Chapter 17
Pulse Wave Analysis of Traditional Chinese Medicine Based on Hemodynamics Principles

Rui Guo
Shanghai University of Traditional Chinese Medicine, China

Yiqin Wang
Shanghai University of Traditional Chinese Medicine, China

Haixia Yan
Shanghai University of Traditional Chinese Medicine, China

Fufeng Li
Shanghai University of Traditional Chinese Medicine, China

Jianjun Yan
East China University of Science and Technology, China

Zhaoxia Xu
Shanghai University of Traditional Chinese Medicine, China

ABSTRACT
From the perspective of hemodynamics principles, the pressure pulse wave marked in the radial artery is the comprehensive result of pulse wave propagation and reflection in the arterial conduit. The most common pulse charts (also called pulse wave) obtained by Traditional Chinese Medicine (TCM) pulse-taking technique, if quantified and standardized, may become a universal and valuable diagnostic tool. The methods of feature extraction of TCM pulse charts currently involve time-domain analysis, frequency-domain analysis and time-frequency joint analysis. The feature parameters extracted by these methods have no definite clinical significance. Therefore, these feature parameters cannot essentially...
differentiate different types of TCM pulse. In this chapter, the harmonic analysis method was applied to analyze the common TCM pulse charts (plain pulse, wiry pulse, slippery pulse). Velocity and reflectivity coefficients of pulse were calculated. We found that wave velocities and reflection coefficients of different TCM pulse have different distributions. Furthermore, we studied the clinical significance of velocities and reflection coefficients. The result suggests that wave velocity and reflection coefficient are the feature parameters of TCM pulse with physiological and pathological significance, which can be used to interpret formation of Chinese medicine pulse. Our study reveals the mechanism of TCM pulse formation and promotes non-invasive TCM pulse diagnostic method.

INTRODUCTION

Pulse diagnosis of Traditional Chinese Medicine (TCM), as a non-invasive detection method, has won the praises and attention in both China and around the globe. Nevertheless, the traditional pulse diagnosis lacks objective evaluation standards, which has severely restricted the research and clinical application of pulse diagnosis, as Sphygmology Classic states that “the theory of pulse is abstruse and the conditions of pulse are difficult to differentiate”. Therefore, objective and digital pulse diagnosis becomes important for the modernization of this ancient and valuable traditional Chinese medicine technique.

For many years, the objective and quantification problem of TCM pulse has been a hotly-pursued area of multi-disciplinary research. Currently, a lot of researchers in China and abroad have put forward different methods concerning pulse wave signal analysis, involving time-domain analysis, frequency-domain analysis and time-frequency joint analysis, etc. The extracted parameters include waveform amplitude and area, power spectrum, cepstral (logarithm of power spectrum Inverse Fourier Transform called cepstral), wavelet energy at different scales, etc. However, there are still some limitations that remain to be overcome: the research on TCM pulse is limited to the application of signal processing methods for analyzing the waveform of pulse, without much consideration regarding the formation principle of pulse wave. The extracted feature and parameter are insufficient for interpreting clinical pathology, i.e., diagnostic purposes.

A classical treatise of pulse has pointed out that: “the heart is the basis of life and the origin of blood vessel” (Suwen · Thesis on Zangxian). The contraction and relaxation of the aortic pulse result from the periodic contraction and relaxation of the heart that propagate from the bottom of aortic pulse and along the arterial duct in waveform. This waveform is called the pulse wave. The information acquired from radial artery is actually the comprehensive reflection of waveform (shape), velocity (fast or slow), period (rhythm) and swing (intensity) of the pulse wave presented in radial artery (Liu & Li, 1982). This result informs us that the scientific nature of pulse may be revealed via studying the propagation law of pulse wave in arterial conduit. In recent years, we have studied the variation range of the pulse wave velocity and reflection coefficient of slippery pulse, wiry pulse and plain pulse gathered from hundreds of healthy people based on theory of pulse wave propagation and reflection of hemodynamic principles, and we have obtained some meaningful results that are presented in this chapter.

HEMODYNAMIC PRINCIPLE BASIS OF TCM PULSE WAVE

In TCM, pulse refers to what the doctor senses by palpating the examinee’s radial artery with fingers. Diagnosis information is then extracted based on the association of the pulse with pathol-