CHAPTER 1
INTRODUCTION

1. INTRODUCTION

Radial pulse based diagnosis is well known to *Āyurveda* and is primarily based on *Tridoṣas* namely *vāta*, *pitta* and *kapha*. As per *Āyurveda*, imbalance in *Tridoṣas* is termed as disease and restoring the balance is health. The classical texts *Caraka Samhita,* (B.Dash, 1995), *Suśruta samhita* (K.A Shastry, 1997) and *Aṣṭāṅga Hṛdayam* (Moreshwar, 1993) have discussed in detail the nature of *Tridoṣas* and its usefulness in disease diagnosis and prognosis. The art of pulse reading is unique to *Āyurveda* where physicians place index, middle and ring fingers on the wrist and assess the intensities of *vāta, pitta and kapha* which forms the basis for diagnosis and treatment. *Śārṅgadhara* in his work *Śārṅgadhara Samhita* (P. H. C. Murthy, 2007) has introduced pulse examination as a means of diagnosis which is considered to be first time in history of *Āyurveda* wherein pulse based diagnosis is dealt with, later *Yoga Ratnākara* (SSB, 2011), *Bhāvaprakaśa* (Murthy, 2008) and *Basavarājīyam* also added *Nāḍī Parīkṣa* as part of disease diagnosis. Secondly in *Āyurveda* the constitution of an individual termed as *prakṛti* is assessed from *Nāḍī* by looking at dominant *doṣas* and based on the type of *doṣa* there are seven types of *prakṛti* which are combinations of *Tridoṣas,* namely *vātaja*, *pittaja*, *kaphaja*, *vātapittaja pittaja*, *vātakaphaja*, *pittakaphaja* and *vātapittakaphaja*. In *Āyurveda* it is important to determine the *prakṛti* of a person which plays a key role in disease diagnosis and treatment. Traditionally *Āyurveda* doctors used to examine the physical and psychological factors of the individual and also assess *Tridoṣas* from pulse

to identify the *prakṛti* which could be subjective in nature. In the recent past there is a growing research interest in studying *prakṛti* in an objective manner with the help of *prakṛti* assessment tools (Rastogi, 2012), as *Āyurveda* doctors have agreed the need for research based standardized tool for *prakṛti* assessment (Ramakrishna, Kishor, Nagaratna, & Nagendra, 2014). The standardized questionnaires such as *Suśruta prakṛti Inventory* (SPI) (Ramakrishna B R; Kishore K R; Vaidya V; Nagaratna R; Nagendra H R, 2006), *Caraka Child Personality Inventory* (Suchitra & Nagendra, 2013), *Mysore Tridoṣa Scale* (Shilpa & Venkatesha Murthy, 2011) have shown significant results in *prakṛti* assessment. Recent studies on genetics with help of *prakṛti* questionnaires have shown that *prakṛti* and genes are closely associated which emphasizes the significance of questionnaires in assessing *prakṛti* (Chatterjee & Pancholi, 2011; K. Joshi, Ghodke, & Patwardhan, 2011; Prasher et al., 2008; Rotti et al., 2014).

The traditional texts have discussed the details of *Nāḍī Parīkṣa* in succinct set of *ślokas* but the physiology behind *Nāḍī Parīkṣa* was not dealt with. There is no doubt traditional *Āyurveda* doctors were adept in diagnosing the diseases effectively by examining the pulse but it is subjective in nature which largely depends on the individual's knowledge, skill and experience. As part of *Nāḍī Parīkṣa* various aspects of *Nāḍī* were analyzed wherein *gati* or movement of the pulse, the speed and rhythm of the pulse and arterial stiffness are some of the prominent parameters assessed from *Nāḍī* as part of disease diagnosis. The significance of arterial stiffness in predicting the cardiovascular disease is

well understood from the recent studies in modern medicine but the significance of arterial stiffness in *Tridoṣa* analysis is not yet studied.

1.1 ARTERIAL STIFFNESS IN *ĀYURVEDA*

The role of arterial stiffness in *Nāḍī Parīkṣa* is not dealt with in many of the classical texts of *Āyurveda* except for *Basavarājīyam* (Rangacharya, 2007). *Basavarājīyam* has explained that nature of *vāta Nāḍī* to be *kaṭhin* and it is well known fact that *vāta* pulse is fast which confirms that the pulse is faster in stiff arteries and the recent studies have confirmed the same. In *dvitīya prakaraṇa* of *Basavarājīyam,* the nature of *mṛtyu Nāḍī* was explained where in it is mentioned that *kaṭhin Nāḍī* is one of the factors which can lead to death of the patient which can be interpreted that *kaṭhin Nāḍī* is a risk factor for cardiovascular disease. The classical texts of *Āyurveda* have not discussed much about *kaṭhin Nāḍī* but the description of *mṛtyu Nāḍī* from *Basavarājīyam* confirms the importance *Āyurveda* has given to arterial stiffness. The stiffness of the artery is closely associated to *kāṭhiṇya* which 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 (Vasant Dattatray, 2007).

