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Original Research Article (Clinical)

Significance of arterial stiffness in *Tridosha* analysis: A pilot study

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ABSTRACT

Background: The variations in *Tridoshas* are the basis for disease diagnosis and treatment in *Ayurveda*. The *doshas* are assessed by sensing the pulse manually with fingers which depends on skill of the physician. There is a need to measure *doshas* using instruments and study them objectively.
Objective: Arterial stiffness is well established pulse parameter in modern medicine and is closely associated to *kathinya* in the context of Ayurveda. The aim of our study was to measure arterial stiffness using *Nadi Tarangini*, a pulse acquisition system, and investigate the significant variations of stiffness across *Tridosha* locations.
Materials and methods: A total of 42 samples of *vata*, *pitta* and *kapha* pulses with proper systolic and diastolic peaks were included in the study. The arterial stiffness parameters namely stiffness index (SI) and reflection index (RI) were considered for the study. The data was analyzed using one-way ANOVA followed by Tamhane's T2 test. The changes in SI and RI between males and females were assessed using independent samples *t* test.
Results: SI at *vata* (5.669 ± 1.165) was significantly low compared to *pitta* (8.910 ± 3.509) and *kapha* (8.021 ± 2.814); RI at *vata* (0.846 ± 0.071) was significantly low compared to *pitta* (0.945 ± 0.043) and *kapha* (0.952 ± 0.033). SI at *kapha* was significantly low in females compared to males.
Conclusion: The SI and RI acquired using *Nadi Tarangini* have shown significant variations across *Tridosha* locations. The framework developed to measure the arterial stiffness across *Tridosha* locations can be used for the interventional studies in *Ayurveda* which in turn can help in disease diagnosis and treatment.

1. Introduction

Ayurveda is well known for its pulse based diagnosis which is primarily based on *Tridoshas* namely *vata*, *pitta* and *kapha*. As per Ayurveda, imbalance in *Tridoshas* is termed as disease and restoring the balance is health. The classical texts *Caraka Samhita* [1], *Sushrutha Samhita* [2]and *Ashtanga Sangraha* [3] have discussed in detail the nature of *Tridoshas* and its usefulness in disease diagnosis and treatment. The art of pulse reading is unique to Ayurveda where physicians place the index, middle and ring fingers on the wrist and assess the intensities of *vata*, *pitta and kapha doshas* respectively which forms the basis for diagnosis and treatment. *Sarangadhara* [4], in his work *Sarangadhara Samhita*, introduced pulse examination as a means of diagnosis and is considered to be done for the first time in history of Ayurveda. The classical texts *Yoga Ratnakara* [5] and *Bhava Prakasha* [6] also emphasized the importance of pulse based diagnosis.

Ayurveda has thousands of years of rich experience and assessment of *prakriti* plays a critical role in disease diagnosis and treatment. *Ayurveda* has very strong roots in pulse based diagnosis but it is subjective in nature and depends on the skill of the physician. It lacks the scientific evidence which is the need of the day as evidence based research is gaining importance in accepting any medicine or system of medicine [7,8]. In the recent past there is a growing research interest in studying *prakriti* in an objective

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manner with the help of *prakriti* assessment tools [9] as Ayurvedic physicians have agreed the need for research based standardized tool for *prakriti* assessment [10]. The standardized questionnaires such as *Sushrutha Prakriti Inventory* (SPI) [11], *Caraka Child Personality Inventory* [12], *Mysore Tridosha Scale* [13] have shown significant results in *prakriti* assessment. Recent studies on genetics with help of *prakriti* questionnaires have shown that *prakriti* and genes are closely associated which emphasizes the significance of questionnaires in assessing *prakriti* [14–17]. To strengthen the research further there is a need for measuring *Tridoshas* like any other clinical parameter like blood pressure, fasting blood sugar etc. This necessitates the need for a very precise pulse acquisition system which captures the pulse at *vata*, *pitta and kapha* locations. With the advancement of sensor technology pulse vibrations can be acquired very precisely and studies on the pulse acquired using *Nadi Tarangini* [18], have shown complete and reproducible high quality *vata*, *pitta and kapha* signals with significant variations in *Tridosha* locations with age and disorder which were matching with Ayurvedic literature. *Nadi Tarangini* based studies on pulse rate variability [19], beat to beat alterations [20], spectral analysis [21] and classification of diabetes [22] have shown significant results. These studies have demonstrated the pulse acquisition capabilities of the instrument which is a key requirement for pulse based research. However, evidence based research still needs parameters which represent the pulse with appropriate physiological basis and good literature support.

