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Pulse Spectrum Analysis of Hospital Patients with Possible Liver Problems

W.A. Lu[1], C.H. Cheng[1], Y.Y. Lin Wang[2] and W.K. Wang[3*]

[1]*Department of Traditional Chinese Medicine, Taipei Municipal Ho-Ping Hospital*
[2]*Department of Physics, National Taiwan Normal University &*
National Research Institute of Chinese Medicine
[3]*Biophysics Laboratory, Institute of Physics, Academia Sinica, Taipei, Taiwan 115*
** Corresponding author*

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Abstract: Pulse diagnosis were performed on 85 patients who came to the hospital for liver and gall-bladder problems. Correlation between liver tests, which include T- Bil, D - Bil, SGOT, SGPT, ZTT, Alp, γ- GT, Cho, Alb and ultra sound scanning, and pulse diagnosis were analyzed. 77 out of 85 subjects showed abnormal liver tests. We used the following 5 criteria for pulse diagnosis as liver abnormality to test the correlation: (1) $C1 \geq 3+$ and $C1 + C4 \geq 4+$ or $C1 + C6 \geq 4$ (in intensity); (2) $C1 \leq 3$ (in intensity); (3) $C6 \geq 3$ and $C1 + C6 \geq 4$ (in intensity); (4) $C6 \leq -2$ (in intensity) and $C6 \leq -2$ (in the phase) and (5) $C1 \geq 2$ $C3 \leq -2$ (in intensity) or $C3 \leq -2$ (in the phase). For C1 (liver) every 5% above normal was given one "+," every 5% below normal was given one "-." For C3 (spleen), C4 (lung), C6 (gall-bladder), every 10% above normal was given one "+," every 10% below normal was given one "-." For the phase, every 10% delay in the traveling speed was given one "-." When considering only the "+" and "-" states and neglecting the quantity of "+" and "-," there are 2^{11} (from intensity) x 2^{11} (from phase), which equal 2048 x 2048 possible states in the pulse analysis. We considered only 5 criteria for liver abnormality; the correlation was still very high, $p < 0.0002$, Kappa = 0.64. It strongly suggests that meridian theory and pulse diagnosis have physiological and pathological importance.

Blood tests are standard diagnostic procedures for liver problems. Indicators such as SGOT (serum glutamate oxaloacetate transaminase), SGPT (serum glutamate pyruvate transaminase) are related to the damage and leakage of liver cells. It is not easy to assess liver problems if they are not causing leakage. There is also no easy assessment as how liver problems are affecting other parts of the body (Daniel & Kurt 1991), such as spleen, stomach, lung and gall-bladder. In this report, we studied patients who visited the hospital for possible liver problems, and evaluated the possibility of using pulse spectrum theory to diagnose liver problem.

In our previous report on pulse analysis of chemical factory workers, we found that

lung meridian and liver meridian were closely related to liver problems, which might be induced by chemicals (Wang *et al.,* 1996b). Data on that study was gathered from regular checkups, and most of the subjects were not aware of any physical problem. In this study, the subjects were patients who came to the hospital for uncomfortable feeling or liver problem. Following our last investigation, we again used the liver meridian and lung meridian as markers in pulse diagnosis. In addition, gall-bladder meridian and spleen meridian were used as additional markers, since they are closely related to the liver in physiology (McCuskey, 1994; Sasaki *et al.,* 1986; Zachary *et al.,* 1986; Miller *et al.,* 1984; Thomas *et al.,* 1982) and *Yellow Emporer's Canon of Internal Medicine* (*Huang Ti Nei Ching*).

Material and Methods

Subjects

Eighty-five patients were used in this study. They (56 males and 29 females between 16 to 65 years of age with average 41.5 ± 12.0 years) came to the hospital for treatment of liver problem or some unknown uncomfortable feeling.

