

Alteration of Pulse in Human Subjects by Three Chinese Herbs

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(Accepted for publication January 3, 1994)

Abstract: Human subjects were fed with extract of three Chinese herbs, *Panax ginseng*, *Panax quinquefolium* roots and *Ganoderma lucidum*. Pulse of the radial artery was examined. Our results indicate that each herb has a specific effect on the Fourier components of the pulse, and is in agreement with traditional Chinese medical descriptions.

Pulse diagnosis is a powerful and unique diagnostic modality in traditional Chinese medicine. The variation of pulse provides important information for traditional Chinese medicine practitioner to diagnose as well as monitor therapeutic effects on illness. This monitoring is a systematic method described in the medical text *Huang-Ti-Nei-Ching* which is different from Western medicine.

In our previous reports, we suggested that the Fourier components of the pulse may be related to the resonant conditions of blood distribution to the organs (Wang *et al.*, 1987, 1989a, b, c; Wang Lin *et al.*, 1991). Herbs may change the pumping of the heart or the physical conditions of an organ, both of which can be shown in the pulse shape (Wang Lin *et al.*, 1992).

In the present study, we investigate the herb-pulse relationship in human subjects. Three herb extracts, *Panax ginseng*, *Panax quinquefolius* (American ginseng) and *Ganoderma lucidum* were studied. These herbs are widely used in Chinese medicine. There are no apparent side effects if used within the normal dose range. *Panax ginseng* and American ginseng are two species of the genus *Panax* in the family *Araliaceae* (Hu, 1977; Hou, 1977). Their chemical constituents and pharmacological activities have been studied extensively. *Panax ginseng* has been reported to have anti-fatigue properties, transient regulatory action on carbohydrate metabolism and blood pressure (Li and Li, 1973; Popov and Gold, 1973). It also has effects on macromolecular synthesis in the liver, testes and bone

marrow (Yamamoto *et al*, 1974; Iijima *et al*, 1976). For American ginseng, the chemical structures of its saponins are very similar to those in *Panax ginseng*, except that the ratio of panaxadiol to panaxatriol is different between these two species (Hou *et al*, 1977). These saponins are thought to be the major active components of ginseng. *Ganoderma lucidum* has been reported to be effective in the treatment of hypertension (Lee *et al*, 1990), hyperglycemia (Kimura *et al*, 1988) and allergy (Tasaka *et al*, 1988). It inhibits the aggregation of platelet (Shimizu *et al*, 1985) and the synthesis of cholesterol (Komoda *et al*, 1989), and it also exhibits antitumor activity (Sone *et al*, 1985 and Furusawa *et al*, 1992).

Pulse shape of the radial artery was recorded before and after herb extract was fed to the subject. The pulse was then decomposed into harmonic components by the Fourier analysis method. The results of this study are in concert with our previous experiment in rats (Wang *et al*, 1992). For human subjects, each Chinese herbal medicine has a specific effect on the harmonic components of the pulse, and are closely related to the meridian-related effects described in the pharmacology classic literature, *Pen-ts'ao Be-Yio*.

Material and Methods

Human subjects aged between 17 to 33 with no apparent illness were randomly divided into three groups. There were 12 males and 2 females in the *Ganoderma lucidum* group; 5 males and 2 females in the *Panax ginseng* group and 11 males and 5 females in the American Ginseng group. All subjects were asked not to take any medication 3 days before the experiment. During the test day, they were not allow to have any alcoholic or caffeinated beverages. Every subject was food restricted at least one hour before experiment. A half hour rest was routinely required before the test. Room temperature was kept between 23 to 25 °C.

Each subject was asked to lie down and relax with eyes opened for five minutes. Pulse pressure on the right hand radial artery was then recorded with a pressure transducer (PSL-200GL, Kyowa Electronic Instrument Co. Ltd. Japan) which was fixed on the skin by scotch tape and an adjustable belt with a small button to give suitable pressure on the transducer (period 1). Our criterion of a good measurement was to seek the largest amplitude of the pulse. Six measurements were taken in a two minutes interval. The transducer was kept at the same spot with the same pressure for these six measurements. Warm herbal extract was then fed to the subject. The pulse was measured at the same manner for three more times at 30 minutes (period 2), 60 minutes (period 3) and 90 minutes (period 4) after herbal extract administration. The output of the transducer was connected to an IBM PC via an A/D converter with sampling rate = 430 data points/sec. Pulse spectrum was analyzed with Fourier transform using $T(\text{period}) = 1$ pulse as described previously (Wang *et al*, 1992).

The standard deviation of heart rate averaged from four to six consecutive pulses in a measurement and was not allowed to exceed 5%. Data of the four measurement periods was an average of the 6 measurements, standard deviation of heart rate in these 6 measurements was required to be within 10% to be considered good data.

