and 2. The numbers in the parentheses were the excepting value. The blood tests and ultrasound scanning results were used as the gold standard, and the validity of the pulse spectrum analysis was determined by the Kappa value with:

$$\text{Kappa value} = \frac{\text{Actual agreement beyond chance}}{\text{Potential agreement beyond chance}}$$

(when K = 0 ~ 0.2 : slight agreement, 0.2 ~ 0.4: fair, 0.4 ~ 0.6: moderate, 0.6 ~ 0.8: substantial, 0.8 ~ 1.0: almost the same).

With the chi squared test:

$$x^2 = \Sigma[(0-E)^2/E]$$

where 0 = the observed value and E = the expecting value. From the X^2 value, we may find the p value, which is the chance of noncorrelation [12].

Table 1. Agreement between pulse diagnosis and the standard tests.

Pulse Diagnosis	Abnormal	Normal	Total
Abnormal	73 (68)	2 (7)	75
Normal	4 (9)	6 (1)	10
Total	77	8	85
$X^2 = 27.626$ $p = 0.000000147$ Kappa = 0.64			

Table 2. Number of patients who fit into each criterion of pulse diagnosis.

Criterion of Pulse	Intensity	Phase	Subject Total (Left Pulse)	Subject Total (Right Pulse)	Subject Total (Left or Right)
1. (A)	$C_1 \geqq 3$ $C_1+C4 \geqq 4$		5	3	6
1. (B)	$C_1 \geqq 3$ $C_1+C_6 \geqq 4$		6	3	6
2.	$C_1 \leqq 3-$		0	0	0
3.	$C_6 \geqq 3$ $C_1+C6 \geqq 4$		0	2	2
4.	$C_6 \leqq 2-$	$C_6 \leqq 2-$	4	6	9
5.(A)	$C_1 \geqq 2$ $C_3 \leqq 2-$		13	15	17
5.(B)	$C_1 \geqq 2$	$C_3 \leqq 2-$	10	13	17

Results

Results for the 85 patients with possible liver problems, using the six pulse criteria in comparison with the blood tests and ultrasound results, are shown in Table 1. Results of using each of the six criteria to check the cirrhosis patients separately are shown in Table 2. The "subject total (left pulse)" column gives the number of patients with the criterion in the left-hand radial arterial pulse. The "subject total (right pulse)" column gives the number of patients with the criterion in the right-hand radial arterial pulse. The "subject total (left or right pulse)" gives the number of patients with the criterion in either the left- or the right-hand radial arterial pulse.

Discussion

There are 11 meridians (from 0 to 10th harmonics) in the spectrum analysis, and each has intensity and phase indicators. Each indicator may be in an "N", "+" or "–" state, with different quantities. Even if we do not consider the quantitative results, but just focus on the states, there are a total of 3^{11} (from intensity) x 3^{11} (from phase) = 177,147 x 177,147 possible states. We chose just a few criteria from the billions of the possible states and obtained good correlation. This result strongly suggests that the meridian theory and pulse feeling have physiological and pathological importance.

Liver cirrhosis is defined as widespread fibrosis with nodule formation [13]. The normal zonal architecture of the liver cannot be recognized. Three anatomical types of cirrhosis are recognized: micornodular, marconodular, and mixed. The Child-Pugh classification scheme (grades A, B, C)—which depends on jaundice, ascites, encephalopathy, serum albumin concentration, and prothrombin

time—gives a good prognostic guide in the *clinic [14]. The etiology of disease in the* 24 patients with liver cirrhosis is mostly chronic hepatitis virus B, and only a few are alcohol related. Chronic hepatitis is defined as a chronic inflammatory reaction in the liver, continuing without improvement for at least six months [15]. It can be further classified into chronic persistent, chronic lobular, and chronic active hepatitis (mild and severe) [13].

These 24 patients also possessed splenomegaly, abdominal wall venous collaterals, and different degrees of ascites in clinical associations. All the grades of Child-Pugh classification were found among the patients who possessed $C_3 \leqq 2-$ in intensity and $C_3 \leqq 2-$ in the phase in the pulse spectrum diagnosis. This finding strongly suggests that the related organ, the spleen, and the spleen meridian, which is related to the blood composition, is affected in severe liver problems, as we suggested above.

However, in our other observations we also found that some subjects who possessed $C_3 \leqq 2-$ in intensity and $C_3 \leqq 2-$ in phase did not have liver problems, but instead other types of problems. This finding suggests that this criterion is related to spleen problems or the spleen meridian. However, the other organ that is the source of this spleen problem cannot be determined using this criterion.

With a blood test or ultrasound scanning, each test is an indication of a specific problem. In pulse spectrum analysis, we are in the same situation such that each criterion should have its own pathological meaning, since these spectra are related to different meridians and each meridian has its own physiological function and pathological roles [6]. In this article we found the special importance of the spleen meridian in severe liver problems. This is consistent with the teaching by Chang-Chung-Ching who stated in Chin-Kuei-Yao-Lueh [7] that "the superior physician knows that liver disease eventually transmits to the spleen meridian."

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