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PROPOSAL FOR EXPLORING POSSIBILITIES FOR FINGER PHOTOPLETHYSMOGRAPHY AS A SUBSTITUTE FOR PULSE DIAGNOSIS IN AYURVEDA

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ABSTRACT

Ancient Indian system of medicine popularly known as Ayurveda was heavily dependent on diagnosis through nadi parikshan i.e. pulse diagnosis. This required no sophisticated instrument and was totally dependent on the expertise of the expert. In the modern times we have highly sophisticated instruments but the expertise available earlier for diagnosis is missing. This paper proposes use of modern instruments to overcome this lacking expertise and hence to revive this dying art of nadi parikshan.

Keywords: Finger PPG, Pulse diagnosis, Ayurveda

1. INTRODUCTION

In the ancient science of Ayurveda, the five basic elements of earth, fire, water, ether and air are said to manifest in the human body as three basic constituents, known as tridosha. The tridosha namely vata-pitta-kapha govern several biological, psychological and physiopathological functions of the body, mind and consciousness. Imbalance in these tridoshas becomes a major cause of illness. According to ayurveda, 'nadi parikshan' or in conventional English terms 'pulse analysis' is a major technique to detect such illness.

2. PULSE

Pulse represents the tactile arterial palpation of the heartbeat by trained fingertips. The pulse becomes palpated in any place that allows an artery to be compressed against a bone. The common pulse sites on the human body are at the neck (carotid artery), at the wrist (radial artery), behind the knee (popliteal artery), on the inside of the elbow (brachial artery), and near the ankle joint (posterior tibial artery). The pulse can also be measured by listening to the heart beat directly (auscultation), using a stethoscope. Modern pulse prediction corresponds to the ancient method of 'nadi parikshan'. Way back in the ancient times, in-depth nadi parikshan was performed by expert physicians, then known as vaidyas. They could feel the pulse of the radial artery by their fingertips, read the imbalance in the tridoshas and diagnose a number of ailments. Although it is hard but not impossible to find an expert vaidya in today's time, but with technological advancements we can boast of such instruments and techniques which can give us an accurate account of the human pulse and the associated ailments. The way to obtain tridosha is through a "pulse waveform" obtained on a wrist with the index, middle and the ring fingers respectively as shown in Figure 1 [1]. The nadi which resembles the ECG has been explored the most in the recent studies by placing an appropriate pressure sensor at the radial artery to obtain the pulse waveforms. This convenient, inexpensive, painless, and noninvasive pulse-based diagnosis extracts the imbalances of Tridosha, which in turn identify the presence and location of disorders in a patient's body [1].

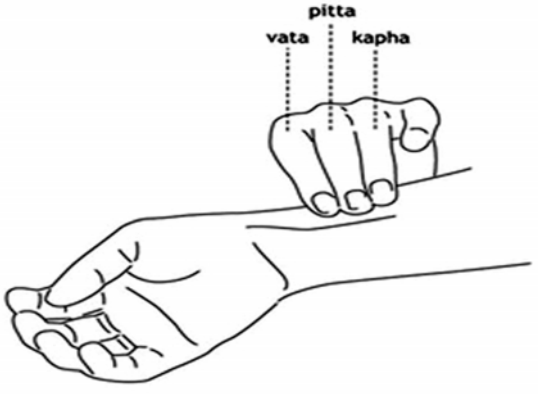

Figure 1: Traditional Method of Nadi Parikshan

The proposed approach to study and probably correlate the tridoshas with present day pulse diagnosis is Finger Pulse Plethysmography. Not much research has been done on this application of Photo plethysmography yet, however it is anticipated that the study of finger PPG may throw light upon the relation between the ancient technique and present technology [2].

3. PLETHYSMOGRAPHY

Photoplethysmography (PPG) is a simple and inexpensive optical technique that can be used to detect blood volume changes in the micro vascular bed of tissues [3]. The basic PPG technology requires two opto-electronic components: a light source to illuminate the tissue (e.g. skin), and a photo detector to measure the small variations in light intensity associated with changes in perfusion in the catchment volume. It operates at a red or a near infrared wavelength. The most recognized waveform feature is the peripheral pulse, which is synchronized to each heartbeat [4].

The pulsatile component of the PPG waveform is called the 'AC' component and usually has its fundamental frequency, typically around 1 Hz, depending on heart rate. This AC component is superimposed onto a large quasi-DC component that relates to the tissues and to the average blood volume. This DC component varies slowly due to respiration, vasomotor activity and vasoconstrictor waves and several other factors.

There are two main PPG operational configurations: transmission ('trans-illumination') mode operation where the tissue sample (e.g. fingertip) is placed between the source and detector, and reflection ('adjacent') mode operation where the LED and detector are placed side-by-side. Transmission mode PPG imposes more restrictions than the reflection mode PPG on the body locations available for study. The PPG probe should be held securely in place to minimize probe-tissue movement artifact. Artifacts can also arise from ambient light interference but can be reduced by suitable probe attachment to the skin (e.g. using a dark Velcro wrap-around cuff) and by further shading of the study site area and performing measurements in subdued lighting, and by electronic filtering [3].

