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Pulse Spectrum Analysis of Chemical Factory Workers with Abnormal Blood Test

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Abstract: Double blind tests to check the correlation between pulse diagnosis and liver function tests were performed. Blood tests including T-Bil, D-Bil, SGOT and SGPT of 70 chemical factory workers were compared with pulse analysis. Special attention was paid to the indicators of liver and lung meridians for pulse diagnosis. It was found that using the criterion (1) C1 ≥ 3+ and C1 + C4 ≥ 4+ (hyperfunction) and (2) C1 ≤ 3- (hypofunction) as abnormal liver meridian (for C1, every 5% above normal give one +, every 5% below normal give one -; for C4 every 10% above normal give one +, every 10% below normal give one -). The correlation or agreement between the blood tests and the pulse diagnosis was very high (noncorrelation chance checked by X^2-test, $P < 0.001$, degree of agreement checked by Kappa test Ka = 0.61 which means a substantial relationship). Suggestions such as more tests, more criteria and precautions for future study are also proposed.

This study is a double blind test to see if pulse analysis can be used to diagnose liver disease. In animal studies, chemicals such as Carbon tetrachloride (Reynolds and Moslen, 1980), hydrochloride D+galactosamine (Reutter and Haque, 1975) or acetaminiphen (Mitchell, 1988) were used as hepatotoxines to induce liver damage. Hepatoactive drugs (Lin *et al.*, 1994) were then used to study curative effect. That is a simple and powerful model for liver disease studies. However, it is impossible to administer hepatoactive drugs as done in animal studies to humans. The subjects in this study were chosen from a chemical factory that produces many pesticides and detergents; such as paraquat, endosulfan e.c., glyphasate, and propoxur e.c., all of which are strong toxins. The workers in the factory had an annual examination, which included blood tests and urine tests for liver and kidney diseases. Data for this study was collected during these examinations.

Material and Methods

A total of 70 subjects (60 males, 10 females) were involved in this study. All were between 22 to 64 years of age (average ages were 31 for males and 43 for females with S.D. = 11.7 years).

There were two tests in this study:

(1) Blood tests were done at the National Taiwan University Hospital. These included SGOT (serum glumtamic oxatoacetic transaminase), SGPT (serum glumtamic pyruvic transaminase), total Biliribrin (T-Bil), D-Bil, and other parameters. In this report, the following were considered abnormal (normal ranges are shown in the parentheses).

T-Bil > 1.3 mg/dl (0.2 - 1.0 mg/dl)
D-Bil > 0.5 mg/dl (< 0.4 mg/dl)
SGOT > 40 μ/dl (< 31 μ/ml)
SGPT > 35 μ/dl (5-31 μ/ml)

(2) Pulses were read within three weeks after blood tests. The experimental setup was described in our previous report (Wang *et al.,* 1995a). Briefly, 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 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. The subject was asked to rest for 20 minutes before 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 points/sec. The pulse spectrum was analyzed with a Fourier transformer using (periods) = 1 pulse as described earlier (Wang *et al.,* 1989b). The analysis gives spectrum readings up to the 10th harmonic. Harmonics above the 11th become very small and were not recorded.

Pulse 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 recordings from those who had no known health problems.

From previous studies (Wang *et al.,* 1989a,b, Wang Lin *et al.,* 1991), it is known that C1 is related to the liver and liver meridian. Therefore C1 was used as an indicator. In Chinese traditional medicine *(Huang-Ti-Nei-Ching),* lung (C4) has the character of metal and liver has the character of wood. These two meridians interfere with each other, therefore, special attention was paid to these two parameters. In this study, every 5% above standard in C1 was noticed with one + sign, and every 5% below standard one - sign; for C4, every 10% above standard was noticed as one + sign, and every 10% below standard as one - sign. According to traditional Chinese medicine, lower lung function (C4 -) will interfere with the liver less thus causing hyper liver function (C1 +). This situation should be distinguished from hyperfunction due to an abnormal liver. The criteria C1 $\geq$ 3+ and C1 + C4 $\geq$ 4+ (hyper-function) and C1$\leq$ 3- (hypofunction) were used to define an abnormal liver. If the lung is normal then no - sign will appear on C4, C1 $\geq$ 3+ will indicate hyper liver function. However, hypo function lung influence on liver is corrected by the criterion C1 + C4 $\geq$ 4+; a conclusion of abnormal hyper liver function will be established only if the number of + signs appear on C1 is 4 more than the - signs on C4.

The instrument with the designated software was a model WK-92 pulse-feeling machine.

Results

The results are summarized in Table 1. The blood test is used as the golden standard; the validity of the pulse machine results is as following:

Sensitivity = 0.93, Specificity = 0.67,
Positive predictive value = 0.91, Negative predictive value = 0.71,
Observed agreement, accuracy rate = 0.8714 = (51+10)/70,
Agreement expected on the basis of chance = 0.6714 = 47/70,
Kappa value = (0.8714-0.6714)/(1-0.6714) = 0.61 which is in the substantial range.

We may also use X^2-test by applying $X^2 = \Sigma[(O-E)2/E]$ (O: observed value; E: Expecting value). In this study, $X^2 = 25.97$ which means $P < 0.001$.

Table 1

	Blood test abnormal	Blood test normal	Total
Pulse abnormal	10 (3)	4 (11)	14
Pulse normal	5 (12)	51 (44)	56
Total	15	55	70

Both the Kappa and X^2-test were done to check the statistical significance.
The numbers in parentheses ( ) are the expected values.

Discussion

In this study, only a few criteria were selected to check for correlation. It is therefore surprising to note P<0.001. The results suggest that SGOT, SGPT, T-Bil and D-Bil are sensitive tests for liver damage, and that the lung and liver meridians are closely related as understood in traditional Chinese medicine *(Huang-Ti-Nei-Ching)*. The physiological basis for this can be explained. If lung function is weak, oxygen supply to the organs will not be sufficient, and some intermediate metabolites will be accumulated in the body due to lack of oxygen. It would then be necessary for the liver to utilize enzymes to catalyze the intermediates and complete the metabolic process so that the metabolites can be removed by the kidney. Therefore, blood flow toward the liver will be elevated. Similar elevation has been observed in people after alcohol consumption, which also must be removed by the liver.

From this study, it can be understood why Xiao-Chai-Hu-Tang has been suggested for treatment of minor liver problems (Gibo *et al.,* 1992, Iwanaka *el al,* 1992). The major ingredients of Xiao-Chai-Hu-Tang are *Radix Bupleuri* and *Panax ginseng. Radix Bupleuri* affects the liver meridian (Wang Lin *et al.,* 1992), while ginseng improves the lung meridian (Wang *et al.,* 1994). This formula indeed improve liver problems, which originate in the liver and lung meridians.

In order to obtain accurate pulse spectrum and make correct diagnosis, the following points should be considered:

(1) Subjects should not take any medicine for two days before the pulse reading. Most drugs have an effect on the pulse spectrum (Wang Lin *et al.,* 1992, Wang *et al.,* 1994, 1995b). Therefore, taking medicine will change the pulse and cause ambiguities in pulse diagnosis.

(2) Subjects should not be hungry. This is especially important for blood test subjects who are asked to fast prior to drawing blood. Hunger causes serious shifts of the pulse spectrum (Wang *et al.,* 1996).

(3) More tests such as Alp, LDH, LAP, γ-GTP or even ultra-sound and image scanning may be needed to test for all possible liver problems.

(4) More criteria in pulse diagnosis may be needed to detect other possible liver problems, such as in the spleen and gall-bladder meridians, both of which may be affected by liver dysfunction (Harrison, 1983).

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