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Short Communication

An exploratory clinical study to determine the utility of heart rate variability analysis in the assessment of *dosha* imbalance

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ABSTRACT

The present study is a comparison of the data of spectral analysis of heart rate variability with clinical evaluation of pathological state of *doshas*. The calculated cardiointervalography values are combined into three integral indexes, which according to the authors' opinion reflect the influence on heart rhythm of *vata*, *pitta* and *kapha*, the regulation systems of the body known as *doshas* in Ayurveda. Seven gross *dosha* imbalances were assessed to test the agreement between the two methods in this study. Heart Rate Variability (HRV) spectral data was collected from 42 participants to make the comparison with the clinical assessment of *dosha* imbalance. Clinical method of *dosha* assessment and method of calculating integral indexes by cardiointervalography data showed substantial agreement by Kappa coefficient statistic ($k = 0.78$) in assessment of gross *dosha* imbalance. The results of the data generated from this pilot study warrant further studies to rigorously validate the algorithms of HRV analysis in understanding *dosha* imbalance in Ayurvedic clinical practice and research settings.

1. Introduction

Ayurveda explains homeodynamics and health in terms of balance of the three *doshas* (regulatory systems), whereas disease is the outcome of the failure to maintain homeodynamics and is understood in terms of the imbalance of *doshas*. In order to formulate a specific treatment protocol, an Ayurvedic physician has to determine the exact nature of imbalance of the *doshas* and the specific substratum in which the imbalance manifests. To a great extent, imbalance of the *doshas* can be understood by careful analysis of clinical symptoms and signs. However, in many instances, it can be challenging to compute the imbalance in terms of the dominance and relative increase or decrease of the *doshas*. In ancient times, Ayurvedic physicians developed protocols for detailed examination of tongue, eyes, urine, faeces, skin and so on to measure imbalance of *doshas*. Subtle techniques like pulse diagnosis were introduced later on and eventually became the gold standard for diagnosing *dosha* imbalance.

1.1. HRV and imbalance of the doshas?

HRV is the result of the impact of the autonomous regulation on the heartbeat. *Doshas* are also autonomous regulators of body physiology. It is well known that 90% of our responses to the challenges of the external environment are determined by the autonomous nervous system. Travis and Wallace have discussed about the possible correlations between autonomous nervous system and the *doshas* [1]. Tyagi and Cohen have reviewed evidence indicating that physiological and psychological stress disrupts autonomic balance, which has long-term implications in a wide range of mental and physical illnesses [2]. Several studies have demonstrated that HRV is a useful tool in assessing pathology as well as treatment outcomes in many diseases. Masel et al. showed that HRV could be a surrogate marker for alleviation of cancer through pain and could also detect pain without active participation of the patients [3]. Kim et al. have demonstrated that perioperative HRV correlated with pre-operative depressed mood

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in patients with hepatic cancer [4]. Koszewicz et al. profiled autonomic dysfunctions in patients with primary brain tumor revealing sympathetic hyperactivity through HRV analysis [5]. Zhou et al. have reviewed the role of HRV in the prediction of survival in patients with cancer [6]. Taffe et al. have assessed post prandial HRV spectral analysis to differentiate overweight from normal weight adults [7]. Gupta et al. concluded that a significantly raised central vagal outflow and a concomitant significantly low central sympathetic efferent could be appreciated in asymptomatic asthmatic patients as compared to that in the control group by HRV spectral data analysis [8]. These studies indicate that HRV can vary in different diseases and also in specific stages of different diseases, which is also the case with the *Tridoshas*. This study aims to generate pilot data that will help in understanding the correlation between *dosha* imbalance and HRV patterns in patients diagnosed with different clinical conditions.

1.2. Previous studies exploring the correlation between HRV and doshas

Recently, Harupjit Singh from the Electrical and Instrumentation Engineering Department Thapar University, Patiala explored the relationship between three Ayurvedic *doshas* and HRV frequency bands by conducting a pilot study for his masters thesis [11]. His study involved only twenty-five patients and it achieved classification accuracy of 53% in case of the *vata dosha* and 70% in case of the *pitta dosha*.

2. Materials and methods

2.1. Study description

For the purpose of this study, forty-two patients with different Ayurvedic constitutions and pathology were randomly selected. All patients were attending the Amrita School of Ayurveda Hospital and signed a voluntary informed agreement to participate in the study.