4. FINGER PLETHYSMOGRAPHY WAVEFORM AND FEATURES

The Pulse Wave (PW) is a complex physiological phenomenon observed and detected in blood circulation. In the course of heart systole a certain amount of blood is ejected and it is moved into the arteries because of transformation between kinetic and potential energy of each segment of ejected blood. On each artery or venous section affected by a pulse wave, three coherent phenomena are observed: blood flow (flow pulse), the increase of blood pressure (pressure pulse) and extension of transverse profile (profile or volume pulse).

The typical volume or pressure pulse wave shape of the peripheral (radial) artery is shown in. In time domain analysis of pulse wave, the are following proportions can be measured: crest time (TP1), dicrotic wave time (TP2), total pulse duration (TPT), interwave time (IWT) measured in two thirds of systolic peak, second forward wave time (T2), systolic amplitude (AP1), dicrotic wave amplitude (AP2). These are self explanatory in nature (Figure 2a).

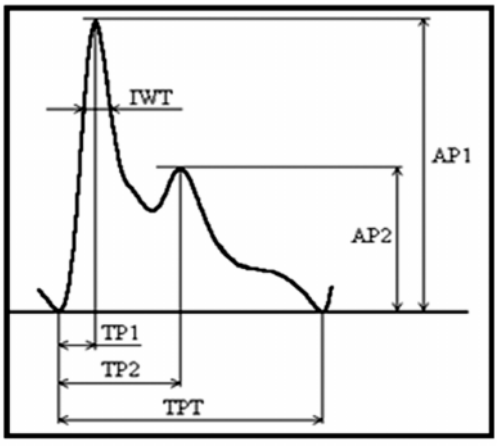

Figure 2: (a) Finger Pulse Waveform

From the above mentioned proportions, the following parameters can be derived: relative crest time (RCT) = TP1/TPT, interwave distance (IWD) = IWT/TPT, relative dicrotic wave amplitude (DWA) = AP2/AP1 (also called index of pressure wave reflection or reflection index (RI)) or relative dicrotic wave time (DWT) = TP2/TPT, all these parameters are dimensionless [5].

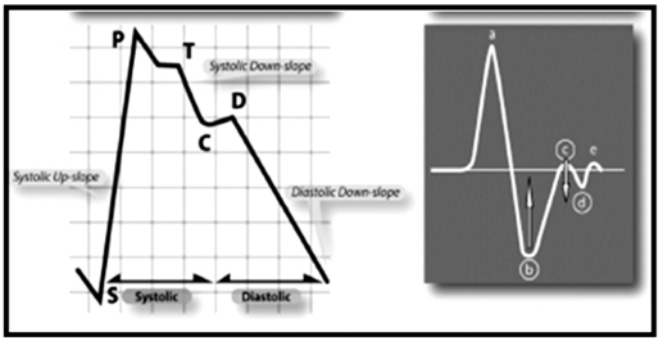

Figure 2: (b) Second derivative of finger pulse waveform

To extract more features in the time domain itself researchers have typically applied second derivative of the pulse, as shown in Figure 2b. This allows us the precise analysis of sudden changes in the waveform and time shifts. The first-order derivative parameters have a non acceptable variation and therefore are not used. But, the second-order derivative (called Acceleration Plethysmogram, APG) is more useful. The second-order derivative waveform comprises of five main parts, labeled from *A* to *E*: initial positive (*A*), early negative (*B*), re-increasing (*C*), late re-decreasing (*D*) and diastolic positive (*E*). From these determinants, the following parameters can be calculated: *B*/*A* ratio, *C*/*A* ratio, *D*/*A* ratio, *E*/*A* ratio and aging index AGI = (B-C-D-E)/A [5].

5. PROPOSAL FOR EXPLORING POSSIBILITIES FOR FINGER PHOTOPLETHYSMOGRAPHY AS A SUBSTITUTE FOR PULSE DIAGNOSIS IN AYURVEDA

This paper proposes that the features extracted from finger pulse waveform PPG may assist in determining the level of tridoshas in human body. To derive this relation it is important that we study the pulse waveform obtained from Finger PPG, extract features from its pulse in time domain as well as from its derivative known as acceleration plethysmogram. Additional features may also be derived from the frequency domain analysis of the pulse waveform. Analysis of these features may include their study before and after meals. According to ayurveda, there is a considerable change in body pitta level before and after meals. If such a change is quantified by analysis of the pulse waveform we may use finger PPG as a diagnosis tool for a number of ailments. Not only will this non invasive technique be easy and simpler in implementation, it will also lead to quicker and accurate diagnosis.

6. REFERENCES

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