As per our literature review we found that arterial stiffness measured from pulse wave is accepted as an important parameter in assessing the cardiovascular risks. Number of studies have been done on arterial stiffness measured using carotid femoral (cfPWV), brachial ankle (baPWV) and photoplethysmography (PPG) techniques. The arterial stiffness measured with brachial ankle pulse wave velocity (baPWV) has gained clinical and research importance and studies have established the significance of arterial stiffness measured with this technique [23]. In similar lines the arterial stiffness measured using PPG has shown significant association with cardiovascular risk scores [24]. The digital volume pulse (DVP) acquired using PPG is composed of forward and reflected waves. Due to the reflected wave a peak appears in the diastolic phase and is known as diastolic peak. The time interval between systolic and diastolic peaks is proportional to the total path length of the pressure wave (from root of the artery to reflection point and back to root of the artery) and height of the person. The stiffness index (SI) is the ratio of height of the person to the time interval between systolic and diastolic peaks and reflection index is the ratio of diastolic to systolic peaks [25].

In Ayurveda, the pulse parameters *gati* (movement), *vega* (rate), *tala* (rhythm), *bala* (force), *tapamana* (temperature), *akruti* (volume and tension) and *kathinya* (consistency of the vessel wall) are considered to be of clinical importance [26]. The parameter *kathinya* represents the condition of the vessel wall such as thickness, hardness, elasticity and it is qualitatively assessed by rolling the artery between the finger and radial artery bone. The hardness of the artery was discussed in detail in Basavarajeeyam [27]. As the evidence based research is gaining importance there is a need to quantitatively assess *kathinya* with the help of instruments. The arterial stiffness measures the stiffness of the arteries and we think it is closely associated to *kathinya*. We aimed at studying the significance of arterial stiffness measured from radial artery across *Tridosha* locations. We have identified *Nadi Tarangini* for this study and the arterial stiffness indices namely stiffness index (SI), and reflection index (RI) were considered for the study. We hypothesized that stiffness indices vary significantly when measured at *Tridosha* locations. To test this hypothesis, we have measured the arterial stiffness at *vata*, *pitta* and *kapha* locations using *Nadi Tarangini* and assessed the significance of its variations across *Tridosha* locations.

2. Materials and methods

2.1. Participants

In the present study we took the data from the yoga camps conducted by S-VYASA as part of its ongoing studies on Yoga Therapy for Type 2 diabetes. The participants of yoga camps include individuals with no diabetes, diabetes and pre-diabetes. Pooja More et al. have investigated the diagnostic capability of *Nadi Tarangini* instrument in diagnosing diabetes using frequency domain analysis [22]. We have identified 90 participants not having diabetes for our study and investigated the variations of arterial stiffness across *Tridosha* locations. A total of 42 samples of *vata*, *pitta* and *kapha* pulses with proper systolic and diastolic peaks were included in our study after analyzing 90 participants' *Nadi* data acquired using *Nadi Tarangini*.

2.2. Inclusion criteria

All men and women above 40 years who were not suffering from diabetes or pre-diabetes were included in the study. The health of the participants was assessed by an Ayurvedic doctor by interviewing the participants on their health status. The participants who were currently not having any diseases and were not taking any medicines for any of the diseases were included in the study.

2.3. Exclusion criteria

The participants who were on regular medication and suffering from severe depression were excluded from the study. The participants who were not willing to participate in the study were excluded.

2.4. Ethics consideration

The study was approved by Institutional Ethics Committee of S-VYASA. We have explained the study to all the participants and the written informed consent was obtained from all the participants. We have considered only those participants who were willing to be part of the study.

2.5. Study design

The aim of the study was to investigate the changes in SI and RI across *vata*, *pitta* and *kapha* locations and accordingly three groups were created. The SI and RI measured at *vata* location were entered into *vata* group and similarly for the other two pulse locations. We have not assessed *prakriti* of the person in our study and groups were not formed based on *prakriti* but based on the location of the pulse. The age, height, body mass index (BMI), systolic blood pressure (SBP), and diastolic blood pressure (DBP) of the participants were measured. All the measurements were done at the beginning of the camp. The blood pressure was measured using sphygmomanometer.

2.6. Pulse measurement

Nadi Tarangini, a simple, cost-effective and non-invasive pulse acquisition system, was used for collecting pulse data which has three linearly placed pressure transducers, a 16bit multifunction data acquisition card NI USB-6210 (National Instruments, TX, USA)