Pulse spectra measured at periods 2, 3 and 4 were compared with the pulse spectrum measured at the first period. Variations of pulse spectra between these comparison were expressed as the percentage differences of the first 9 harmonic proportions which were defined as :

ALTERATION OF PULSE BY CHINSEES HERBAL MEDICINE

$$\% \text{ Difference of } n\text{th harmonic proportion} = \frac{C_n(T_i) - C_n(T_o)}{C_n(T_o)} \times 100\%$$

where T_i = after drug period i , T_o = before drug step; C_n = n th harmonic proportion = $(A_n/A_o) \times 100\%$. A_n = amplitude of the n th harmonic of pulse spectrum, A_o = DC component of pulse spectrum.

Ganoderma lucidum powder extract was from National Research Institute of Chinese Medicine. 250 mg was used for each subject. *Panax ginseng* or American ginseng was soaked twice in 55° C water. 10.75 g in 50 c.c. extracts were used for each test.

Results and Discussions

The Fourier components of the pulse generated by blood pressure were obtained through a Fourier analyzer. The difference between post and pre-treatment of the first harmonic C1 to the 9th harmonic C9 were calculated. The three curves in Figure 1, 2 and 3 correspond to the pulse in the three post treatment periods. The standard error of mean of the first curve (period 2) was also plotted in each figure. The standard error of mean for the other two curves are about the same (not shown). For all three herbs, the effects on pulse reached maximum in about 30 minutes. The effects were kept up to 90 minutes.

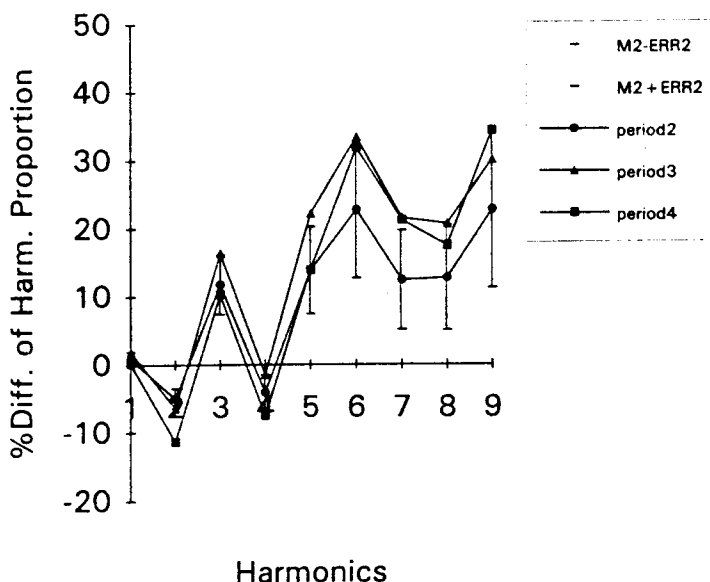


Figure 1. *Ganoderma lucidum* effect on human pulse. The standard error of mean of the first curve (period 2) were also plotted. The mean of the first curve $M2 \pm SEM$ were plotted as $M2 + ERR2$ and $M2 - ERR2$ respectively. Period 2, 3 and 4 each represents 30, 60 and 90 minutes after herb treatment.

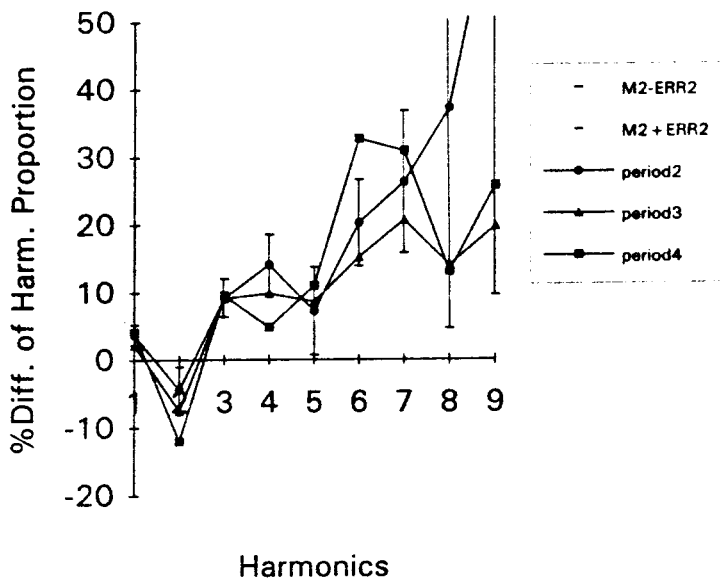


Figure 2. *Panax ginseng* effect on human pulse. The standard error of mean of the first curve (period 2) were also plotted. Period 2, 3 and 4 each represents 30, 60 and 90 minutes after herb treatment.