Two groups of tests were compared in this study:

1. Blood test and ultra sound scanning

All tests were done in Ho-Ping Municipal Hospital. The blood tests included SGOT (serum glutamic oxaloacetic transaminase), SGPT (serum glutamic pyruvic transaminase), D-Bil (Direct Bilirubin), T-Bil (Total Bilirubin), Alp (alkaline phosphates), γ-GT (γ-glutamyl transpeptidase), ZTT (zinc sulfate turbidity), Cho (cholesterol) and Alb (albumin).

In this study, abnormalities from either blood test or ultra sound scan were considered abnormal (Daniel and Kurt, 1991). The following were considered abnormal (normal range are in parentheses):

T-Bil > 1.0 mg/dl (0.1 - 1.0 mg/dl)
D-Bil > 0.4 mg/dl (0.1 - 0.4 mg/dl)
SGPT > 35 IU/l (6 - 35 IU/l)
SGOT > 30 IU/l (0 - 30 IU/l)
Alp > 220 IU/l (75 - 220 IU/l)
γ-GT > 45 IU/l (5 - 45 IU/l)
ZTT > 12Kυ-u (3 - 12Kυ-u)
Cho > 250 mg/dl (120 - 250 mg/dl)
Alb < 3.5 gm/dl (3.5 - 5.0 gm/dl)

2. Pulse test

Pulse were taken and analyzed during the patient's first visit to avoid the hunger effect (it is routine to ask patients to fast before drawing blood for testing) (Wang *et al.,* 1996a). Patients

who did not take any medicine within the last 3 days were selected as subjects.

Procedures for pulse analysis were similar to our previous experiments (Wang *et al.*, 1994, 1995, 1996a, 1996b). Briefly, the radial artery pressure pulse of both hands were recorded with a pressure transducer (PSL-200GL, Kyowa Electronic Instrument Co. Ltd., Japan) fixed on the skin with scotch tape and an adjustable belt with a small button to give suitable pressure on the transducer. Criterion of a good measurement is to seek the largest pulse amplitude. Subject was asked to rest for 20 minutes, then 4 consecutive pressure pulse measurements were taken. The output of the pressure transducer was stored in an IBM PC via an A/D converter with sampling rate of 430 data point/sec. Pulse spectrum were analyzed with Foulier transform using periods = 1 pulse as described earlier (Wang *et al.*, 1989). The analysis gave a spectrum reading up to the 10th harmonic. Intensity of harmonics above the 11th became very weak and were 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.

In addition to the criteria for abnormality in our last report (Wang *et al.*, 1996b), we added a few more criteria: (i) $C6 \geq 3$ together with $C1 + C6 \geq 4$; (ii) $C6 \geq -2$ (in intensity) and $C6 \leq -2$ (in the phase); (iii) $C1 \geq 2$ $C3 \leq -2$ (in intensity) or $C3 \leq -2$ (in the phase). We had therefore five criteria for abnormal liver function:

1. $C1 \geq 3$ and $C1 + C4 \geq 4$ or $C1 + C6 \geq 4$ (in intensity)
2. $C1 \leq 3$ (in intensity)
3. $C6 \geq 3$ and $C1 + C6 \geq 4$ (in intensity)
4. $C6 \leq -2$ (in intensity) and $C6 \leq -2$ (in the phase)
5. $C1 \geq 2$ $C3 \leq -2$ (in intensity) or $C3 \leq -2$ (in the phase)

For the phase we introduced a new criterion. If the phase angle delayed every 10%, we gave one "-," which signified the traveling speed of this harmonic was slowed by 10%. In general this change was mainly due to the structure change in the meridian or its related organ (Wang *et al.*, 1989, 1995).

For the intensity, the definition was the same as we used before; for C1 (liver) every 5% above normal was given one "+" and every 5% below normal was given one "-." For C3 (spleen), C4 (lung) and C6 (gall-bladder), every 10% above normal was given one "+" and every 10% below normal was given one "-."