1.2 ARTERIAL STIFFNESS IN MODERN MEDICINE

Arterial stiffness measured from pulse wave has gained significant research interest after longitudinal studies have demonstrated the independent predictive value of arterial stiffness in identifying cardio vascular risk (S Laurent et al., 2001). The origin of arterial

stiffness started with the hydraulic and elastic theories postulated by Young and Poiseuille and later Marey and Mahomed introduced Sphygmographs and made significant contributions to the pulse wave analysis. Earlier studies on arterial stiffness were based on arterial tree modeling and extensive studies were done in estimating systemic arterial stiffness using Windkessel and propagative models. The systemic arterial stiffness measurement based on arterial tree modeling measures the pulse at either distal or proximal arteries and determines arterial stiffness based on the arterial tree models which use numerous theoretical approximations. The systemic arterial stiffness is a better estimation for clinical studies but as of today there is no evidence in longitudinal studies that the systemic arterial stiffness has independent predictive value of cardiovascular risk. In later years the regional and local stiffness measurements have gained significant research interest as the longitudinal studies confirmed that increased values of pulse wave velocity measured are associated to increased cardiovascular risk. The regional arterial stiffness measures the pulse at two arteries along with the physical distance between the arteries and computes the pulse wave velocity as the ratio of the distance between the arteries to the time taken for pulse transit time between the arteries. Local arterial stiffness measurements make use of ultrasound devices in measuring the stiffness between two adjacent locations and the predictive values of carotid stiffness is established with longitudinal studies. Local arterial stiffness has been limited to clinical use as it is more time consuming and needs lot of technical expertise to be used in epidemiological studies. The advantage with regional and local arterial stiffness measurement techniques is that the arterial stiffness is measured directly without any theoretical approximations.

The regional and local arterial stiffness measurements are done primarily at aorta and peripheral arteries. The pressure wave as it propagates from central to peripheral arteries gets amplified at peripheral artery due to multiple reflections from various reflection sites and the reflection sites are closer to peripheral arteries when compared to central arteries. As a result due to the pulse amplification, peripheral arteries do not give accurate results in cardiovascular studies and hence the arterial stiffness measured from peripheral arteries was not used as a surrogate for aortic and carotid stiffness (Stephane Laurent et al., 2006). Despite the limitations Japanese have demonstrated that the arterial stiffness measured using brachial ankle pulse wave technique (baPWV) is positively correlated to the gold standard carotid femoral pulse wave (cfPWV) technique which is a significant step in cardiovascular studies using peripheral arteries. The studies using baPWV have demonstrated the ability of the arterial stiffness measured from brachial and ankle arteries in predicting cardiovascular events but still there is a need to establish this with longitudinal studies. There are very limited cardiovascular studies with radial artery; however, the pressure wave from radial artery is used to reconstruct the aortic pressure wave using transfer function and is used to estimate the aortic augmentation index and central systolic pressure. The results of the study conducted by Sandrine (Sandrine C. Millasseau, Patel, Redwood, Ritter, & Chowienczyk, 2003) confirm that the aortic augmentation index (AIx) measured from radial artery and the aortic AIx estimated from the radial artery using transfer function are linearly correlated and hence the aortic augmentation can be directly measured from radial artery without any transfer function. This is a very significant result but extensive studies need to be done to establish the significance of arterial stiffness measured from radial artery in assessing the

cardiovascular studies. In another independent study by Wu et al, the stiffness index - a measure of arterial stiffness - is linearly correlated with stiffness index measured from PPG (Photoplethysmography) and is associated with fasting plasma glucose highlighting its significance in radial artery based studies (H. T. Wu et al., 2011). The studies have shown that arterial stiffness is closely associated to diabetes and obesity which are considered as cardiovascular risk factors but warrants extensive studies to establish the association.

1.3 NEED OF THE STUDY

Āyurveda has very strong roots in pulse based diagnosis but it is subjective in nature and depends on the skill of the physician. It lacks scientific evidence which is the need of the day as evidence based research is gaining importance in accepting any medicine or system of medicine (Hankey, 2010; Rastogi, 2010). To strengthen research in *Āyurveda ,* there is a need for assessing the pulse parameters similar to any other clinical parameter such as blood pressure, fasting blood sugar etc. which requires a framework for evidence based research to study the pulse parameters in the context of *Āyurveda*. This necessitates the need for a very precise pulse acquisition system which captures the pulse at *vāta, pitta and kapha* locations and secondly, there is a need to identify the pulse parameters which represent the pulse with appropriate physiological basis and good literature support. With the advancement of sensor technology pulse vibrations can be acquired very precisely using instruments such as *Nāḍī Taraṅgiṇi* and the pulse parameters such as pulse wave velocity and arterial stiffnes which are extensively studied in modern medicine can be considered for the study. The classical texts of *Āyurveda* and recent

studies in modern medicine have established the significance of arterial stiffness in disease diagnosis and prognosis. As the evidence based research is gaining importance there is a need to study the significance of arterial stiffness in *Tridoṣa* analysis.

1.4 SCOPE OF THE RESEARCH

The scope of this research is to study the significance of arterial stiffness measured from radial artery in *Tridoṣa* analysis as defined in classical *Āyurveda* texts and investigate the association of arterial stiffness with diabetes and obesity. *Nāḍī Taraṅgiṇi*, a non-invasive pulse acquisition system, is considered for the study which acquires the pulse from *Tridoṣa* locations at the wrist (A. Joshi, Kulkarni, Chandran, Jayaraman, & Kulkarni, 2007).