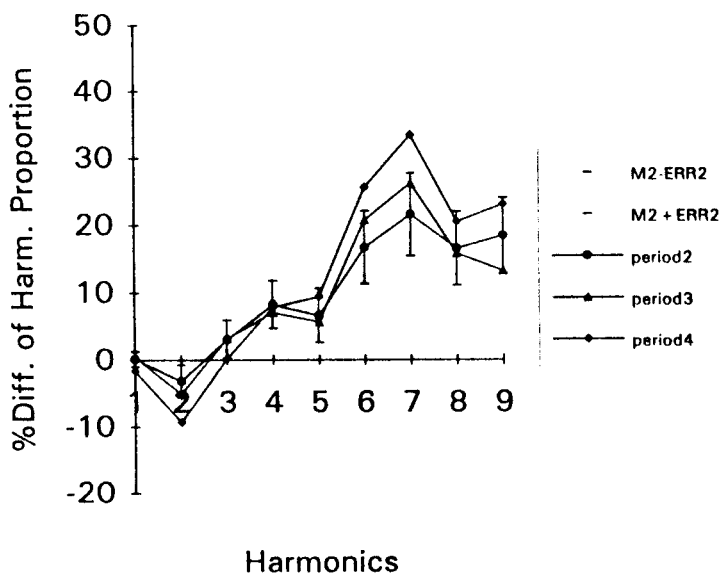


Figure 3. American ginseng effect on human pulse. The standard error of mean of the first curve (period 2) were also plotted. Period 2, 3 and 4 each represents 30, 60 and 90 minutes after herb treatment.

ALTERATION OF PULSE BY CHINSEES HERBAL MEDICINE

These experimental results showed that each herb had a specific effect on the Fourier components of the pulse of human subjects. C3, C6, C9 were increased extensively for subjects treated with *Ganoderma lucidum*. C5, C7, C8 were also increased but in a smaller extent. C2 was decreased. There was no significant effect on C1, and C4 (Figure 1).

For *Panax ginseng* and American ginseng treated groups (Figure 2,3), there were significant increase for the higher harmonic components such as C6, C7, C8, and C9. C2 was decreased. Both groups showed C7 as a peak. Although C4 and C5 were increased in both ginseng groups, the increase of C3 in the American ginseng treated group was insignificant when compared with the *Panax ginseng* group.

According to *Pen-ts'ao Be-Yio*, *Panax ginseng* is good for the spleen, lung and stomach; however American ginseng is considered mainly for the lung and stomach. From our results, the pulse spectrum varied in a similar fashion for both groups, except C3. In traditional Chinese medicine, C3 is related to the spleen (Wang *et al.*, 1989c and Young *et al.* 1989). The results of the present study is in agreement with the traditional Chinese medical descriptions.

We treated rats with *Panax ginseng* using the same method as described in our previous report (Wang Lin *et al.*, 1992). Despite the absence of the higher components in rat, the pulse spectrum varied in a similar manner as in human subjects. There were considerable increase of C3, C4 and C5 components (Figure 4). *Panax ginseng* contributes to the same Fourier components redistribution of the pulse in human and rats. The herbal effect on pulse was consistent in these two species.

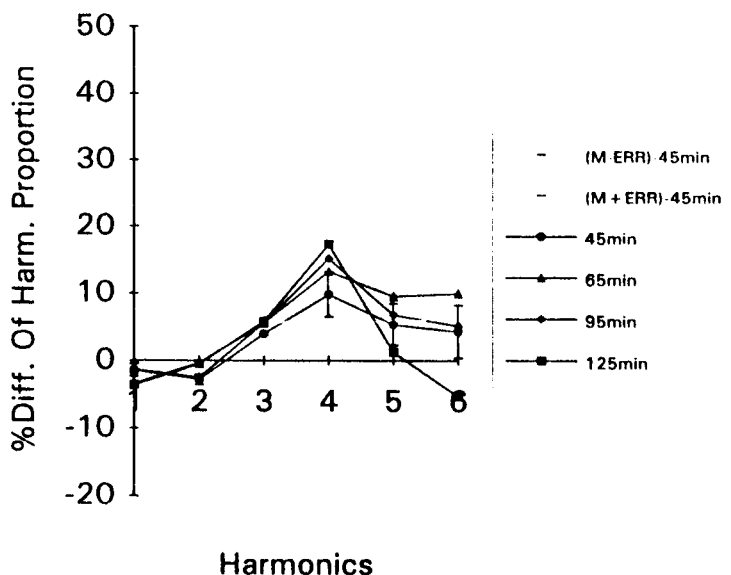


Figure 4. *Panax ginseng* effect on rat pulse. Four after herb treatment curves of 45, 65, 95 and 125 minutes were shown. The standard error of mean of the first curve (45 minutes) were also plotted (Wang Lin *et al.*, 1992).

We previously reported that harmonic component may be related to energy distribution in different meridian (Wang *et al*, 1989c). Our results strongly suggest that the effects of medicinal herbs on meridians as described in the Chinese medical literature can be expressed by the variations of harmonic components in the pulse.

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ALTERATION OF PULSE BY CHINSES HERBAL MEDICINE

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