Criteria for exclusion from the study included: medications for cardiac ailments influencing chronotropy of sinus node; multiple heart rhythm failures; divergence in data in verification of pathological *dosha* dominance between checklist of *dosha* dominance symptoms and expert assessment; HRV recording with many artefacts.

A checklist of *dosha* dominance symptoms compiled from the classical texts was used to make an exhaustive listing of the clinical symptomatology of the patient. The patients were then seen by a team of clinical experts who assessed the *dosha* dominance by performing an independent clinical assessment of the patient. Eleven participants with discrepancy in *dosha* dominance based on checklist and clinical assessment were excluded from the study and forty-two participants with congruence in *dosha* dominance based on checklist and clinical assessment were included for HRV analysis.

Researchers who filled the *dosha* dominance checklist, the clinical experts and the experts who recorded HRV spectral data were mutually blinded from the results of the independent assessments.

A VedaPulse hardware and software kit was used (manufactured by Biokvant LLC, Russia) for objective quantitative assessment of pathological *dosha* dominance using algorithms of HRV analysis. These algorithms were developed with inputs from Ayurvedic professionals with expertise in pulse diagnosis as well as pilot studies in a number of people.

Analysis of pathological *dosha* dominance included sequential actions, including: registration of biopotentials of the work of the heart for 5 min by placing electrodes on the wrists, software filtration of the signal with further receiving of HRV periodogram and analysis of cardiointervalogram using methods of spectral data analysis [9].

Frequency analysis of cardiointervalogram was done using discrete Fourier transform with overlapping. Periodogram was divided into three equal parts and for each of them a Fourier spectrum was calculated, after which these spectrums were averaged (see Fig. 2). Using the Fourier analysis, we estimate three spectral intervals: VLF – interval of very low frequencies (blue color); LF – interval of low frequencies (red color); HF – interval of high frequencies (green color). Horizontal axis shows frequencies in Hz, vertical axis shows spectrum power in ms2.

Practically the quantitative calculation of the *dosha* balance was done the following way: we calculated absolute values of the spectrum and rated them using 10-grade system of measurement, in which case the values of 2–4 points were considered a relatively standard interval which roughly corresponds with the average population value of the norm by absolute values of spectrum (see Fig. 3). If the normalized values of *doshas* in points were higher than the indicated interval and spectrums in VLF and LF intervals were dominating, it corresponded with–*vata-pitta*. If VLF and HF spectrums dominated, it corresponded with *vata-kapha*. If LF and HF spectrums dominated, it corresponded with-*pitta-kapha*. If all three spectrums had a rising tendency, it corresponded with VPK. In Fig. 3, Yellow bar (Factor "V") – total value of *vata dosha*; red bar (Factor P) – total value of *pitta dosha*; blue bar (Factor K) – total value of *kapha*. Corridor of norm 2–4 is highlighted in green.

To detect frequency intervals, we use the following frames:

For VLF – (Time = 25–300 s, frequency = 0.04–0.0033 Hz)
For LF – (Time = 6.6–25 s, frequency = 0.15–0.04 Hz)
For HF – (Time = 2.5–6.6 s, frequency = 0.4–0.15 Hz)

A group of scientists under the leadership of Dr. Sorokin began to do comparative analysis of the HRV data with the clinical analysis of the *dosha* balance starting from 2006, the results of which were published. Later, similar algorithms for calculating *doshas* by HRV were offered in the works of Kelkar et al. [10] and Harupjit Singh [11], where they showed the connection of these intervals with *doshas* on the sample of several hundred participants. The difference of our work is that the power of spectrum in intervals was rated using a 10-grade system, which simplified the comparison with the scoring system of *dosha* calculation by clinical method. Normalizing of the absolute spectral power to a 10-grade scale is necessary to create relative values of the secondary indices – factor V, factor P, factor K, which reflect the *dosha* balance. The use of such normalizing eases the perception of the balance of these factors between them, which is hard when comparing the absolute values of the specter. This normalizing does not change the mathematic approach to the calculation, it only facilitates better visualization of the data.

2.2. Scales to assess dosha dominance

There are simple to complex scales to assess *dosha* dominance and simplest scale categorizing *dosha* dominance in seven categories was chosen for comparing diagnostic agreement in this study. The most complex scale of *dosha* dominance has sixty-three categories, which take into account the permutations and combinations of the relative increase and decrease of the *doshas*.

These seven categories cover the single, dual (samsarga) and triple (sannipāta) combinations of *doshas* that are routinely

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