Blood test was used as the golden standard. The validity of pulse spectrum analysis was analyzed by Kappa value and X^2-test.

$$\text{Kappa value } (\kappa) = \frac{\text{Actual Agreement beyond chance}}{\text{Potential Agreement beyond chance}}$$

when $\kappa = 0$ -0.2: slight agreement; 0.2-0.4: fair; 0.4-0.6: moderate; 0.6-0.8: substantial; 0.8-1.0: almost

In the X^2 test: $X^2 = \sum [(O - E)^2/E]$, where O is the observed value; E the expected

value. From the X^2 value, we could find out the p value, the chance of non-correlation (Kleinbaum *et al.*, 1988; Rosner 1990; Landis and Koch, 1977).

Results

Results are presented in the following 4 tables. Numbers (without parentheses) in the tables were the observed valued where as numbers in the parentheses ( ) were the expected value. Criteria 1, 2, 3 and 4 were used in Tables 1, 2 and 3 to evaluate the validity of pulse diagnosis while criteria 1, 2, 3, 4 and 5 were used in Table 4.

Table 1. SGOT and SGPT

	Abnormal	Normal	Total
Abnormal	33 (31)	29 (31)	62
Normal	10 (12)	13 (1)	23
Total	43	42	85

$X^2 = 0.638$, $p = 0.425$, $\kappa = 0.093$

Table 2. SGOT and SGPT + Bilirubin (T + D)

	Abnormal	Normal	Total
Abnormal	40 (36)	22 (26)	62
Normal	10 (4)	13 (9)	23
Total	50	35	85

$X^2 = 3.066$, $p = 0.08$, $\kappa = 0.206$

Table 3. All indicators in the tests

	Abnormal	Normal	Total
Abnormal	60 (56)	2 (6)	62
Normal	17 (21)	6 (2)	23
Total	77	8	85

$X^2 = 7.777$, $p = 0.0053$, Kappa = 0.30

Table 4. All indicators in the tests

	Abnormal	Normal	Total
Abnormal	65 (61)	2 (6)	67
Normal	12 (16)	6 (2)	18
Total	77	8	85

$X^2 = 13.863$, $p = 0.000196$, $\kappa = 0.40$

Discussion

Results of this study clearly indicated that criteria 1 and 2 used in our previous study (Wang *et al.,* 1996a) were not sufficient for pulse diagnosis of liver disease, as SGOP, SGPT and Bilirubin (T + D) are not sufficient for liver disease testing.

In our last study (Wang *et al.,* 1996a), the main cause of liver problem might be induced by chemical poisons, and the main route of chemica' poisons to enter the human body might be the air. Therefore the lung and lung meridian could be the first target to suffer, and the lung and liver meridian became good indicators at that transient stage of abnormality. If the liver problem does not start from the lung or becomes more severe, the other related meridians such as gall-bladder and spleen may also be effected as well.

From the four tables listed above, the p values corresponded very well with the values of Kappa.

There are 11 meridians (from 0 to 10th harmonics) in the spectrum analysis and each of them has intensity and phase indicators, each indicator may go either "+" or "-" with different quantities. Even if we do not consider the quantitative results and just focus on the "+" and "-" states, there are 2^{11} (from intensity) x 2^{11} (from phase), which equal 2048 x 2048 possible states. We chose just a few criteria in the millions of possible states, and got a good correlation. This strongly suggests that the meridian theory and pulse diagnosis have physiological and pathological importance.

As stated in the introduction, most of the subjects in this study have liver problems. 77 out of the 85 subjects showed liver problem with at least one of the tests. It was reasonable that the more criteria we chose in the pulse spectrum analysis, the better the correlation would be.

This study should not be considered as merely a correlation study, but rather as a classification of pulse spectrum in patients with liver problems. The blood test or the ultrasound test each indicats a specific problem. In the pulse spectrum analysis, each criterion has its own pathological meaning since these spectrum are related to different meridians, and each meridian has its own physiological functions and pathological roles (*Huang Ti Nei Ching*).

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